BRIMS
TIDAL ARRAY

openhydro
a DCNS company

sse

Environmental Statement

Volume 2-B

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Acronyms

AA	Appropriate Assessment
AC	Alternating Current
ADBA	Archaeological desk-based assessment
ADCP	Acoustic Doppler Current Profiler
AfL	Agreement for Lease
AIF	Anticipated Impact Footprint
AIS	Automatic Identification System
AoS	Area of Search
ASCOBANS	Agreement on Conservation of Small Cetaceans of the Baltic and North Seas
ATBA	Area to be Avoided
B.P.	Before Present
BATNEEC	Best Available Technology Not Entailing Excessive Costs
BDMPS	Biologically Defined Minimum Population Size
BOCC	Birds of Conservation Concern
BPI	Burial Protection Index
BTAL	Brims Tidal Array Limited
BTO	British Trust for Ornithology
CAP	Common Agricultural Policy
CCGT	Combine Cycle Gas Turbine
CD	Chart Datum
CEMD	Construction Environmental Management Document
CfD	Contract for Difference
CHTDL	Cantick Head Tidal Development Limited
CIA	Cumulative Impact Assessment
CIRIA	Construction Industry Research and Information Association
CITES	Convention on International Trade in Endangered Species
CO_2	Carbon Dioxide

COWRIE	Collaborative Offshore Wind Research into the Environment
CPA	Coastal Protection Act
CRM	Collision Rate Model
CWMTA	Cape Wrath Military Training Area
DBA	Desk-based Assessment
DECC	Department of Energy and Climate Change
DfT	Department for Transport
DIO	Defence Infrastructure Organisation
DP	Dynamic Positioning
DP (vessel)	Dynamic Positioning (vessel)
DTI	Department of Trade and Industry
EC	European Commission
ECoW	Ecological Clerk of Works
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EGA	Expert Geomorphological Assessment
EIA	Environmental Impact Assessment
EMD	Environmental Management Document
EMEC	European Marine Energy Centre
EMF	Electro-Magnetic Field
EMMP	Environmental Mitigation Monitoring Plan
EMR	Electricity Market Reform
EPS	European Protected Species
ERCoP	Emergency Response Cooperation Plan
ERM	Encounter Rate Model
ES	Environmental Statement
ESAS	European Seabirds at Sea
ETA	Engineering Technology Applications Limited

ETI	Energy Technologies Institute
ETV	Emergency Towing Vehicle
EU	European Union
FAD	Fish Aggregation Device
FAO	Food and Agricultural Organisation
FCS	Favourable Conservation Status
FEPA	Food and Environment Protection Act
FRS	Fisheries Research Services
FSA	Formal Safety Assessment
GBS	Gravity Base Structure
GCR	Geological Conservation Review
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GVA	Gross Value Added
GW	Gigawatt (power)
GWDTE	Ground Water Dependent Terrestrial Ecosystem
HAT	Horizontal Axis Turbine
HDD	Horizontal Directional Drilling
HIE	Highlands and Islands Enterprise
HRA	Habitats Regulations Appraisal
HSE	Health and Safety Executive
HVAC	High Voltage Alternating Current
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for Exploration of the Sea
ICIT	International Centre for Island Technologies
IEEM	Institute of Ecology and Environment Management
IHO	International Hydrographic Organisation

IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
IROPI	Imperative Reasons of Overriding Public Interest
IUCN	International Union for Conservation of Nature
IWC	International Whaling Convention
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LBAP	Local Biodiversity Action Plan
LCCA	Local Coastal Character Areas
LNCS	Local Nature Conservation Site
LSE	Likely Significant Effect
MAIB	Marine Accident Investigation Branch
MBES	Multibeam Echo-Sounder
MCA	Maritime and Coastguard Agency
MCAA	Marine and Coastal Access Act
MCZ	Marine Conservation Zone
MDA	Military Danger Area
MEG	Marine Energy Group
MEHRA	Marine Environmental High Risk Area
MESH	Mapping European Seabed Habitats
MGN	Marine Guidance Notice
MHWS	Mean High Water Springs
MLWS	Mean Low Water Spring
MMEA	Marine Modelling Enabling Action
MMFR	Mean Maximum Foraging Range
MMMP	Marine Mammals Management Plan
MNCR	Marine Nature Conservation Review
MoD	Ministry of Defence

MPAs	Marine Protected Areas
MRESF	Marine Renewable Energy Strategic Framework
MS	Marine Scotland
MSI	Maritime Safety Information
MSL	Mean Sea Level
MS-LOT	Marine Scotland Licensing Operations Team
MU	Management Units
MW	Megawatt (power)
NBN	National Biodiversity Network
NCI	Nature Conservation Importance
NCMPA	Nature Conservation Marine Protected Area
NGET	National Grid Electricity Transmission
NLB	Northern Lighthouse Board
NMR	National Monuments Records
NPF	National Planning Framework
NPPG	National Planning Policy Guidance
NPS	National Policy Statement
NRA	Navigational Risk Assessment
NREAP	National Renewable Energy Action Plan
NSA	National Scenic Area
NSIP	National Significant Infrastructure Projects
NSP	Noise Sensitive Property
NTU	Normal Turbidity Unit
OBRC	Orkney Biodiversity Records Centre
OCT	Open Cut Trench
ODBOA	Orkney Dive Boat Owners Association
OFA	Orkney Fisheries Association
OFS	Orkney Fisherman’s Society

OIC	Orkney Islands Council
ORCA	Orkney Research Centre for Archaeology
OREI	Offshore Renewable Energy Installations
OS	Ordnance Survey
OSF	Orkney Sustainable Fisheries
PAC	Pre Application Consultation
PAM	Passive Acoustic Monitoring
PAT	Pop-up Archival Tags
PBD	Project Briefing Document
PBR	Potential Biological Removal
PEMP	Project Environmental Management Plan
PFOW	Pentland Firth and Orkney Waters
PHA	Preliminary Hazard Analysis
RAF	Royal Air Force
RCAHMS	Royal Commission on the Ancient and Historical Monuments of Scotland
REE	Roving Eye Enterprises
REZ	Renewable Energy Zone
RIB	Rigid Inflatable Boat
RLG	Regional Locational Guidance
RNLI	Royal National Lifeboat Institution
ROV	Remotely Operated Vehicle
RSPB	Royal Society for the Protection of Birds
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SAMS	Scottish Association of Marine Science
SAR	Search and Rescue
SCADA	Supervisory Control And Data Acquisition
SEA	Strategic Environmental Assessment

SEPA	Scottish Environment Protection Agency
SFF	Scottish Fishermen's Federation
SHEPD	Scottish Hydro Electric Power Distribution
SHE-T	Scottish Hydro Electric Transmission PLC
SLVIA	Seascape, Landscape and Visual Impact Assessment
SMRU	Sea Mammal Research Unit
SMS	Safety Management System
SNH	Scottish Natural Heritage
SOPEP	Shipboard Oil Pollution Emergency Plans
SPA	Special Protection Area
SPFA	Scottish Pelagic Fisherman's Association
SPP	Scottish Planning Policy
SSB	Subsea Base
SSC	Suspended Sediment Concentrations
SSSI	Sites of Special Scientific Interest
STW	Scottish Territorial Waters
T	Tonnes
TCE	The Crown Estate
TEC	Tidal Energy Converters
THC	The Highland Council
TSS	Turbine Support Structure
TWh	Terawatt Hour
UFEN	UK Fisheries Economics Network
UKBAP	UK Biodiversity Action Plan
UNCLOS	United Nations Convention of the Law of the Sea
VMP	Vessel Management Plan
VMS	Vessel Monitoring System
VTS	Vessel Traffic Service

WANE	Wildlife and Natural Environment Licences
WCA	Wildlife and Countryside Act
WDC	Whale and Dolphin Conservation
WHS	World Heritage Site
ZTV	Zone of Theoretical Visibility

Coastal and Terrestrial Ecology

Chapter 10

10 COASTAL AND TERRESTRIAL ECOLOGY

10.1 INTRODUCTION

This chapter of the Environmental Statement (ES) considers the potential effects of the proposed Brims Tidal Array Project (the Project) on the coastal and onshore environment including intertidal habitats, terrestrial habitats, protected fauna and terrestrial birds. This assessment covers the potential impacts associated with the cable landfall construction, operation and decommissioning on the coastal and onshore environment up to and above Mean High Water Spring (MHWS).

All other impacts associated with the cable landfall and substation installation activities including onshore access, equipment laydown, working areas and construction compounds and all other onshore infrastructure will be assessed as part of a separate ES and planning application (see Chapter 21 Overview of Onshore Impacts).

This chapter is supported by ecological surveys conducted by Royal Haskoning and Aquatera, and a desk-based report on wintering barnacle geese (see Section 10.5). Related chapters include Chapter 11 Benthic Ecology, which addresses offshore habitats, and Chapter 14 Ornithology, which covers marine bird interests.

10.2 STUDY AREA

The geographical focus of this assessment includes the onshore Areas of Search for export cable corridor up to MHWS and the terrestrial habitats immediately adjacent that could potentially be affected by the cable landfall installation activities. The study area includes the following three cable landfall areas of search: Sheep Skerry, Moodies Eddy and Aith Hope (see Figure 10.1).

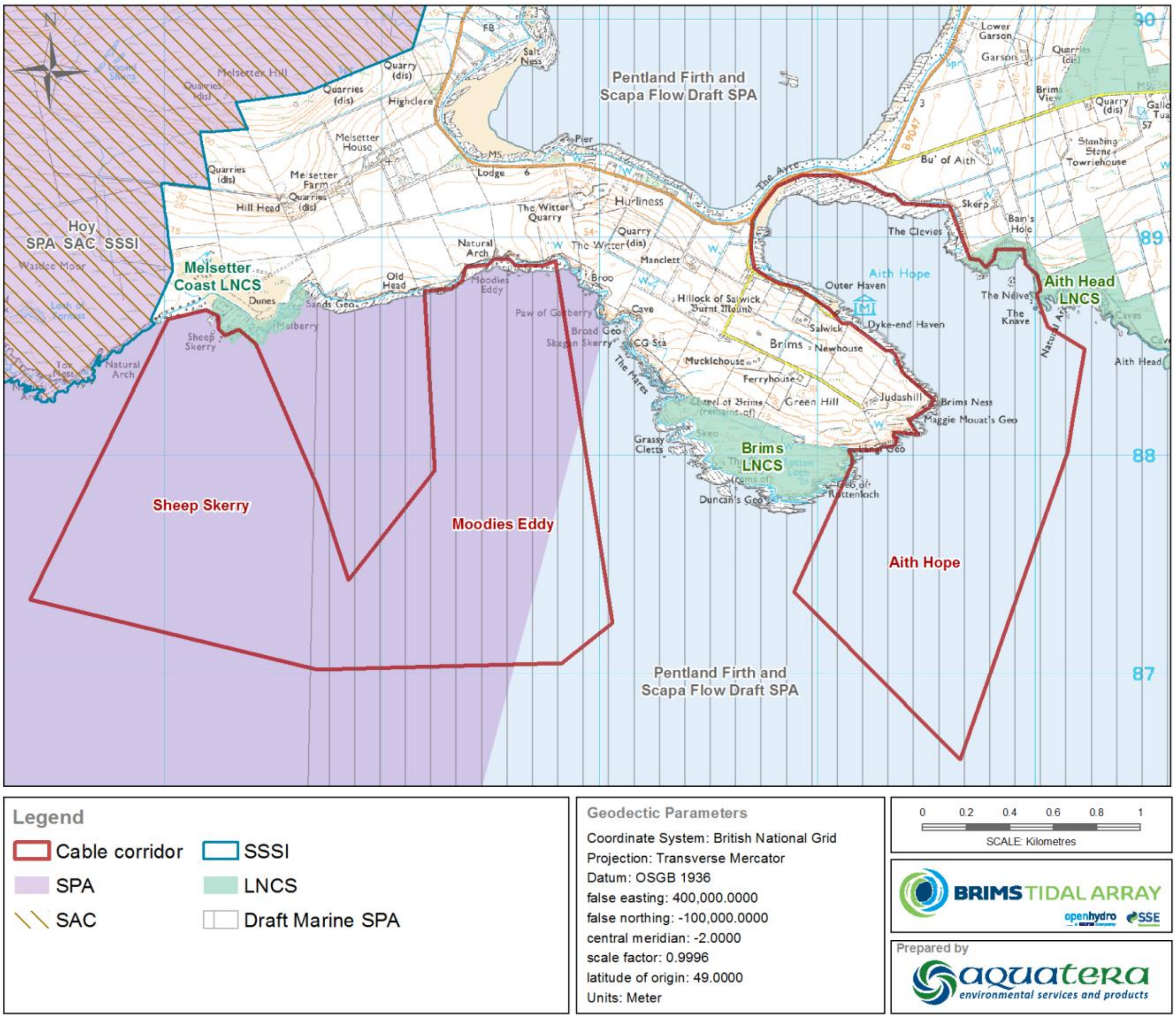

Figure 10.1: Study area for coastal ecology showing designated sites

10.3 DESIGN ENVELOPE CONSIDERATIONS

The Project has taken a design envelope approach. The basis of the design envelope is to apply a “worst case” approach to the assessment of the different impacts associated with the Project. With this in mind the maximum “worst case” project parameters considered for the assessment of coastal and terrestrial ecology are presented in Table 10.1. The Project is considering three different potential landfalls as described above. Each of these landfalls is assessed separately, in line with this approach.

Table 10.1: Design envelope parameters for assessment of coastal and terrestrial ecology

Project parameters relevant to the assessment	Maximum Project parameters for the impact assessment	Explanation of maximum Project parameters
Location of cable landfall	Sheep Skerry Moodies Eddy Aith Hope	Three separate landfalls are being considered and each is assessed separately.
Method to be used to bring cables ashore at landfall	Open Cut Trench or Horizontal Directional Drill (HDD)	Assume land-based long HDD would have greatest capacity for potential disturbance to breeding/wintering birds in fields. Long HDD would avoid impacts on intertidal species. Open cut trenching would have greatest capacity for potential disturbance to cliff-nesting bird species. Open cut trench and short HDD would affect intertidal habitats.
Width of cable corridor at landfall	Stage 1: maximum 20m (maximum affected area for 4 cables) Stage 2: maximum 85m (maximum affected area for 16 cables)	Stage 1: 5m per cable for 4 cables Stage 2: 5m per cable for 16 cables
Duration of works	Stage 1: 4 cables in 2019/2020 Stage 2: 12 cables in 2021/2022 Two cables laid per installation operation	Assume construction activities occur throughout the year.

10.4 LEGISLATIVE FRAMEWORK AND POLICY CONTEXT

The following legislation relevant to the assessment of coastal and terrestrial ecology has been considered in this assessment:

The Habitats Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora) - promotes the maintenance of biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species listed on the Annexes to the Directive at a favourable conservation status, introducing robust protection for those habitats and species of European importance. Member states are required to contribute to a coherent European ecological network of protected sites by designating Special Areas of Conservation (SACs) for habitats listed on Annex I and for species listed on Annex II;

The Birds Directive (The Council Directive on the Conservation of Wild Birds (2009/147/EC)) – provides measures for the identification and classification of Special Protection Areas (SPAs) for rare or vulnerable species listed in Annex I of the Directive, as well as for all regularly occurring migratory species;

The Habitats Regulations (Conservation (Natural Habitats, &c) Regulations 1994 (as amended)) form the implementation of the Habitats and Birds Directives in terrestrial areas and in territorial waters out to 12 nautical miles. The Habitats Regulations also underpin the protection afforded to European Protected Species (EPS), i.e. those species listed in Annex IV of the Habitats Directive whose natural range includes Great Britain, including otter. Under these regulations, otters and otter shelters are legally protected whether or not an otter is present;

The Wildlife and Countryside Act 1981 (as amended) - The Act makes it an offence (with exception to species listed in Schedule 2) to intentionally: kill, injure, or take any wild bird, take, damage or destroy the nest of any wild bird while that nest is in use or being built or take or destroy an egg of any wild bird. The Act also makes it an offence (subject to exceptions) to intentionally or recklessly kill, injure or take any wild animal listed on Schedule 5, and prohibits interference with places used for shelter or protection, or intentionally disturbing animals occupying such places. The Act also prohibits certain methods of killing, injuring, or taking wild animals;

UK Biodiversity Action Plan - The UK BAP defines a number of priority species and habitats that have been identified as being the most threatened and in need of conservation action at a national level using the application of criteria based on international importance, rapid decline and high risk (Biodiversity Reporting and Information Group, 2007);

The Scottish Biodiversity List (Biodiversity Scotland, 2013) - a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland; and

Orkney Local Biodiversity Action Plan (LBAP) 2013 – 2016 – this plan is the means by which the UK BAP and the Scottish Biodiversity Strategy are implemented at the local level. Targets set nationally for species and habitats of conservation concern are translated into actions which are achievable in a local context. This plan also provides a focus for the conservation of locally valued species and habitats.

10.5 SUPPORTING SURVEYS AND STUDIES

Coastal ecology desk studies undertaken to date include:

- A review of designated sites within 5km of the Project study area, including statutory sites obtained from Scottish Natural Heritage (SNH)'s Sitelink (gateway.snh.gov.uk/sitelink) website;
- Review of information on non-statutory, locally designated sites within 1km of the proposed Project site, obtained from the OIC website (www.orkney.gov.uk);
- A biological records search using information from National Biodiversity Network (NBN) (http://www.nbn.org.uk/);
- A specially commissioned biological records search undertaken by the Orkney Biodiversity Records Centre (OBRC) in 2012; and
- A desk-based assessment of the use of fields by wintering Greenland barnacle geese in South Walls (14b).

The following field studies undertaken to date for Sheep Skerry, Moodies Eddy and Aith Hope.

10.5.1 Sheep Skerry

- Phase 1 habitat survey and otter survey conducted by Aquatera on 25 June 2015 (Supporting Document: Crossley, 2015);
- Phase 1 Intertidal habitat survey conducted by Aquatera on 19 June 2015 (Supporting Document: Aquatera, 2015a); and
- Breeding bird surveys and shoreline survey undertaken by Aquatera; two visits: 23 June and 6 July 2015 (Supporting Document: Aquatera, 2015d).

10.5.2 Moodies Eddy and Aith Hope

- Extended Phase 1 habitat survey conducted by Royal Haskoning, 21-25 August 2012 (Supporting Document: RHDHV, 2012);
- Intertidal survey conducted by Royal Haskoning, 21-23 August 2012 (Supporting Document: RHDHV, 2014a);
- Otter survey conducted by Royal Haskoning, 21-24 August 2012 (Supporting Document: RHDHV, 2014b); and,
- Breeding bird surveys (three visits between 24 May and 5 July 2012) and Shoreline surveys (Moodies Eddy was surveyed on 25 May 2012 and Aith Hope was surveyed on the 29 May 2012) undertaken by Aquatera (Supporting Document: Aquatera, 2012a).

10.6 DATA GAPS AND UNCERTAINTIES

10.6.1 Sheep Skerry

The Brown and Shepherd (1993) method for surveying breeding waders requires a minimum of two visits, one early in the season (early April to mid-May) and the second, mid-May to late June. The O'Brien and Smith (1992) method requires three visits between 15 April and 19 June. Due to the timing at which the Sheep Skerry site first became an option as a possible cable landfall location, the early part of the breeding season had already passed. However due to the exceptionally wet and cold spring in 2015, it is likely that the cold weather delayed the onset of the breeding season for most species. The findings recorded during the two visits that were undertaken are considered sufficient to provide representative data on the number and distribution of the species breeding in the area taking into consideration the possibility that a few breeding attempts that had already fledged or failed may have been missed.

10.6.2 Moodies Eddy and Aith Hope

Access for the intertidal habitat survey at Moodies Eddy was restricted due to the presence of high, steep-sided cliffs which made some sections of the coastline inaccessible with no safe access to the shore. Where possible, these areas were surveyed from the cliff top where the biotopes were assigned based on what could be viewed through binoculars and experience from other parts of the nearby survey area.

It was not possible to survey Moodies Eddy or sections of Aith Hope cable landfall for otters due to the inaccessible nature of the shoreline (see Figure 1.1 in Supporting Document: RHDHV, 2014b). As rain had occurred overnight, it is also possible that some recent field signs of otter may have been washed away and thus some field signs went undetected. These limitations aside, the results of the field surveys are considered to allow a sufficient evaluation of potential constraints and the potential for negative impacts from the proposed Project.

10.7 CONSULTATIONS

A list of feedback from all consultees is summarised in Chapter 6 Consultation Process. The key points raised by stakeholders regarding coastal and terrestrial ecology are presented in Table 10.2.

Table 10.2: Key issues raised by stakeholder during consultation

Topic	Stakeholder	Comment	Response/Action taken	Section cross-reference
Scoping				
Wintering Greenland barnacle geese from Switha SPA	SNH	Wintering Greenland barnacle geese from Switha SPA use fields in South Walls. Given its location in respect to feeding and buffer zones for barnacle geese under the South Walls Goose Management Scheme, we consider that the south west section of South Walls (Aith Hope cable landfall) is less suitable for cable landfall. SNH hold data of recent goose counts in South Walls.	The most recent data on goose counts was requested from SNH. These data have been used in this assessment.	See Section 10.9.6.3
Disturbance to birds	SNH	Disturbance due to installation activities should be considered, as some activities may disturb birds.	Noted.	See Section 10.12.1.4
Mitigation	Orkney Islands Council (OIC)	It will be important to consider the timing of each stage of the Project in order to avoid disturbance to bird species during their breeding season.	Mitigation measures to avoid disturbance to breeding birds have been considered.	See Sections 10.11.2 and 10.12.1.4
Orkney LBAP	OIC	The most recent and up to date Orkney LBAP should be used. This is LBAP 2013-2016 and can be found at: http://www.orkney.gov.uk/Service-Directory/L/Local-Biodiversity-Plan.htm	This plan has been referred to and considered in this assessment.	See Section 10.9
Post-Scoping				
Mitigation for wintering Greenland barnacle geese from Switha SPA	SNH	The fields around Aithsdale are preferred traditional feeding grounds for barnacle geese. The works are likely to disturb barnacle geese feeding on nearby fields and our advice would be that construction activities should be timed to avoid the wintering season (October –April). The geese generally arrive about 16 October and leave around 16 April.	Mitigation measures to avoid disturbance to Greenland barnacle geese have been considered.	See Sections 10.11.2 and 10.12.1.5

10.8 ASSESSMENT METHODOLOGY

10.8.1 Assessment Criteria

The methodology used to assess the significance of potential effects on ecological receptors has considered guidelines produced by the Institute of Ecology and Environmental Management (IEEM, 2006; 2010). The appraisal of predicted effects on ecological receptors is based on both the value of a receptor and the nature and magnitude of the effect that the Project will have on it. This has been deduced through consultation with key stakeholders and professional judgement. Table 10.3 defines the sensitivity for the various environmental receptors considered in this chapter.

The IEEM guidance recommends that the predicted impacts on the receptors be described and quantified, giving consideration to the following parameters: confidence in predictions, positive or negative, extent, magnitude, duration, reversibility and timing and frequency. Professional judgement has been used to assign the impacts on the receptors to one of four levels of magnitude, defined in Table 10.4. Finally, Table 10.5 provides the overall classification scheme for impacts on ecology and nature conservation, considering the sensitivity of the receptor and the magnitude of the impact.

Table 10.3: Definitions for sensitivity of coastal and terrestrial ecology

Sensitivity of receptor	Criteria
High	A qualifying feature of an SAC, SPA or Ramsar site or notified feature of a SSSI A regularly occurring substantial population of an internationally important species (listed on Annex I of the Birds Directive or Annex II or IV of the Habitats Directive) The species/habitat affected has no or very limited capacity to avoid, adapt to, accommodate or recover from the impact.
Medium	A nationally important designated site e.g. MPA, SSSI, or a site considered worthy of such designation A viable area of a habitat type listed in Annex I of the Habitats Directive or of smaller areas of such habitat which are essential to maintain the viability of a larger whole A regularly occurring substantial population of a nationally important species, e.g. listed on Schedules 1, 5 and 8 of the Wildlife and Countryside Act (1981) (as amended), including species listed on UK BAP priority lists The species/habitat affected has a limited capacity to avoid, adapt to, accommodate or recover from the impact.
Low	Areas of internationally or nationally important habitats which are degraded but are considered readily restored A regularly occurring, regionally significant population of a species listed as being nationally scarce The species/habitat affected has some tolerance to avoid, adapt to, accommodate or recover from the impact.
Negligible	Areas of internationally or nationally important habitats which are degraded and have little or no potential for restoration A good example of a common or widespread habitat in the local area, e.g. those listed as broad habitats on the Local BAP Species of national or local importance, but which are only present very infrequently or in very low numbers within the subject area Areas of heavily modified or managed vegetation of low species diversity or low value as habitat to species of nature conservation interest; common and widespread species Species/habitats generally tolerant of the impact and can accommodate or recover from the impact.

Table 10.4: Definitions for magnitude of effect for coastal and terrestrial ecology

Magnitude of effect	Criteria
High	An irreversible (permanent) impact on a habitat, species assemblage/community, population or group from which recovery is not possible within a reasonable timescale Major loss or major alteration to key elements of the baseline (pre-development) conditions such that the post-development character/composition/attributes will be fundamentally changed
Medium	A reversible (temporary) impact on a habitat, species assemblage/community, population or group from which recovery is possible within a reasonable timescale Loss or alteration to one or more key elements/features of the baseline conditions such that post-development character/composition/attributes will be partially changed
Low	A reversible (temporary) impact on a habitat, species assemblage/community, population or group from which spontaneous recovery is possible or that is within the range of variation normally experienced between years Minor shift away from baseline conditions; change arising from the loss/alteration will be discernible but underlying character/composition/attributes of the baseline condition will be similar to the pre-development situation
Negligible	Very slight change to the baseline condition; change barely distinguishable, approximating the 'no change' situation A short-term but reversible effect on a habitat, species assemblage/community, population or group that is within the normal range of annual variation
Positive	The creation of new habitat or restoration of a degraded habitat

Table 10.5: Assignment of impact significance for coastal and terrestrial ecology based on sensitivity of receptor and magnitude of effect

Sensitivity of Receptor	Magnitude of effect			
	High	Medium	Low	Negligible
High	*MAJOR*	*MAJOR*	*MODERATE*	*MINOR*
Medium	*MAJOR*	*MODERATE*	*MINOR*	*MINOR*
Low	*MODERATE*	*MINOR*	*NEGLIGIBLE*	*NEGLIGIBLE*
Negligible	*MINOR*	*NEGLIGIBLE*	*NEGLIGIBLE*	*NEGLIGIBLE*

For the purposes of the EIA, any impacts classified as 'major' or 'moderate' are deemed to be significant.

10.9 BASELINE DESCRIPTION

10.9.1 Introduction

This section describes the ecology of each of the potential landfalls. The Sheep Skerry landfall area of search extends approximately 510m. The Moodies Eddy landfall area of search extends approximately 690m and the Aith Hope landfall area of search includes a much larger area, extending some 3,830m from Geo of Rottenloch on the Brims peninsula in the west to The Knave on South Walls in the east (see Figure 10.1).

10.9.2 Designated Sites

There are several sites designated for their nature conservation interests at European and national levels that could potentially be affected by the proposed Project (Table 10.6 and Figure 10.1). There are no Marine Protected Areas (MPAs), National Nature Reserves or Local Nature Reserves within the vicinity that could be affected by the proposed Project.

Local Nature Conservation Sites (LNCSs) are listed in the Orkney Local Development Plan which has been accepted by the Council and is currently awaiting the Scottish Government's examination process. LNCSs that could potentially be affected by proposed Project are shown in Figure 10.1 and listed in Table 10.7.

Designated sites relevant to each of the cable landfall options are described below.

10.9.2.1 Sheep Skerry

The Sheep Skerry potential landfall location is adjacent to the eastern edge of the Hoy SPA/SAC/SSSI designated for important habitats, geological features and populations of breeding birds (Table 10.6). The AoS for the export cable corridor partially overlaps with the marine component of Hoy SPA which supports populations of European importance of breeding seabirds. Sheep Skerry AoS also partially overlaps with Pentland Firth and Scapa Flow draft SPA which is an extensive marine area that supports populations of European importance of breeding and wintering season marine bird interests (Table 10.6). These sites are of relevance to the marine environment only therefore potential impacts are assessed in Chapter 14 Ornithology.

There are no LNCSs with habitat or wildlife interests near the Sheep Skerry landfall that could be affected by the cable landfall installation activities. Melsetter Coast LNCS is within the Sheep Skerry landfall however this site is listed for geological interests; therefore any potential impacts are assessed in Chapter 8 Geology and Hydrology.

10.9.2.2 Moodies Eddy

The AoS for the export cable corridor partially overlaps with the marine component of Hoy SPA which is designated for populations of European importance of breeding seabirds. The AoS for the export cable corridor also overlaps with Pentland Firth and Scapa Flow draft SPA which is of importance to breeding and wintering season marine bird interests (Table 10.6). These sites are of relevance to the marine environment only therefore potential impacts are assessed in Chapter 14 Ornithology. Hoy SAC/SSSI and the terrestrial component of Hoy SPA is 1,090m to the west.

There are no LNCSs near this landfall that could be affected by the cable landfall installation activities at Moodies Eddy.

10.9.2.3 Aith Hope

The AoS for the export cable corridor for Aith Hope landfall location is outside the marine component of Hoy SPA however lies partially within Pentland Firth and Scapa Flow draft SPA which is of importance to breeding and wintering season marine bird interests (Table 10.6). These sites are of relevance to the marine environment only therefore potential impacts are assessed in Chapter 14 Ornithology. Hoy SAC/SSSI and the terrestrial component of Hoy SPA is 1,680m to the west. The Aith Hope cable landfall location is adjacent to fields used by wintering Greenland barnacle geese *Branta leucopsis* from Switha SPA/SSSI; see Figure 10.15 and Supporting Document: Aquatera, 2012b.

Aith Hope AoS export cable corridor lies partially within Aith Head LNCS which is listed for important habitats, a hawkweed and breeding birds of prey. Aith Hope AoS export cable corridor is also adjacent to Brims LNCS which is listed for important habitats and breeding birds (Table 10.7).

Table 10.6: Statutory designated sites relevant to the coastal environment

Name	Qualifying interests/Notified features	Distance (km)		
European		Sheep Skerry	Moodies Eddy	Aith Hope
Hoy SAC	Alkaline fens, alpine and boreal heaths, blanket bogs*, calcareous rocky slopes with chasmophytic vegetation European dry heaths, natural dystrophic lakes and ponds Northern Atlantic wet heaths with *Erica tetralix*, petrifying springs with tufa formation (Cratoneurion)*, vegetated sea cliffs of the Atlantic and Baltic coasts *priority habitat	70m	1,090m	1,680m
Hoy SPA	Annex 1 species: red-throated diver *Gavia stellata*, breeding, peregrine *Falco peregrinus*, breeding Migratory: great skua *Stercorarius skua*, breeding, Atlantic puffin *Fratercula arctica*, breeding, Arctic skua *Stercorarius parasiticus*, breeding, black-legged kittiwake *Rissa tridactyla*, breeding, Northern fulmar *Fulmarus glacialis*, breeding, great black-backed gull *Larus marinus*, breeding, common guillemot *Uria aalge*, breeding	0m	0m	720m
Switha SPA	Non-breeding birds: Greenland barnacle goose *Branta leucopsis*	9,530m	8,110m	5,980m
Pentland Firth and Scapa Flow draft SPA[1]	Annex 1 species: Great northern diver *Gavia arctica*, red-throated diver *Gavia stellata*, black-throated diver *Gavia immer*, Slavonian grebe *Podiceps auritus*, Arctic tern *Sterna paradisaea* Migratory: European shag *Phalacrocorax aristotelis*, common guillemot *Uria aalge*, common eider *Somateria mollissima*, long-tailed duck *Clangula hyemalis*, common goldeneye *Bucephala clangula*, red-breasted merganser *Mergus serrator*	370m	0m	0m
National				
Hoy SSSI	Habitats: Bogs: Blanket bog, freshwater habitats: dystrophic loch, uplands: upland assemblage, woodland: upland oak woodland Birds: breeding bird assemblage, seabird colony breeding, Arctic skua, breeding, Northern fulmar, breeding, great black-backed gull, breeding, great skua, breeding, common guillemot, breeding, peregrine, breeding, red-throated diver, breeding	0m	1,060m	1,680m
Switha SSSI	Non-breeding birds: Greenland barnacle goose	9,530m	8,110m	5,980m

1 The current status of a draft SPA does not afford policy protection however the progression of the application to a proposed SPA may occur by the time of submission therefore is included for completeness

Table 10.7: Non-statutory designated sites

Name of site	Special features		Distance from cable landfall (m)
	Habitats	Wildlife	
Aith Head LNCS	Upland heath* Maritime heath Maritime cliff and slope* Maritime grassland	Breeding birds of prey* *Hieracium maritimum* (a hawkweed)	Partially within (Aith Hope AoS export cable corridor)
Brims LNCS	Lowland meadow* Maritime heath Lowland fens* Maritime cliff and slope* Maritime grassland	Curlew *Numenius arquata** Lapwing *Vanellus vanellus** Redshank *Tringa totanus* Common gull *Larus canus* Skylark *Alauda arvensis**	Adjacent to (Aith Hope AoS export cable corridor)

*nationally important habitats and species

10.9.3 Terrestrial Habitats

Phase 1 habitats recorded at Sheep Skerry have been mapped; see Annex 2a in Supporting Document: Crossley, 2015. The Extended Phase 1 habitat survey for Moodies Eddy and Aith Hope covered the accessible terrestrial habitats from Sands Geo near Melsetter in the west to between The Knave and Aith Head in the east: Phase 1 habitats have been mapped; see Figures A.1 and A.2 in Supporting Document: RHDHV, 2012. An overview of some of the coastline in this area is shown in Figure 10.2.

Figure 10.2: Coastline at Brims Ness viewed to the west of Duncan's Geo towards Moodies Eddy with Melsetter in the distance

Table 10.8 provides a summary of the adjacent terrestrial habitats found at the potential cable landfall sites during the Phase 1 habitat surveys along with information concerning their importance with regard to national and local biodiversity lists (UK Biodiversity Action Plan (UK BAP) and Orkney LBAP).

10.9.3.1 Sheep Skerry

The area of sand dunes at Sheep Skerry is categorised as 'Open dune' and 'Dune grassland' which form the 'Fixed dunes with herbaceous vegetation' habitat listed in Annex I of the EC Habitats Directive and the 'Coastal Sand Dune' habitat which is a UK BAP and Orkney LBAP priority habitat. Most of the sand dunes are a worked-out sand quarry however there is a remnant of semi-natural habitat in the form of a narrow band of fixed open dune along much of the seaward edge, although this is badly eroded in places. The steep banks named Melberry are in a more favourable condition than the rest of this habitat at this site. The dune grassland is mostly semi-improved, retaining some of the quality of typical dune grassland with abundant red fescue *Festuca rubra* but with only occasional presence of characteristic species such as lady's-bedstraw *Galium vernum*; it is generally species-poor and includes improved grassland species such as ryegrass *Lolium perenne*, meadow-grass *Poa spp*. and weeds. Given that this area is worked for constructional sand, and is not specifically mentioned in the Orkney LBAP, it is not considered to be a highly valued example of this type of habitat in Orkney.

The western end of the site is peatland (wet dwarf shrub heath) and blanket bog which is heavily grazed but is not otherwise modified or damaged. For a short distance along the western shore there is a 3m-wide strip of coastal grassland with spring squill *Scilla verna* and sea plantain *Plantago maritima* which has been grazed short but is in favourable condition. These three habitat types are listed in Annex I, UK BAP and the Orkney LBAP however they are small fragments of habitats of which there are extensive areas, in more favourable condition elsewhere in Hoy and Orkney. An acid/neutral flush (a UK BAP priority habitat) is present in the wet dwarf shrub heath. This is considered a minor feature on the site.

Other Annex I/UK BAP/Orkney LBAP habitats present at the site include dune slack of which there are two small patches in hollows in the sand substrate which have some of the character of dune slack, with sedges *Carex spp.* and northern marsh orchids *Dactylorhiza purpurella* however these areas show signs of eutrophication which is apparent in the lush growth of competitive plants including marsh horsetail *Equisetum palustre* and watercress *Nasturtium officinale*. Water draining from the central dune slack issues onto the sand beach via a break in the dune ridge; this running water is listed as priority habitat in the Orkney LBAP. A notable species, whorl-grass *Catabrosa aquatica* was recorded growing at the mouth of the burn where it emerges onto the sandy beach. This species is listed as 'Locally scarce' with less than 11 recorded sites in Orkney, but has no higher conservation designation.

Towards the western end of the site there is a 200m section of the shore with boulders up to 1m in diameter that have been cast above HWM. This habitat is also listed in the Orkney LBAP.

10.9.3.2 Moodies Eddy

The Moodies Eddy landfall is adjacent to improved grassland fields[2]; see Figure A.1 in Supporting Document: RHDHV, 2012. No notable species were found in this area.

10.9.3.3 Aith Hope

The Aith Hope potential landfall area extends from Geo of Rottenloch in the west to The Knave in the east. Aith Hope is a narrow isthmus connecting Hoy to South Walls with a road separating Aith Hope from North Bay. A small linear stretch of strandline vegetation runs from east to west along the north and south of the Ayre (and adjacent to the causeway; see Figure 10.3 and Figure 10.4). The substrate consists of pebbles and sand. Typical species included lyme grass *Leymus arenarius*, false-oat grass *Arrhenatherum elatius*, curled dock *Rumex crispus* and broad-leaved dock, hawksbeard *Hieracium sp*, orache *Atriplex prostrate agg*, mayweed *Tripleurospermum sp*. and sea plantain. This habitat is considered to fall within the description for Vegetated Shingle, a UK BAP priority habitat, and also a priority habitat in the Orkney LBAP. It is not known what species of hawksbeard *Hieracium* spp*.* was encountered during the survey; however it should be noted that *Hieracium orcadense* or hawkweed is a priority species in the Orkney LBAP (although not listed in the UK BAP or Scottish Biodiversity List).

2 Coded as Arable fields on map, but Target Note states as improved grassland in the process of being cut for silage.

Figure 10.3: Vegetated shingle habitat at Aith Hope

Figure 10.4: Vegetated shingle habitat at Aith Hope

This isthmus is adjacent to a patch of marshy grassland lying to the east that is characterised by a high proportion of swamp vegetation including yellow-flag iris *pseudocorus*, common reed *Phragmites communis*, reed canary-grass *Phalaris arundinacea* and false-oat grass.

At the south eastern tip of the Brims Ness peninsula, there is a patch of neutral grassland/semi-improved along the cliffs at the entrance to the bay. This habitat is associated with the lowland meadows UK BAP habitat. However, it is unlikely that there will be a landfall along the cliffs at this location.

Other UK BAP priority habitats can be found in small patches between the Geo of Rottenloch and Langi Geo in the west (Wet heathland acid grassland) and between The Clevies and The Knave in the east (Coastal dry heath) which is within Aith Head LNCS.

In addition, arable field margins are a UK BAP habitat; however they are not a priority habitat in the Orkney LBAP. However, the margins of these fields, which are separated by fences, are not managed for wildlife habitat.

Table 10.8: Summary of terrestrial habitats within the potential landfall options

Phase 1 classification (JNCC, 2010)	EC Habitats Directive UK Interest features (Jackson & MacLeod, 2000)	UK BAP Priority Habitat (Brig, 2007)	Orkney LBAP Priority Habitat
Sheep Skerry (west to east)			
Coastal grassland	Vegetated sea cliffs of the Atlantic and Baltic coasts	Maritime cliff and slope	Yes
Wet dwarf shrub heath	Northern Atlantic wet heaths with Erica tetralix	Upland heathland	Yes
Blanket bog	Blanket bogs	Blanket bog	Yes
Boulders/rocks above high water mark	N/A	N/A	Storm beach
Marshy/marshy grassland	N/A	N/A	Wet meadow

Phase 1 classification (JNCC, 2010)	EC Habitats Directive UK Interest features (Jackson & MacLeod, 2000)	UK BAP Priority Habitat (Brig, 2007)	Orkney LBAP Priority Habitat
Acid/neutral flush	N/A	Upland flushes, fens and swamps	Yes
Semi-improved acid grassland	N/A	N/A	No
Running water	N/A	N/A	Burns and canalised burns
Dune grassland	Fixed dunes with herbaceous vegetation	Coastal sand dunes	Yes
Open dune			
Dune Slack	Humid dune slacks	Coastal sand dunes	Yes
Moodies Eddy			
Improved grassland	N/A	N/A	No
Aith Hope (west to east)			
Improved grassland	N/A	N/A	No
Wet heathland/acid grassland	N/A	Lowland heathland	No
Neutral grassland – semi-improved	N/A	Lowland meadows	No
Arable fields	N/A	Arable field margins	No
Poor semi-improved grassland	N/A	N/A	No
Improved grassland	N/A	N/A	No
Strandline vegetation	N/A	Vegetated shingle	Yes
Marshy grassland	N/A	N/A	No
Improved grassland	N/A	N/A	No
Dry dwarf shrub heath – acid	European dry heath	Coastal dry heath	No
Poor semi-improved grassland	N/A	N/A	No

10.9.4 Intertidal Habitats

The intertidal zone within the study area is composed of a number of different substrates, ranging from solid bedrock in the more exposed locations, through to cobbles and sand in the more sheltered environments of Aith Hope. This variety of habitats supports a number of biotopes, some of which support very few species (for example, barren shingle and sand), while others (for example, bedrock and boulder biotopes) support a large number of species. Table 10.9 provides a summary of the intertidal habitats of conservation importance found at the potential landfall locations during the dedicated surveys. A full description of all of the habitats and species recorded is presented in the Survey Reports (see (Supporting Document: RHDHV, 2014a) and (Supporting Document: Aquatera, 2015a)).

10.9.4.1 Sheep Skerry

The area surveyed for the Sheep Skerry AoS cable corridor extended from Tor Ness in the west to Sands Geo in the east. The coastline at Sheep Skerry is backed by dunes with small cliffs rising from the high splash zone further to the east and west (Figure 10.5). To the west of the beach at Sheep Skerry, the beach is characterised by large boulders showing typical zonation as you move from high to low water (Figure 10.6). The upper shore here is characterised by lichens moving into green seaweeds and then fucoids, primarily spiral wrack *Fucus spiralis*, before reaching the kelp zone, dominated by kelps and thong weed *Himanthalia elongata*, at low water.

The beach at Sheep Skerry is backed by high dunes, with a freshwater source emanating at the foot of the dunes. The upper shore is fairly barren with the only observed fauna being sandhoppers *Amphipoda spp*. Lower down the shore occasional boulders are found partially covered by sand providing a habitat for sand scoured red seaweeds. Evidence of lugworms *Arenicola marina* is also found on the lower shore.

Figure 10.5: Sheep Skerry (facing east)

Figure 10.6: Boulder beach

To the east of this beach the shore again becomes rock, but this time is characterised by ledges rather than boulders. Again evidence of classical zonation can be found, with a wide *Verrucaria spp.* zone found in the splash zone followed by barnacle *Semibalanis balanoides* covered rocks with occasional limpets *Patella vulgata*. In areas channel wrack *Pelvetia canaliculata* is also observed at the upper end of the mid-shore. Below the mid-shore similar species are evident again to the boulder shore to the west with fucoids and kelps dominating. The structure of the ledges provides habitats for beadlet anemones *Actinia equina* in crevices and shallow rockpools. Sections of the ledges are also covered with shallow rockpools dominated by green seaweeds and large wide gullies further down the shore retain water at low tide creating permanent kelp dominated rock pools. To the east of the rocky ledges is another sandy beach at Sands Geo. Here there appears to be less infauna possibly due a black anoxic layer close to the surface.

The dog whelk *Nucella lapillus* was the only species of importance found in the study area, observed in the barnacle zone on the rocky ledges between the two beaches. The dog whelk is an OSPAR[3] species, but is common throughout the UK and is not protected under any other legislation.

Five biotopes were recorded that are listed under EC Habitats Directive as they may form part of an Annex I habitat (see Table 10.9). Two of these, LR.MLR.BF.Fser.Bo and LR.FLR.Rkp.G are also UK BAP habitats (Figure 10.7). However, all of these habitats are widespread or common around the UK coasts and are not thought to be of particular conservation importance in the area.

3 On a list of threatened and/or declining species and habitats in the north-east Atlantic, created under the OSPAR Convention for the protection of the marine environment of the north-east Atlantic.

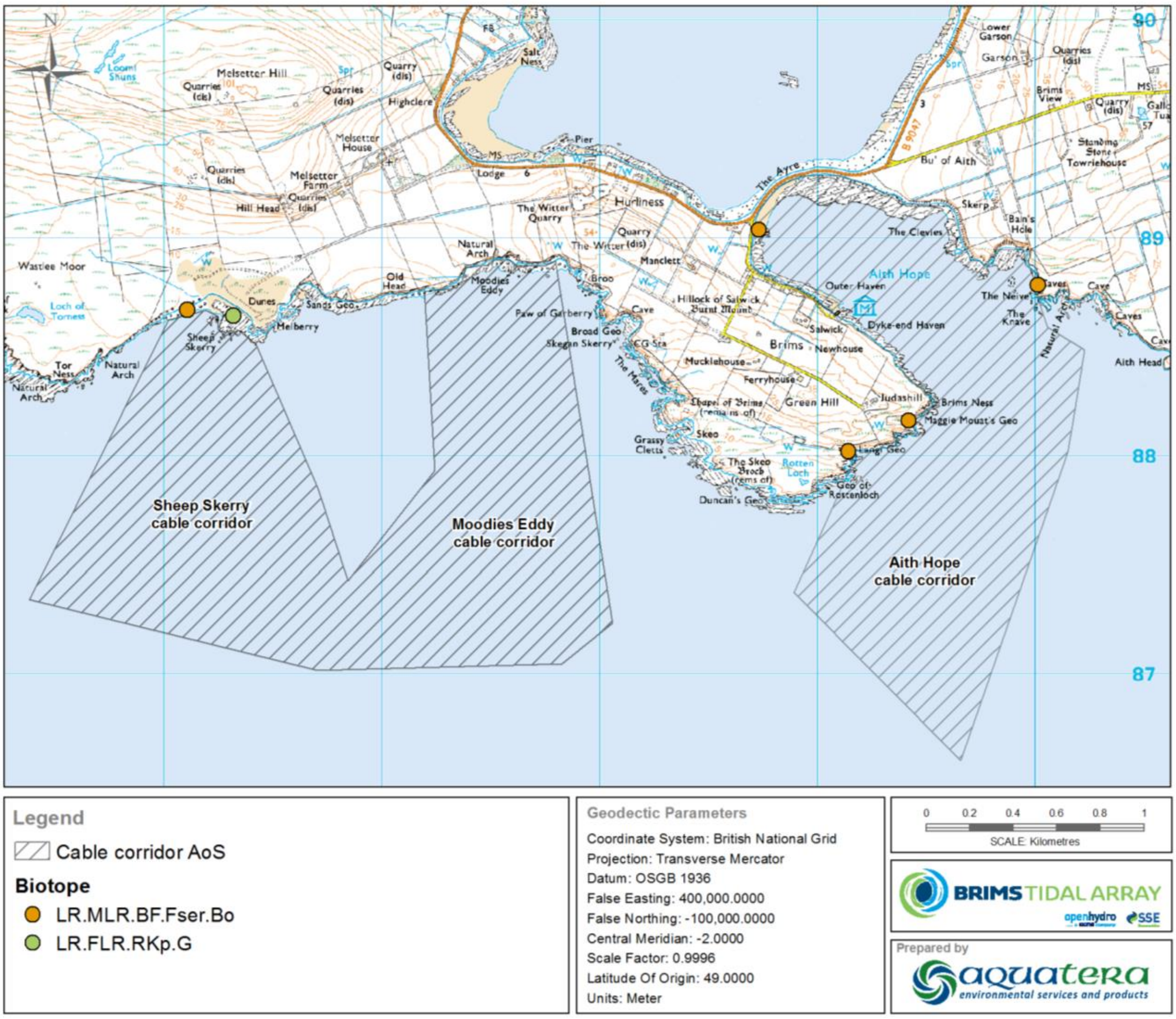

Figure 10.7 UK BAP habitats recorded within the potential cable landfall Areas of Search during the intertidal surveys

10.9.4.2 Moodies Eddy and Long Geo

Moodies Eddy is a wide open bay with an intertidal area extending some 20m (Figure 10.8). Although access to the intertidal area was not possible during the survey due to the presence of cliffs, habitats were observed through binoculars. The substrate consists of a mixture of bedrock and boulder. A wide *Verrucaria spp.* zone in the upper shore leads to a narrow and broken bank of spiral wrack. The mid shore is dominated by barnacles and few other species, gutweed *Ulva intestinalis* was present on the sheltered side of boulders but a lot of bare rock was present. The low shore appears to support dabberlocks *Alaria esculenta* and thong weed *Himanthalia elongata*, however this was difficult to confirm from distance.

In the middle of Moodies Eddy, Long Geo cuts back further inland (Figure 10.9). This is a long narrow boulder-filled geo and although the view was obstructed, it was thought that the intertidal area does not extend far into the geo.

There were no habitats of conservation importance identified at this landfall area of search.

Figure 10.8: Moodies Eddy viewed from the west

Figure 10.9: View down Long Geo

10.9.4.3 Aith Hope

The south eastern coast of the Brims peninsula was characterised by exposed bedrock, much of it vertical or close to in nature. Here the barnacles *Semibalanus balanoides* and *Chthamalus montagui* dominated with the only seaweed present in the upper and mid-shore being stunted channel wrack *Pelvetia canaliculata*. In the very low shore dabberlocks *Alaria esculenta* and oarweed *Laminaria digitata* were present. These biotopes persisted in an easterly direction until Brims Ness.

The south western side of Aith Hope from approximately 200m north west of Brims Ness to Aith View was more homogenous than the more exposed coastline to the west. The zonation in this section of the shore was very clear with five biotopes present running along the shore in consecutive bands (see Figure 3.5 in Supporting Document: RHDHV, 2014a).

There were a few exceptions to the general pattern of biotopes recorded, and these occurred where small embayments broke the uniform nature of the surrounding area. These small bays were characterised by a low number of species and different biotopes and supported the following “Littoral mixed sediment” LS.LMx, “High energy littoral rock” LR.HLR and “Barren littoral coarse sand” LS.LSa.MoSa.BarSa consecutively.

There are a number of different sediment type biotopes at the apex of Aith Hope (Figure 10.10). The upper shore is approximately 8m wide and substrate is dominated by sand and mixed sediment biotopes; there is a very scattered strandline across much of the upper shore but no obvious mega flora or fauna growing (Figure 10.11). Below this is a 15m wide sandy zone, with deep sand. This is bare of fauna and flora apart from scattered strand. The substrate on the lower shore consists of small boulders and cobbles in a sandy matrix; toothed wrack and gutweed *Ulva intestinalis* cling to boulders. Between the boulders is a mass of brown filamentous algae, which is not attached. Within the kelp zone, small stunted dabberlocks and sea lace *Chorda filum* are also present on cobbles and boulders. The sandy substrate continues seaward as far as visible.

Figure 10.10: View down the shore from apex of Aith Hope

Figure 10.11: Sand-dominated biotopes in the upper shore of the apex of Aith Hope

Further to the east, rock slabs and ledges supported a more diverse range of biotopes; here the intertidal area covers a much larger area than in any other part of the survey area. The fucoid zone is extensive, and unlike that recorded on the western side of Aith Hope, the zonation is less clear. However, barren sediment dominated biotopes were still recorded in the very upper shore such as “shingle (pebble) and gravel shores” LS.LCS.Sh.

Few species of conservation importance were identified within the intertidal study area (Table 10.9). The dog whelk *Nucella lapillus*, an OSPAR[4] species, was found throughout the survey area. Dog whelk is a common species in the UK and is not protected under any other legislation.

Two UK BAP habitats were identified; the biotope LR.FLR.Rkp.G was recorded to the west of Geo of Rottenloch, and therefore falls just outside of the study area. The biotope LR.MLR.BF.Fser.Bo was found at four locations, near Langi Geo, at Maggie Mouat’s Geo, on the western extent of The Ayre, and at the Neive on the eastern side of Aith Hope (see Figure 10.7). Although these biotopes can form part of the Annex I ‘Reefs’ habitat, both of these biotopes are very common in the UK and are not considered to be of particular conservation importance in the area.

Table 10.9: Intertidal biotopes of conservation importance recorded at the potential landfall options

Biotope	Description	Conservation status
Sheep Skerry		
LR.MLR.BF.Fser.Bo	*Fucus serratus* and under-boulder fauna on lower eulittoral boulders	Part of ‘Reefs’ in Annex I of EC Habitats Directive UK BAP
LR.LLR.F.Asc	*Ascophyllum nodosum on* very sheltered mid eulittoral rock	Part of ‘Reefs’ in Annex I of EC Habitats Directive

4 On a list of threatened and/or declining species and habitats in the north-east Atlantic, created under the OSPAR Convention for the protection of the marine environment of the north-east Atlantic.

Biotope	Description	Conservation status
LR.FLR.Rkp.FK	Fucoids and kelp in deep eulittoral rockpools	Part of 'Reefs' in Annex I of EC Habitats Directive
LR.FLR.Rkp.G	Green seaweeds (*Ulva spp*. and *Cladophora spp*.) in upper shore rockpools	Part of 'Reefs' in Annex I of EC Habitats Directive UK BAP
LS.LSa.MoSa.BarSa	Barren littoral coarse sand	Part of 'Mudflats and sandflats not covered by seawater at low tide' in Annex I of EC Habitats Directive
Moodies Eddy		
None	No habitats of conservation importance were identified however direct access to the intertidal area was not possible due to the presence of large cliffs	None
Aith Hope		
LR.HLR.FR.Him	*Himanthalia elongata* and red seaweeds on exposed to moderately exposed lower eulittoral rock	Part of 'Reefs' in Annex I of EC Habitats Directive
LR.LLR.F.Fves.X	*Fucus vesiculosus* on mid eulittoral mixed substrata	Part of 'Reefs' in Annex I of EC Habitats Directive
LR.MLR.BF.Fser.Bo	*Fucus serratus* and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders	Part of 'Reefs' in Annex I of EC Habitats Directive UK BAP
LS.LSa.MoSa.BarSa	Barren littoral coarse sand	Part of 'Mudflats and sandflats not covered by seawater at low tide' in Annex I of EC Habitats Directive

10.9.5 Protected Fauna

The European otter *Lutra* is a semi-aquatic mammal, which is common around the freshwater and coastal areas of Scotland. UK populations are internationally important, especially since their widespread decline across much of their western European range (JNCC, 2004), and this species is designated as a European Protected Species (EPS). Otter is also listed as priority species for conservation on the UK Biodiversity Action Plan (UKBAP) and is listed on the Orkney Local Biodiversity Action Plan and places of shelter are legally protected whether or not an otter is present. Populations in coastal areas utilise shallow, inshore marine areas for feeding and require fresh water for bathing and terrestrial areas for resting and breeding holts (JNCC, 2004). Where otters live in coastal areas (particularly in Scotland) they tend to have a largely diurnal habit, live in group territories, and have home ranges below 5km (Kruuk, 1996).

Records provided by the NBN indicated the presence of otter is widespread across Orkney; however there are no existing records for the study area. Three records for otter in South Walls were provided by OBRC however these records date from 1965-1985.

No otters or signs of otter were recorded during the survey at Sheep Skerry (see Supporting Document: Crossley, 2015). Direct access to the shoreline at Moodies Eddy was not possible due to the inaccessible nature of the coastline therefore this area was surveyed where possible from the cliff top. At Aith Hope, the field survey was limited to the area of Aith Hope roughly between Brims Ness itself to the west and Inner Head to the east due to the presence of steep cliffs (see Figure 1.1 in Supporting Document: RHDHV, 2014b). The results of the otter survey can be seen in Figure A.1 in Supporting Document: RHDHV, 2014b. Otter spraints were recorded at six locations. In addition, two potential pathways were located, just to the west of The Ayre and two potential lie-ups were found, one on either side of The Ayre. No otter holts were found.

In general, given the widespread presence of otter in Orkney, and the location of the study area along the coast, it is likely that all landfall options could receive some use by otter.

10.9.6 Birds

This section lists the ornithological interests present in the terrestrial environment within the three cable corridors and the land immediately adjacent. All ornithological interests present in the marine environment are described in Chapter 14 Ornithology. All species recorded breeding in the Study Area during the shoreline and breeding bird surveys are shown in Table 10.10. As Sheep Skerry AoS is adjacent to Hoy SPA, all qualifying features of Hoy SPA recorded breeding within a surrounding buffer area of at least 500m have also been considered.

Table 10.10: Species recorded breeding within the Study Area during shoreline and breeding bird surveys

Landfall	Species	Conservation status (highest level only)	Number
Sheep Skerry AoS	Lapwing	UK BAP	4 birds (2 pairs)
	Black-headed gull	Scottish Biodiversity List	9 pair
	Oystercatcher	none	4 pair
	Wheatear	none	1 pair
	Common gull	none	10 pair
Moodies Eddy AoS	Herring gull	UK BAP	144 birds (24 nests observed)
	Oystercatcher	none	4 pair
	Ringed plover	none	1 pair
	Northern fulmar	none	400 AONs
	Raven	none	1 pair
	Razorbill	none	12 birds on cliff, 4 birds close inshore
Aith Hope AoS	Arctic tern	EC Birds Directive - Annex I	8 birds Brims LNCS
	Lapwing	UK BAP	6 birds Brims LNCS
	Curlew	UK BAP	6 birds South Walls 6 birds Brims 2 birds Brims LNCS

Landfall	Species	Conservation status (highest level only)	Number
	Oystercatcher	none	8 pair South Walls 4 pair Brims 6 pair Brims LNCS
	Redshank	none	7 birds Brims LNCS
	Snipe	none	1 pair Brims LNCS
	Northern fulmar	none	37 AONs Brims 6 AONs South Walls
	Shelduck	none	1 pair

10.9.6.1 Sheep Skerry

No breeding birds were recorded within the shoreline section of the Study Area (see Figure 10.12). The enclosed field boundary immediately adjacent to the Sheep Skerry cable landfall AoS is of low ornithological interest with two pairs of lapwing *Vanellus* (a UK BAP priority species) the only species of any conservation importance recorded breeding in the area (Table 10.10). A small mixed colony of black-headed gulls *Chroicocephalus ridibundus* and common gulls *Larus canus*, four pairs of oystercatcher *Haematopus ostralegus* and one pair of wheatear *Oenanthe* were also present.

Sheep Skerry cable landfall AoS is adjacent to Hoy SPA which supports populations of European importance of breeding seabirds. Great skua *Stercorarius skua* was the only Hoy SPA qualifying feature recorded breeding within a surrounding buffer area of at least 500m (Figure 10.12). Three apparently occupied territories (AOTs) were recorded. Two red-throated divers *Gavia stellata* (another Hoy SPA qualifying feature) were recorded just outside the 500m buffer area however these birds were non-breeders with no signs of breeding recorded. All other breeding birds recorded within the Study Area are shown in Figure 3.1 in Supporting Document: (Aquatera, 2015d).

There is no suitable foraging habitat for wintering Greenland barnacle geese at Sheep Skerry potential cable landfall site.

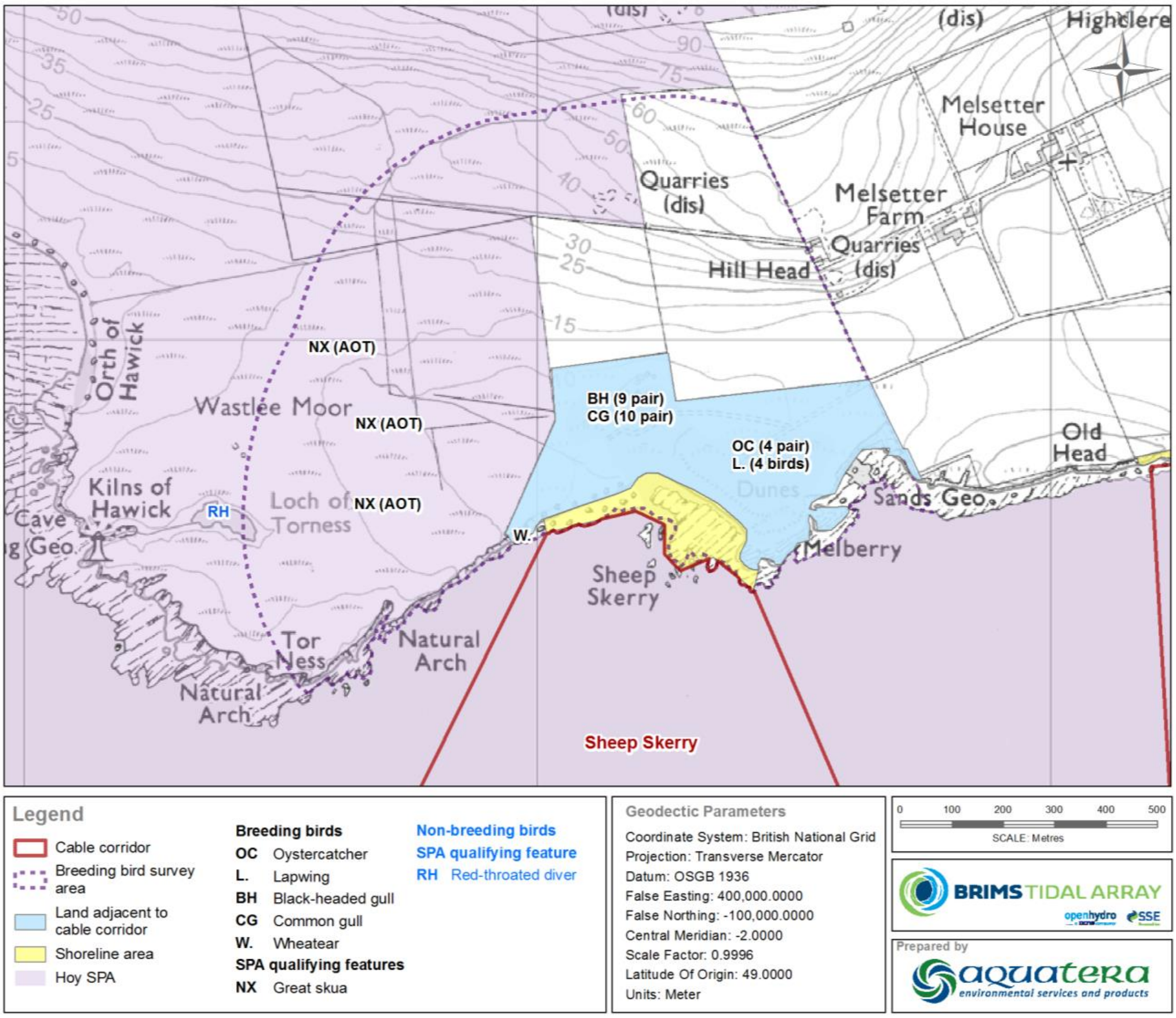

Figure 10.12: Bird survey results for Sheep Skerry cable landfall AoS

10.9.6.2 Moodies Eddy

Within the shoreline section of the Study Area 400 Northern fulmar Apparently Occupied Nests (AONs), one pair of raven and 16 razorbills *Alca torda* were recorded (Figure 10.13 and Table 10.10). Northern fulmar is an abundant and common breeding species in Orkney with an estimated population of approximately 91,000 AONs in Orkney recorded during the Seabird 200 census (Mitchell *et al.* 2004). A small herring gull colony (144 birds) was located approximately 100m to the east: herring gull is a UK BAP priority species. The fields contiguous to Moodies Eddy cable landfall AoS are of little ornithological interest holding four pairs of breeding oystercatcher and one pair of ringed plover *Charadrius hiaticula*.

There is no suitable foraging habitat for wintering Greenland barnacle geese at Moodies Eddy potential cable landfall site.

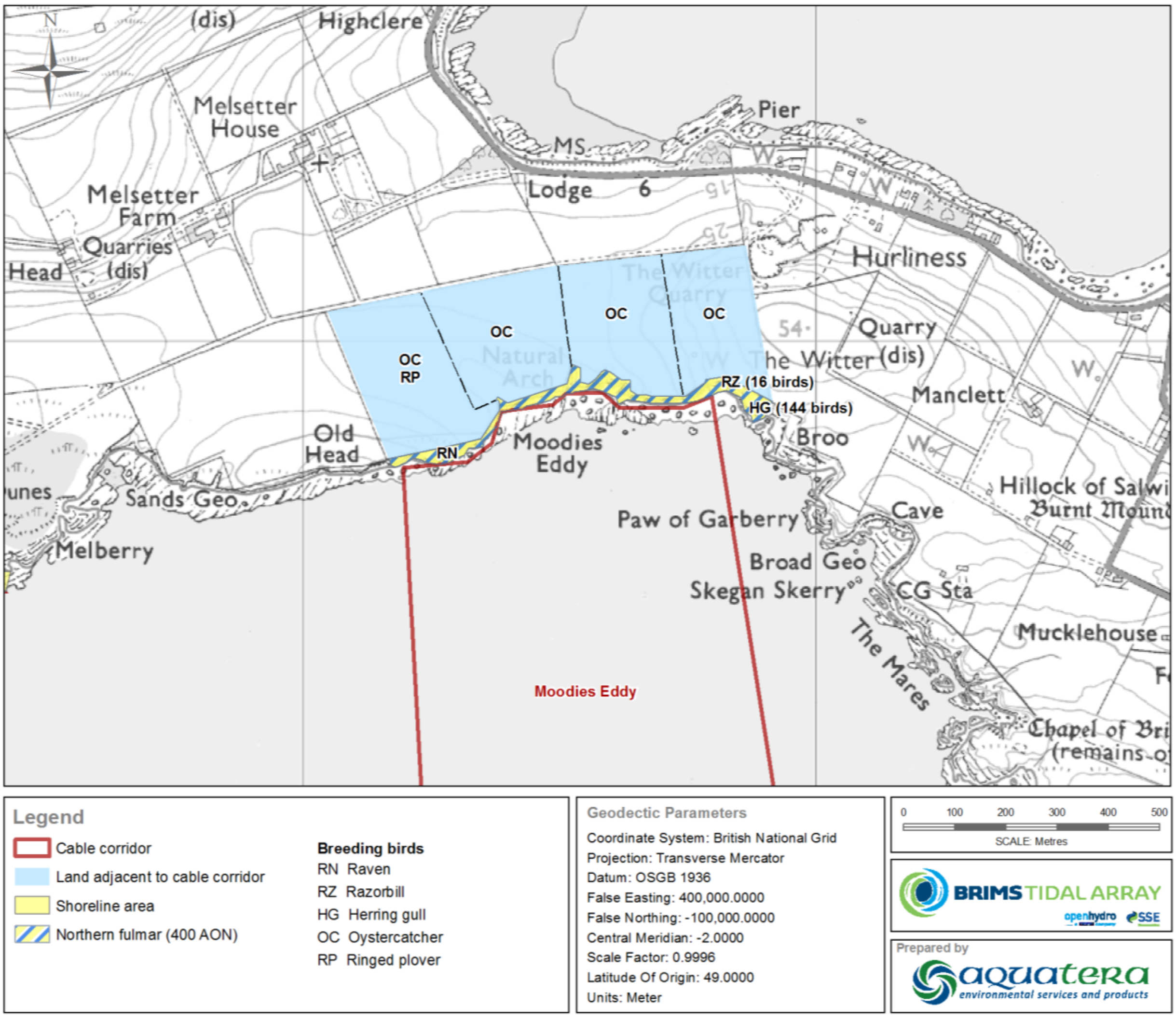

Figure 10.13: Bird survey results for Moodies Eddy cable landfall AoS

10.9.6.3 Aith Hope

On the Brims coastline within the Aith Hope export cable corridor AoS, the shoreline survey recorded 37 Northern fulmar AONs (Figure 10.14 and Table 10.10). On the South Walls coastline, six Northern fulmar AONs and one shelduck *Tadorna* nest were recorded.

No breeding birds were recorded within the area of Aith Head LNCS that overlaps with the Aith Hope export cable corridor AoS. On South Walls, the coastal fields adjacent to the Aith Hope export cable corridor AoS held low numbers of breeding waders including eight pairs of oystercatcher and six curlew *Numenius arquata*. On the Brims side, the coastal fields adjacent to the Aith Hope export cable corridor AoS held four pairs of oystercatcher and six curlew. Brims LNCS which is adjacent to the Aith Hope export cable corridor AoS is the area of highest ornithological interest in the Melsetter/Brims area with a small colony (eight birds) of Arctic tern *Sterna paradisaea* (an Annex I species), six pairs of oystercatcher, one pair of common snipe *Gallinago*, two curlew, six lapwing *Vanellus* (a UK BAP species) and seven common redshank *Tringa totanus*.

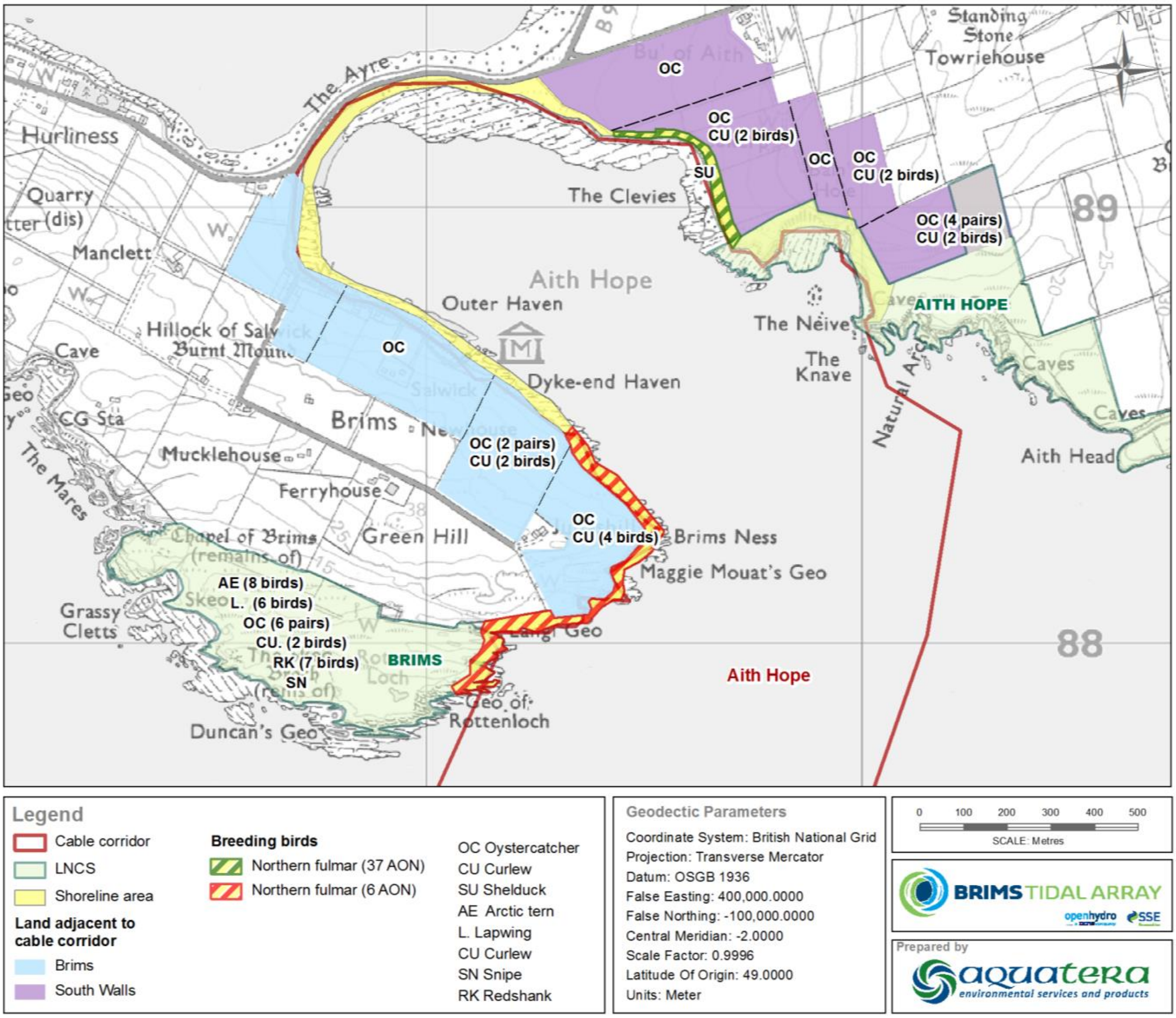

Figure 10.14: Bird survey results for Aith Hope cable landfall AoS

During the winter months (October to April), many fields in South Walls including those adjacent to the potential Aith Hope cable landfall site are regularly used by foraging Greenland barnacle geese from Switha SPA (see Figure 10.15 and Supporting Document: Aquatera, 2012b).

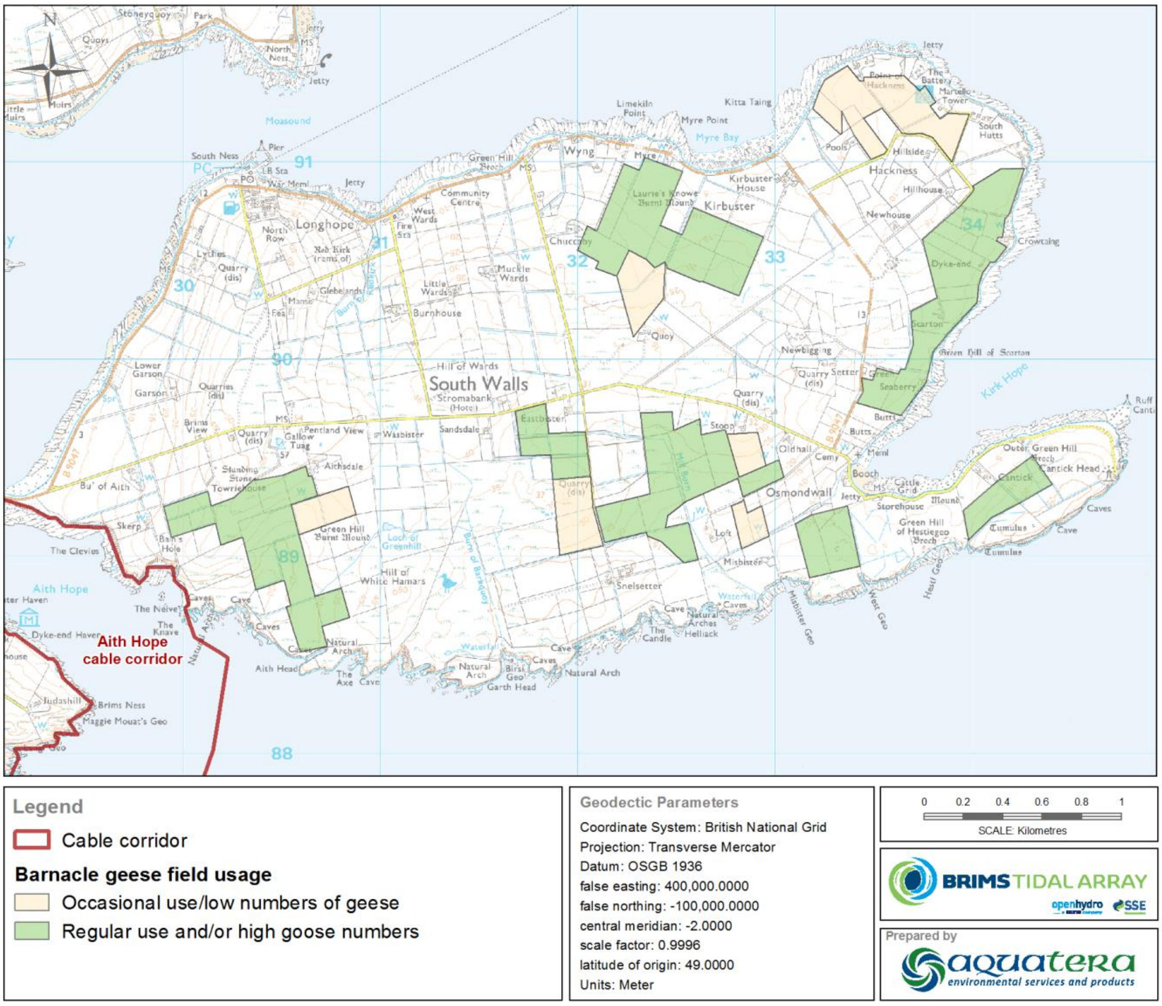

Figure 10.15: Wintering barnacle goose field usage 2013/2014

10.9.7 Local Biodiversity Action Plan

The Orkney Local Biodiversity Action Plan (OLBAP; OIC, 2013) includes Action Plans for the following habitats found in the study area: Coastal Sand Dunes and Links (Sheep Skerry) and Coastal Vegetated Shingle (Aith Hope). Species associated with coastal sand dunes in Orkney are listed in Table 10.11. The coastal sand dune habitat at Sheep Skerry is not considered to be a particularly valued example of this habitat. Species associated with vegetated shingle habitats are listed in Table 10.12.

Table 10.11: Species associated with coastal sand dunes in Orkney

Scientific name	Common name	Scientific name	Common name
Lutra	European otter	*Polyommatus icarus*	Common blue
Alauda arvensis	Skylark	*Diarsia mendica orkneyensis*	Ingrailed clay
Carduelis flavirostris	Twite	*Euxoa cursoria*	Coast dart
Bombus distinguendus	Great yellow bumblebee	*Nematus stichi*	A sawfly
Bombus muscorum	Heath carder bee	*Chrysolina crassicornis*	A leaf beetle
Carex maritima,	Curved sedge	*Ammophila arenaria*	Marram
Asio flammeus	Short-eared owl	*Erodium cicutarium*	Common storks-bill
Primula scotica	Scottish primrose	*Calystegia soldanella*	Sea bindweed
Viola tricolor ssp curtisii	Dune pansy	*Mertensia maritima*	Oysterplant
Microtus arvalis orcadensis	Orkney vole	*Juncus balticus*	Baltic rush
Sorex minutes	Pygmy shrew	*Dactylorhiza purpurella*	Northern fen orchid
Apodemus sylvaticus	Wood mouse	*Parnassia palustris*	Grass of Parnassus
Anthus pratensis	Meadow pipit	*Gentianella amarella subsp. septentrionalis*	Autumn Gentian
Haematopus ostralegus	Oystercatcher	*Galium sterneri*	Limestone bedstraw
Somateria mollissima	Eider	*Primula vulgaris*	Primrose
Tadorna	Shelduck	*Dreplanocladus lycopodioides*	A moss
Charadrius hiaticula	Ringed plover	*Brachythecium mildeanum*	A moss
Oenanthe	Wheatear	*Distichium inclinatum*	A moss
Agrotis vestigialis	Archers dart moth	*Riccia cavernosa*	A liverwort
Argynnis aglaja scotica	Dark green fritillary	*Geoglossum arenarium*	An earth tongue

Table 10.12: Species associated with vegetated shingle habitats in Orkney

Scientific name	Common name
Sterna hirundo	Common tern
Sterna paradisaea	Arctic tern
Charadrius hiaticula	Ringed plover
Haematopus ostralegus	Oystercatcher
Oenanthe	Wheatear
Rhamphomyia morio	A fly
Aphrosylus raptor	A dolichopodid fly
Mertensia maritima	Oysterplant
Scutellaria galericulata	Skullcap

The Orkney Local Biodiversity Action Plan contains a comprehensive list of hundreds of species considered to be of conservation concern in Orkney. While a number of these are likely to be present in the study area, it is not thought that the Project has the potential for any significant effects on these species.

10.9.8 Summary

Sheep Skerry landfall AoS is within 100m of Hoy SPA/SAC/SSSI, which is designated for important habitats, geological features and populations of breeding birds (Table 10.6). The only Hoy SPA qualifying feature recorded breeding within a 500m surrounding buffer area of Sheep Skerry AoS was great skua with three AOT s present. Two red-throated divers, another Hoy SPA qualifying feature, were recorded just outside the 500m buffer area however these birds were non-breeders with no signs of breeding recorded. Aith Hope AoS is adjacent to fields used by wintering Greenland barnacle geese from Switha SPA/SSSI.

Both Sheep Skerry and Moodies Eddy partially overlap with the marine component of Hoy SPA and also the Pentland Firth and Scapa Flow draft SPA, which is of importance to breeding and wintering season marine bird interests (Table 10.6). Potential impacts on these designated sites are explored further in Chapter 14 Ornithology.

The Aith Hope AoS lies partially within Aith Head LNCS which is listed for important habitats, a hawkweed and breeding birds of prey. Aith Hope AoS is also adjacent to Brims LNCS which is listed for important habitats and breeding birds (Table 10.7). There are no LNCSs with habitat or wildlife interests near the Sheep Skerry or Moodies Eddy landfalls that could be affected by the cable landfall installation activities.

The area of sand dunes at Sheep Skerry is a UK BAP and Orkney LBAP priority habitat however given that this area is worked for constructional sand, and is not specifically mentioned in the Orkney LBAP, it is not considered to be a highly valued example of this type of habitat in Orkney. There are other small areas of UK BAP priority habitats within the study area at Sheep Skerry and Aith Hope however these are small fragments of habitats of which there are extensive areas in more favourable condition elsewhere in Hoy and Orkney.

In the intertidal area, UK BAP priority habitats were recorded at locations within Sheep Skerry and Aith Hope AoS however, these biotopes are very common in the UK and are not considered to be of particular conservation importance in the area. In addition, the dog whelk *Nucella lapillus* was found throughout the study area and although it is classified as an OSPAR species, it is a common species in the UK and is not protected under any other pieces of legislation.

No otters or signs of otter were recorded during the survey at Sheep Skerry. Moodies Eddy and sections of the Aith Hope AoS could not be surveyed due to the presence of steep cliffs restricting access due to health and safety reasons. Otter signs were recorded at various locations at Aith Hope. No otter holts were found. In general, given the widespread presence of otter in Orkney, it is considered likely that all landfall options could receive some use by otter.

The area of highest ornithological interest in the study area is Brims LNCS which is adjacent to the Aith Hope cable landfall AoS. A small colony of Arctic tern (an Annex I species) was recorded breeding here along with five species of waders. Moodies Eddy holds little of ornithological interest with the exception of 400 Northern fulmar AONs however this is a common and abundant breeding species in Orkney. A small herring gull colony (a UK BAP priority species) was recorded in close proximity to the Moodies Eddy cable landfall. The Sheep Skerry AoS held little of ornithological interest with only two pairs of lapwing (a UK BAP priority species) and a small colony of black-headed gulls the only species of conservation interest.

Wintering Greenland barnacle geese use fields in South Walls including those adjacent to the Aith Hope potential cable landfall area as foraging areas from October to April. There is no suitable foraging habitat for wintering Greenland barnacle geese at Sheep Skerry or Moodies Eddy potential cable landfall areas.

10.10 POTENTIAL IMPACTS

The potential impacts identified for each phase of the Project are:

10.10.1 Construction and Installation

- Physical disturbance of terrestrial habitats during cable landfall installation;
- Physical disturbance of intertidal habitats during cable landfall installation;
- Disturbance of otters during landfall installation;
- Disturbance to breeding birds due to cable landfall installation activities; and
- Disturbance to foraging barnacle geese due to cable landfall installation activities.

10.10.2 Operation and Maintenance

There are no anticipated impacts on the coastal and onshore environment during the operation and maintenance phase of the Project. Once the landfall installation works are complete, the buried cables at the landfall site are not expected to require any maintenance and there will be no other infrastructure in place that would require any maintenance.

10.10.3 Decommissioning

If the Project is repowered, the cables would be left in situ, thus there would be no expected impacts during decommissioning. If the cables are removed, then impacts during decommissioning would be expected to be the same or less as those during construction, as the decommissioning process would be the reverse of the installation procedure requiring the same plant and machinery.

10.11 MITIGATION MEASURES

10.11.1 Project Design and General Mitigation Measures

All project design mitigation and general mitigation measures are set out in Chapter 5 Project Description, Table 5.15 and 5.16 respectively. These are standard practice measures based on specific legislation, regulations, standards, guidance and recognised industry good practice that are put in place to ensure significant impacts do not occur.

10.11.2 Specific Mitigation

The following mitigation measures will be implemented specifically to minimise the impacts on coastal and terrestrial ecology and is detailed in Table 10.13.

Table 10.13: Mitigation measures specific to coastal and terrestrial ecology

Ref	Mitigation Measure Description
CTE01	Reinstatement of sensitive habitats (UK BAP or LBAP) will be reinstated following best practice guidance. Material removed from the terrestrial/intertidal habitat should be stored and replaced within the same terrestrial/intertidal habitat following the cable installation works.
CTE02	A pre-construction survey for otter will be carried out 8-10 weeks prior to works commencing. If any otter shelters are located, further protection measures will be discussed and agreed with SNH/Marine Scotland and implemented, including the possible need for a European Protected Species (EPS) licence if there is potential for disturbance to otter.
CTE03	Mammal exit ramps will be provided for potential hazards such as steep-sided exposed trenches or holes when contractors are off site (i.e. at night time). Temporarily exposed pipe systems will be capped when contractors are off site to prevent otters from gaining access.
CTE04	If works are due to take place during the bird breeding season (April to August inclusive), a pre-construction breeding bird survey will be undertaken by a suitably qualified Ecological Clerk of Works to ensure no nests are present on site or adjacent to the site before works commence.
CTE05	If works are likely to be required during the bird breeding season (April to August inclusive) use of appropriate measures (to be agreed with SNH) to deter birds from breeding on site before construction commences should be implemented at the earliest opportunity before nest building begins. Possible deterrent measures include use of reflective tape or ribbons on posts.
CTE06	Any nesting birds will be noted and works will be programmed to avoid disturbance. An exclusion zone or other alternative approaches to avoid damage or destruction to nests will be devised and agreed as appropriate with SNH. Exclusion zones around active nest sites will be clearly demarcated at the earliest opportunity to protect nesting birds from disturbance. Any nests will be monitored on a weekly basis by the Ecological Clerk of Works to determine when the nesting bird ceases usage of the nest and therefore when it is safe to commence works in the area.
CTE07	If a cable landfall location is chosen on South Walls, within the Aith Hope AoS, construction activities will be timed to have commenced before the arrival of Greenland barnacle geese in mid-October.
CTE08	Where works are to be undertaken during the bird breeding season (April to August inclusive), the Ecological Clerk of Works will be present until the works are completed or until it is clear that no breeding birds would be adversely affected by the works.

10.12 RESIDUAL EFFECTS

10.12.1 Construction and Installation

10.12.1.1 Physical Disturbance of Terrestrial Habitats during Cable Landfall Installation

Cable landfall installation activities will result in direct disturbance to the terrestrial habitats in the immediate vicinity of the works. All methods of cable installation activities have the potential to result in physical disturbance to terrestrial habitats. Open cut trench would affect a larger area compared to HDD and could potentially result in permanent changes depending on the habitat types present. The maximum width of the corridor at the landfall would be 85m.

Sheep Skerry

Habitats of conservation importance at Sheep Skerry include the sand dunes which are a UK BAP priority habitat (Coastal Sand Dunes) and the boulders above HWM to the west of the AoS which are an LBAP habitat. A locally scarce species (Whorl-grass) is present at the mouth of the burn where it emerges onto the sandy beach.

If the cable landfall location is selected to fall within any of these areas, implementation of mitigation to reinstate habitats following guidance will take place after completion of the works. No significant impacts are anticipated to terrestrial habitats.

Moodies Eddy

There would be negligible impacts expected to terrestrial habitats at Moodies Eddy as no habitats or species of conservation importance were noted here.

Aith Hope

The area of strandline vegetation at The Ayre within the Aith Hope AoS is a UK BAP priority and LBAP habitat. If the cable landfall location is selected to fall within this area of habitat, mitigation to reinstate habitats following guidance will take place after completion of the works. No significant impacts are anticipated to terrestrial habitats.

Table 10.14 summarises the physical disturbance during cable landfall installation.

Table 10.14: Physical disturbance of terrestrial habitats during cable landfall installation

Landfall Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
Sheep Skerry (Open cut trench and HDD)	Terrestrial habitats – Coastal Sand Dunes	Low	CTE1	Medium	Reinstatement of habitats following completion of the works	Minor
Moodies Eddy (Open cut trench and HDD)	No potential impact					
Aith Hope (Open cut trench and HDD)	Terrestrial habitats – Vegetated shingle	Low	CTE1	Medium	Reinstatement of habitats following completion of the works	Minor

10.12.1.2 Physical Disturbance of Intertidal Habitats during Cable Landfall Installation

During installation of the cables, the intertidal habitats in the immediate vicinity of the operations will be disturbed by either Open cut trench or short HDD. The long HDD method would avoid impacts on intertidal habitats. The following mechanisms of disturbance are possible:

- Trenching directly through habitats;
- Drilling exit hole for cables directly through habitats;
- Increase in suspended sediment as a result of Open cut trench operation;
- Smothering as a result of Open cut trench operations; and
- Physical disturbance from operation of machinery.

Most of the biotopes identified in the area are not of any particular conservation concern and therefore of negligible sensitivity.

Sheep Skerry

Two UK BAP habitats were recorded at single locations at Sheep Skerry AoS; these are LR.MLR.BF.Fser.Bo (under-boulder communities) and LR.FLR.Rkp.G (green seaweeds in upper shore rockpools). Neither cable landfall installation method is considered to have any adverse impacts on LR.FLR.Rkp.G in this location.

LR.MLR.BF.Fser.Bo is relatively common in the UK and although it is listed as a habitat of conservation concern, it is considered of low sensitivity as it is a common and widespread habitat and not considered to be of particular conservation importance in the area.

If the cable landfall location is selected to fall within the area of LR.MLR.BF.Fser.Bo habitat, a very localised area (maximum width of 85m at Stage 2) would potentially be affected by cable installation activities. An increase in suspended sediment due to the cable laying activities in the vicinity of this habitat could also have an adverse effect on these communities. However, these communities are considered to have high recoverability relative to increases in suspended sediment, and therefore the impact would be reversible and assessed as a medium magnitude, and the resulting effect would be classified as minor and non-significant (Hiscock, 2005).

Implementation of mitigation to reinstate the habitats following guidance will take place after completion of the works. No significant impacts area anticipated to intertidal habitats.

Moodies Eddy

There would be negligible impacts expected to intertidal communities at Moodies Eddy as no habitats of conservation importance were noted here.

Aith Hope

The UK BAP-listed ‘under-boulder communities’ biotope LR.MLR.BF.Fser.Bo, was present in four locations, all within the Aith Hope landfall AoS. This habitat is relatively common in the UK and although it is listed as a habitat of conservation concern, it is considered of low sensitivity as it is a common and widespread habitat and not considered to be of particular conservation importance in the area.

If the cable landfall location is selected to fall within any of these areas of LR.MLR.BF.Fser.Bo habitat, a very localised area (maximum width of 85m at Stage 2) would be affected by cable installation activities. An increase in suspended sediment due to the cable laying activities in the vicinity of this habitat could also have an adverse effect on these communities. However, these communities are considered to have high recoverability relative to increases in suspended sediment, and therefore the impact would be reversible and assessed as a medium magnitude, and the resulting effect would be classified as minor and non-significant (Hiscock, 2005).

If the cable landfall location is selected to fall within any of these areas, implementation of mitigation to reinstate the habitats following guidance will take place after completion of the works. No significant impacts are anticipated to intertidal habitats (see Table 10.15).

Table 10.15: Physical disturbance of intertidal habitats during cable landfall installation

Landfall Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
Sheep Skerry (Open cut trench and short HDD)	Intertidal habitats: biotope LR.MLR.BF.Fser.Bo	Low	CTE1	Medium	Reinstatement of habitats following completion of the works	Minor
Moodies Eddy (Open cut trench and short HDD)	No potential impact					
Aith Hope (Open cut trench)	Intertidal habitats: biotope LR.MLR.BF.Fser.Bo	Low	CTE1	Medium	Reinstatement of habitats following completion of the works	Minor
All (Long HDD)	No potential impact					

10.12.1.3 Disturbance of Otters during Landfall Installation

Otter are protected under Annex IV of the EU Habitats Directive as a European Protected Species (EPS), and therefore are of high sensitivity. Otter are also a UK BAP and LBAP species. Otter are a common species in Orkney, and evidence of use was found along the coastline at Aith Hope AoS including spraints and potential lie-ups and pathways. No otter holts were found. It is considered that there is potential for otter to be present at Sheep Skerry and Moodies Eddy although no signs of otter were found.

Noise and visual disturbance as a result of activities at the landfall location, whether through Open cut trench or HDD, could have an adverse effect on the activities of otter in the area, particularly if they are breeding nearby. Cable installation works would be temporary and any effects would be removed once the works are completed. Construction activity will cease at night when otters are most active.

A pre-construction survey for otter will be carried out 8-10 weeks prior to works commencing to determine if there are any otter shelters (holts or resting sites) present prior to commencement of works that may affect otter habitats. If any otter shelters are located in close proximity to the proposed operations (e.g. within 250m), protection measures will be put in place to avoid impacts on otter or its habitat. This will include discussion with SNH and agreement of further mitigation measures including the possible need for an EPS licence from the Scottish Government.

Otter may be at risk from potential construction hazards such as steep-sided trenches or holes during cable installation activities which could act as pit-fall traps resulting in injury or death. Implementation of the agreed mitigation measure to provide mammal exit ramps and to cap any temporarily exposed pipe systems when contractors are off site, will reduce any risk of adverse effects to minor.

A Species Protection Plan for otter will be developed as part of the PEMP that will address measures to be taken to minimise impacts on otters.

The implementation of these mitigation measures will ensure that significant impacts to otter will be avoided and any risk of impact to otter would be minor at worst (Table 10.16).

Table 10.16: Disturbance of otters during landfall installation

Landfall Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
Sheep Skerry; Moodies Eddy; and Aith Hope (Open cut trench and HDD)	Otter	High	CTE02 CTE03 GM03	Negligible	Pre-construction otter survey, ECoW to supervise works and provision of mammal exit ramps	Minor

10.12.1.4 Disturbance to Breeding Birds due to Cable Landfall Installation Activities

If works occur outside of the bird breeding season, there would be no potential for any impact. If works coincide with the bird breeding season (April to August), noise and visual disturbance from cable landfall installation activities have the potential to affect breeding birds within the immediate vicinity for the duration of the works, particularly those in direct line of sight of the works. It is an offence under the Wildlife and Countryside Act 1981 (as amended) to intentionally destroy or damage a wild bird’s nest while that nest is in use (see Section 10.4).

Sheep Skerry

Although no species of particular conservation importance were recorded within or immediately adjacent to Sheep Skerry AoS, due to the proximity of Hoy SPA, the sensitivity of breeding birds in the area is considered to be high (See Table 10.10). Great skua, a qualifying feature of Hoy SPA are present at their breeding grounds from April until August (inclusive) therefore if works were to occur during this period, there is the potential for up to three great skua AOTs to be affected. However, any disturbance due to cable landfall installation activities would be temporary and confined to a localised area that is already subject to existing levels of disturbance due to the extraction of sand and other agricultural activities which occur in the Sheep Skerry AoS.

There is the potential for more than one breeding season to be affected as installation activities may be staged over a number of years. Noise and visual disturbance from construction activities could result in the temporary displacement of breeding birds within the immediate vicinity of the cable landfall installation activities or alternatively, birds may continue to breed in the area and be subject to disturbance, which could potentially affect breeding success. This would be of greatest consequence if incubating birds or chicks are affected. The construction footprint is outside the Hoy SPA boundary and due to the topography of the land it is likely that much of the area of the Hoy SPA within 500m of Sheep Skerry AoS would be out of direct line of sight of any construction activities.

If works are due to take place during the breeding season, a pre-construction checking survey will be undertaken to ensure no breeding birds are present prior to works commencing. Appointment of an ECoW will ensure that appropriate measures are implemented to supervise works and to safeguard the interests of any breeding birds present. The implementation of these mitigation measures will ensure that significant impacts to breeding birds will be avoided.

No long-term consequences are anticipated as a result of this effect. It is considered that construction disturbance would have short-term adverse effects on great skuas and that any impacts would be reversible therefore this impact is considered as negligible and non-significant.

Great skuas are absent from their breeding grounds during the autumn and winter therefore there is no potential for adverse impacts outside the breeding season.

Moodies Eddy

Breeding birds recorded within the area include a small colony of herring gull (a UK BAP species) and 400 Northern fulmar, a common and abundant breeding species in Orkney. Open cut trenching is considered to be the worst case method in this location with respect to disturbance to breeding birds as birds breeding on the cliffs would be in direct line of sight of the works. Land-based HDD activities on the cliff top would be out of the line of sight of these cliff-nesting species therefore there would be no potential for disturbance.

Noise and visual disturbance from construction activities could result in the temporary displacement of breeding birds within the immediate vicinity of the cable landfall installation activities or alternatively, birds may continue to breed in the area and be subject to temporary disturbance, which could potentially affect breeding success. This would be of greatest consequence if incubating birds or chicks are affected.

The sensitivity of breeding birds in the area is considered to be low as a small colony of herring gull, a UK BAP species, could potentially be affected. The magnitude of impact is assessed as being low as any disturbance would be temporary and confined to a localised area. There is the potential for more than one breeding season to be affected as installation activities may be staged over a number of years. Repeated disturbance may cause displacement of the herring gull colony to an alternative location however any impacts would be reversible.

If works are due to take place during the breeding season, a pre-construction checking survey will be undertaken to ensure no breeding birds are present at Moodies Eddy before works commence. Appointment of an ECoW will ensure that appropriate measures are implemented to supervise works and to safeguard the interests of any breeding birds present. The implementation of these mitigation measures will ensure that significant impacts to breeding birds will be avoided. This impact would be assessed as a low magnitude, and the resulting effect would be classified as negligible and non-significant.

Aith Hope

There are no species of conservation importance present along the coastline of South Walls or The Ayre therefore cable landfall installation works in these areas would not result in any significant impacts to breeding birds. The only breeding species of concern at the Aith Hope AoS is the small breeding colony of Arctic tern (an Annex I species) present within Brims LNCS. The sensitivity of breeding birds in the area is therefore considered to be high.

Land-based HDD is considered to be the worst case method in this location with respect to disturbance to breeding terns as works would potentially be in direct line of sight of the breeding birds. Open cut trenching activities at the base of the cliff would be out of the line of sight therefore there would be no potential for disturbance.

Noise and visual disturbance from cable landfall activities could result in the temporary displacement of breeding birds within the immediate vicinity of the cable landfall installation activities or alternatively, birds may continue to breed in the area and be subject to temporary disturbance, which could potentially affect breeding success. This would be of greatest consequence if incubating birds or chicks are affected. There is the potential for more than one breeding season to be affected as installation activities may be staged over a number of years.

The magnitude of impact is assessed as being low as any disturbance would be temporary and confined to a localised area. Terns are fickle breeders utilising sites for short periods, both within and between years sometimes with whole colonies moving to a different location in response to predation or habitat change (Mitchell *et al.* 2004). Repeated disturbance may cause displacement of the Arctic tern colony to an alternative location however any impacts would be reversible.

If works are due to take place during the breeding season, a pre-construction checking survey will be undertaken to ensure no breeding birds are present at Aith Hope before works commence. Appointment of an ECoW will ensure that appropriate measures are implemented to supervise works and to safeguard the interests of any breeding birds present. The implementation of these mitigation measures will ensure that significant impacts to breeding birds will be avoided. This impact would be assessed as a low magnitude, and the resulting effect would be classified as minor and non-significant.

Table 10.17 summarises the disturbance due to cable landfall installation.

Table 10.17: Disturbance to breeding birds due to cable landfall installation activities

Landfall Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
Sheep Skerry (Open cut trench and HDD)	Breeding birds	High	CTE04 CTE05 CTE06 GM03	Negligible	Pre-construction breeding bird surveys, an ECoW to supervise works, measures to discourage birds from nesting and protection measures for nesting birds	Minor
Moodies Eddy – (Open cut trench)	Breeding birds – Herring gull	Low	CTE04 CTE05 CTE06 GM03	Low	Pre-construction breeding bird surveys, an ECoW to supervise works, measures to discourage birds from nesting and protection measures for nesting birds	Negligible
Moodies Eddy – (HDD)	No potential impact					
Aith Hope – HDD	Arctic tern	High	CTE04 CTE05 CTE06 GM03	Negligible	Pre-construction breeding bird surveys, an ECoW to supervise works, measures to discourage birds from nesting and protection measures for nesting birds	Minor
Aith Hope – Open cut trench	No potential impact					

10.12.1.5 Disturbance to Foraging Barnacle Geese due to Cable Landfall Installation Activities

Sheep Skerry and Moodies Eddy

There is no suitable foraging habitat for wintering Greenland barnacle geese at Sheep Skerry or Moodies Eddy potential cable landfall areas therefore there is no potential for any impacts due to cable landfall installation activities.

Aith Hope

Cable landfall installation activities during the months of October to April have the potential to cause noise and visual disturbance to Greenland barnacle geese from Switha SPA that forage in fields in South Walls immediately adjacent to the Aith Hope export cable corridor AoS. As a qualifying feature of an SPA, Greenland barnacle geese are therefore considered as a high sensitivity species. Both cable landfall installation methods have the potential to disturb foraging Greenland barnacle geese. There is the potential for more than one wintering season to be affected as installation activities may be staged over a number of years however the likelihood is that works would be scheduled to occur during the summer months when weather is more favourable avoiding any potential impacts on wintering barnacle geese.

There are several fields that are regularly used by foraging Greenland barnacle geese present within 250m of the Aith Hope export cable corridor AoS (see Figure 10.15 and Supporting Document: Aquatera, 2012b). The majority of fields regularly or occasionally used by flocks of Greenland barnacle geese are more than 2km to the east of Aith Hope export cable corridor AoS, well away from any potential construction disturbance (see Figure 10.15).

The use of any one particular field by flocks of Greenland barnacle geese is likely to be temporary during the course of a winter as the geese are likely to move around utilising the best available food sources at the time. Any potential disturbance due to cable landfall construction activities is therefore likely to affect Greenland barnacle geese for a limited time rather than for the entire duration of a wintering season. Construction disturbance would affect a limited number of the regularly used foraging areas in South Walls, the majority of which would remain free from disturbance from this Project.

If a cable landfall location on South Walls is used, construction activities will be timed to have commenced before the arrival of Greenland barnacle geese in mid-October so that the geese are more likely to select foraging fields elsewhere in South Walls as any noise and visual disturbance from the construction activities underway may influence the choice of foraging fields at the beginning of the season and may influence the preferred foraging fields for the rest of the season. Construction disturbance will involve the movement of vehicles and people and is therefore not too dissimilar to existing levels of disturbance experienced by Greenland barnacle geese from routine agricultural activities in any other wintering season. As there are numerous alternative foraging areas within the wider area in South Walls that would be free from disturbance from this Project, construction disturbance affecting a small number of regularly used fields in the immediate vicinity of the cable landfall installation works is considered to be an impact of negligible magnitude.

The implementation of this mitigation measure will ensure that significant impacts to foraging Greenland barnacle geese will be avoided. This impact would be assessed as a negligible magnitude, and the resulting effect would be classified as minor and non-significant (Table 10.18).

Table 10.18 Disturbance to foraging barnacle geese due to cable landfall installation activities

Landfall Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
Sheep Skerry	No potential impact					
Moodies Eddy	No potential impact					
Aith Hope (Open cut trench and HDD)	Wintering Greenland barnacle geese	High	CTE07	Negligible	Time works to have commenced before arrival of geese in mid-October	Minor

10.12.2 Operation and Maintenance

Once the landfall has been reinstated, there are no anticipated impacts during the operation and maintenance phase of the lifetime of the Project. There will be a buried cable at the landfall site which will not require maintenance and there will be no other infrastructure in place that would require any maintenance.

10.13 ACCIDENTAL AND UNPLANNED EVENTS

Accidental and Unplanned Events are those incidents not expected to occur during the Project's normal construction, operational or decommissioning phases which have potential impacts on the coastal environment. In the case of coastal ecology two potential events were identified:

- Release of chemical contaminants from devices or vessels; and
- Introduction of alien invasive species from vessel operations.

10.13.1 Accidental Release of Chemical Contaminants from Devices or Vessels

Accidental release of chemical contaminants from devices or vessels most notable hydrocarbons (fuels and hydrocarbons) has a potentially serious environment impact. The magnitude of this impact depends on the quantity and type or material spilled, the tidal currents, sea state and weather conditions at the time of the spill. Each turbine may contain up to 1000 litres of lubricant and other oils.

In order to minimise the risk of an accidental release of contamination from vessels or devices, vessel management plans and other measures in the Environmental Management Plan are designed to control the activity of vessels and the operation of the turbines. These plans will also provide measures to manage any spillage should an incident occur. This will minimise the environmental damage caused by such an incident.

The highly energetic environmental conditions typically encountered in the Project site will tend to rapidly disperse and dilute any spilled material. In addition, the distance of the turbines from the coastal habitat is substantial enough that any spilled material is likely to be highly dispersed and diluted before reaching this habitat. Taking this into account, the potential magnitude of the impact associated with this type of event is considered to be low (Table 10.19).

Table 10.19: Accidental release of chemical contaminants from devices or vessels - impact assessment summary

Infrastructure type	Receptor Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Vessels	Medium	GM14, GM05	Low	Minor
Turbines	Medium	GM14, GM05	Low	Minor

10.13.2 Accidental Introduction of Invasive Species from Vessel Operations

Invasive species from other parts of the world may be introduced into the area via vessel ballast water or as biofouling on hulls. These could potentially travel to the coastal habitat and impact the ecosystem. The Project shall implement vessel management plans that will contain appropriate measures compliant with current International Maritime Organisation (IMO) regulations to minimise the risk of the introduction of non-native species into the coastal area. The residual magnitude for this potential impact has therefore been categorised as Low (Table 10.20).

Table 10.20: Accidental introduction of invasive species - impact assessment summary

Infrastructure type	Receptor Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Vessels	Medium	GM09	Low	Minor

10.14 SUMMARY

The potential impacts associated with the cable landfall construction, operation and decommissioning on the coastal and onshore environment including intertidal habitats and terrestrial habitats, protected fauna and terrestrial birds have been assessed. Three potential cable landfalls have been assessed separately: these are Sheep Skerry, Moodies Eddy and Aith Hope.

The Sheep Skerry landfall area of search is within 100m of the Hoy SPA/SAC/SSSI, designated for important habitats, geological features and populations of breeding birds.

The Aith Hope cable landfall AoS is partially within Aith Head LNCS which is listed for important habitats, a hawkweed and breeding birds of prey. This cable landfall AoS is also adjacent to Brims LNCS which is listed for important habitats and breeding birds, and is the area of highest ornithological interest in the study area. A small colony of Arctic tern (an Annex I species) was recorded breeding here along with five species of waders.

No significant residual effects are anticipated to any terrestrial habitats as a result of the cable landfall installation activities. Although there are two UK BAP and Orkney LBAP priority terrestrial habitats that could be affected by the proposed Project, neither is considered to be particularly valued examples of habitats that are present elsewhere in Orkney. Implementation of mitigation to reinstate the habitat following guidance will take place after completion of the works therefore no significant impacts area anticipated.

The UK BAP-listed 'under-boulder communities' biotope LR.MLR.BF.Fser.Bo, was recorded at a single location within the Sheep Skerry cable landfall AoS and at four locations within the Aith Hope cable landfall AoS. If the cable landfall location is selected to fall within any of these areas of LR.MLR.BF.Fser.Bo habitat, a very localised area would potentially be affected by cable installation activities. Implementation of mitigation to reinstate the habitat following guidance will take place after completion of the works therefore no significant impacts are anticipated.

Otter are likely to use the entire coastline within the study area and may be impacted by disturbance resulting from construction activities. Implementation of mitigation measures will ensure that any significant impacts on otter are avoided.

If works occur outside of the bird breeding season, there would be no potential for any impact on breeding birds. If works are due to take place during the breeding season, a pre-construction checking survey will be undertaken to ensure no breeding birds are present prior to works commencing. Appointment of an ECoW will ensure that appropriate measures are implemented to supervise works and to safeguard the interests of any breeding birds present. The implementation of these mitigation measures will ensure that significant impacts to breeding birds will be avoided.

There is no suitable foraging habitat for wintering Greenland barnacle geese at Sheep Skerry or Moodies Eddy potential cable landfall areas therefore there is no potential for any impacts due to cable landfall installation activities.

Cable landfall installation activities during the months of October to April have the potential to cause noise and visual disturbance to Greenland barnacle geese from Switha SPA that forage in fields in South Walls immediately adjacent to the Aith Hope export cable corridor AoS, however the likelihood is that works would be scheduled to occur during the summer months when weather is more favourable avoiding any potential impacts on wintering barnacle geese. If a cable landfall location on South Walls is used, construction activities will be timed to have commenced before the arrival of Greenland barnacle geese in mid-October so that the geese are more likely to select foraging fields elsewhere in South Walls as any noise and visual disturbance from the construction activities underway may influence the choice of foraging fields at the beginning of the season and may influence the preferred foraging fields for the rest of the season. The implementation of this mitigation measure will ensure that significant impacts to foraging Greenland barnacle geese will be avoided.

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Benthic Ecology

Chapter 11

11 BENTHIC ECOLOGY

11.1 INTRODUCTION

This chapter of the Environmental Statement (ES) considers the potential effects of the proposed Brims Tidal Array Project (the Project) on marine habitats and benthic communities which includes animals and plants living on or in the seabed, and the habitats in which they live. It therefore includes shellfish, however all fish are covered in Chapter 12 Fish Ecology. The spatial scope of the assessment is described in Section 11.2.

Related information on commercial shellfish fisheries is provided in Chapter 16 Commercial Fisheries; and seabed sediments and the physical processes acting upon them is discussed in Chapter 9 Physical Processes.

This chapter was produced by Aquatera on behalf of BTAL and incorporates results of site-specific benthic surveys conducted in the area (Supporting Document: Aquatera, 2015b) and information from other contributors, including Osiris Projects and Partrac (geophysical and hydrographic survey specialists) and strategic studies conducted on behalf of Scottish Natural Heritage (SNH) to inform the baseline assessment for this chapter (See Section 11.5 for details). These studies, alongside reference to the assessments undertaken for the Fish Ecology, Commercial Fisheries and Physical Processes, have been utilised to inform the production of this impact assessment.

11.2 STUDY AREA

The geographical focus for the assessment includes all of the offshore components of the Project, which consists of the Agreement for Lease (AfL) area where the devices, inter-array cables and subsea hubs will be located; and the Area of Search (AoS) for the three proposed export cable corridors, Sheep Skerry, Moodies Eddy and Aith Hope, within which the marine habitats and benthic communities found are described. The Project boundaries were deemed an appropriate extent to conduct the impact assessment, given that the majority of impacts relate directly to the Project footprint. The Project boundaries therefore represent the Project study area for this receptor.

11.3 DESIGN ENVELOPE CONSIDERATIONS

The exact project specifications are in the process of being developed. To allow the preparation of a robust impact assessment a 'worst case' scenario approach has been applied. The design envelope described in Table 11.1 sets out the technological, engineering and design options that have the highest possible potential for benthic ecology impacts and thus form the basis of the assessment.

Table 11.1: Design envelope parameters for benthic ecology assessment

Project parameter relevant to the assessment	Maximum Project parameter for impact assessment	Explanation of maximum Project parameters
Turbine numbers	Stage 1: up to maximum of 30 Stage 2: up to maximum of 170	Full Project: Stage 1 and 2 used for assessment = 200 turbines
Turbine support structure (TSS)	Dimensions: 30 x 40m Seabed footprint: 1,200m^2 per device Total seabed footprint for full Project: 0.24km^2 (2% of AfL area(1)) (1) AfL area = 11.1km^2	Flat base GBS TSS has the largest seabed footprint of all of the potential options under consideration: *Flat base GBS: 1,200m^2* *Three point GBS: 37.5m^2* *Drilled pin pile tripod 154m^2* *Monopile 20m^2*
Cuttings discharge quantity	Maximum of 200 TSS Volume drilled: 2.8m^2 diameter x 12m deep Drill cuttings: 74m^3 per monopile Total drill cuttings for full Project: 14,771m^3	Monopile option creates the maximum quantity of drill cuttings per TSS: *Monopile 74m^3* *Drilled pin pile tripod 20m^3*
Inter-array cables	Maximum of 208 33kV cables Cross-sectional area: 500mm^2 Assuming cable protection with footprint width of 5m Total cable footprint: 0.36km^2 (3% of total AfL area)	Worst case based on one cable per turbine for full Project: Stage 1 and 2 used for assessment.
Subsea hubs	Maximum of 8 subsea hubs length: 15m diameter: 7m Seabed footprint: 37.5m^2 per hub Total seabed footprint: 300m^2	Full Project: Stage 1 and 2 used for assessment
Export cables	Maximum of 16 cables Diameter: 500mm (cross-sectional area: 0.2m^2) Assuming cable protection with footprint width of 5m along 100% of length Total seabed footprint: Aith Hope route: 6.5km length, 0.52km^2 (5% of total AfL area)	Worst case export cable parameters are associated with subsea cable connecting hubs coming to shore via the Aith Hope cable route: *Aith Hope: 6.5km length, 0.52km^2 Moodies Eddy: 2.6km length, 0.2km^2* *Sheep Skerry: 2.5km length, 0.2km^2*
Cable landfall installation	Open cut trench method Maximum trench width: 80m (maximum affected area for 16 cables)	Open cut trench considered as the worst case scenario for benthic ecology when compared with the Horizontal Directional Drill options

11.4 LEGISLATIVE FRAMEWORK AND POLICY CONTEXT

The Conservation of Habitats and Species Regulations 2010 and the EC Habitats and Species Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora): Special Areas of Conservation (SACs) are designated under these legislative frameworks to protect qualifying species and habitats of European importance and together with Special Protection Areas (SPAs) form Natura Sites. The Habitats Regulations require that a Habitats Regulations Appraisal, and in some cases an 'appropriate assessment', be carried out to ensure that any aspect of the Project does not have a significant impact on the conservation objectives of the site, should there be any connectivity.

Marine and Coastal Access Act (2009) and Marine (Scotland) Act (2010): Designated sites with qualifying marine habitats or species (including SACs, SPAs, SSSIs) form part of an ecologically coherent network of Marine Protected Areas (MPAs) under the UK's international commitments to the Convention on Biological Diversity and the OSPAR Convention. A list of Priority Marine Features (PMFs), many of which are characteristic of the Scottish marine environment, was adopted 24th July 2014 as part of Scottish Government's Marine Nature Conservation Strategy to support advice from SNH and JNCC in delivery of the new marine planning licensing system as set out in the Marine (Scotland) Act 2010 and to help target future conservation work in Scotland.

UK Biodiversity Action Plan (UK BAP) – the UK has established a framework and criteria for identifying species and habitats of conservation concern to define a list of priority species and habitats and provide detailed plans for conservation of these resources under its obligations of the Convention on Biological Diversity. Priority Marine Features (PMFs) were identified through the UKBAP review by the Marine Working Group of the Scottish Biodiversity Forum and a draft list produced which includes those for which MPAs will be designated under the Marine (Scotland) Act 2010. Natura Sites (SACs, SPAs) and MPAs are the current mechanisms which enable protection of marine habitats and species, with UKBAP habitats and species serving to identify and focus management and research effort.

Species and habitats of conservation importance relevant to the Project are discussed in detail in Section 11.9.3.

11.5 SUPPORTING SURVEYS AND STUDIES

A comprehensive desk-based review was undertaken to establish a baseline for the Project study area. The following site-specific studies were undertaken to inform the assessment:

- Brims Tidal Array Project. May 2014 Benthic Survey Report. Seabed ROV survey conducted by Aquatera, Roving Eye and Triscom on behalf of BTAL (Supporting Document: Aquatera, 2014).
- Brims Preliminary seabed habitat assessment - April 2009. Seabed ROV survey conducted by Aquatera and Roving Eye on behalf of BTAL.
- Seabed video snapshots collected during various ADCP deployments to assess tidal regime in the Brims area. Collected by Partrac on behalf of BTAL.
- Bathymetry, shallow geology and seabed features: Multi-beam echo sounder, side scan sonar, sub-bottom profiling and magnetometer survey by Osiris Projects 2014 (Supporting Document: Osiris, 2014).

The following strategic studies undertaken or commissioned were consulted to inform the assessment:

- Moore, C.G. (2009) Preliminary assessment of the conservation importance of benthic epifaunal species and habitats of the Pentland Firth and Orkney Islands in relation to the Project of renewable energy schemes. Scottish Natural Heritage Commissioned Report No. 319. Marine Scotland.

11.6 DATA GAPS AND UNCERTAINTIES

The findings of the survey work conducted in 2014 in conjunction with the previously collected seabed footage forms an extensive baseline seabed habitat dataset that support a robust environmental impact assessment for the benthic communities present in the study area. The study area encompasses the entire proposed Project site, with transects selected and surveys undertaken by experienced practitioners, experts in their field. The scope of the baseline assessment and all survey methodologies and results were verified and approved in consultation with SNH and MSS.

The most significant uncertainty is around the coverage of the seabed surveys with the potential for biotopes to be missed. It is not practical to survey the entire seabed area therefore a series of transects, informed by available bathymetry and other geophysical data, are selected to capture representative data across different water gradients and within any apparent seabed features that may exhibit different biotopes or species of interest. As is standard practice for this type of seabed study, the data gathered from these transects are then extrapolated across the wider area according to various environmental factors including seabed type, seabed features and water depth to generate a biotope map for the area. The mapping results present discrete areas of biotope which in reality would likely exhibit a gradual transmission into a new assemblage of species and habitat with some overlap between.

The sensitivities of species associated with benthic habitats are not well understood. Environmental effects of marine renewables deployments in terms of direct impacts such as habitat loss, scour and suspended sediments are recognised; however there are uncertainties around the impacts relating to the effects of some pollutants and electromagnetic fields (EMF). There are limited data available concerning the effect of EMFs on any particular benthic invertebrate species (potential impacts on fish are discussed in Chapter 12 Fish Ecology), particularly as levels of emission are likely to be significantly lower than those administered during laboratory experiments; however the limited benthic-EMF research places benthic species in a category of least concern (discussed further in Section 11.12.2.4) and this has been taken into account when conducting the impact assessment. A precautionary approach is taken with regards to the release of potential pollutants and the use of chemicals, oils and lubricants is limited and strictly controlled (discussed in Section 11.13 Accidental and Unplanned Events).

11.7 CONSULTATIONS

A list of feedback from all consultees is summarised in Chapter 6 Consultation Process. The key points raised by stakeholders regarding benthic ecology are presented in Table 11.2.

Table 11.2: Key issues raised by stakeholder during consultation

Topic	Stakeholder	Comment	Response/Action taken	Section cross-reference
Baseline survey	SNH	Concern that a targeted approach may miss areas of seabed.	Robust baseline survey data gathered and confident in results which have been approved by consultees – SNH/MSS.	Section 11.5 and Section 11.9
ES contents	SNH	The ES is to present clear information on the biotopes present within the proposed Project site.	The full range of biotopes found within the Project study area has been described in the baseline description, presented in the biotopes map and supporting benthic survey report (see Supporting Documentation).	Section 11.9
Array layout	SNH	Habitat/biotope map should be used to inform the final array layout.	A biotopes map has been produced. No biotopes of high sensitivity identified, all widespread and abundant. Therefore, no restrictions posed by sensitive habitat/biotopes when designing array layout.	Section 11.9
Impact assessment	SNH	The impact of settling suspended sediment and drill cuttings on shellfish should be included in the impact assessment.	An assessment of the potential impacts of sediments has been undertaken with reference to associated chapters where necessary i.e. Physical Processes, Fish Ecology.	Section 11.12.1.1
Baseline survey	SNH and MSS	The habitat in the proposed Project site is likely to be appropriate for European Spiny Lobster, baseline surveys should seek to record any sightings of the species.	The baseline surveys were designed such that any observations of these species would be recorded as part of the seabed video review process. No lobsters were observed in any of the footage collected.	Section 11.9.3.5

11.8 ASSESSMENT METHODOLOGY

11.8.1 Assessment Criteria

The methodology used to assess the significance of potential effects on ecological receptors has considered guidelines produced by the Institute of Ecology and Environmental Management (IEEM[5] 2006; 2010). The appraisal of predicted effects on ecological receptors is based on both the value of a receptor and the nature and magnitude of the effect that the Project will have on it. Effects on biodiversity may be direct (e.g. the loss of species or habitats), or indirect (e.g. effects due to noise or disturbance, on receptors located within or outside the Project site). For the marine habitats and benthos

5 Now Chartered Institute of Ecology and Environmental Management (CIEEM)

considered in this chapter, sensitivity is defined by measures of conservation importance and their response to a potential change as shown in Table 11.3.

The IEEM guidance recommends that the predicted impacts on the receptors be described and quantified, giving consideration to the following parameters: confidence in predictions, positive or negative, extent, magnitude, duration, reversibility and timing and frequency. Professional judgement has been used to assign the impacts on the receptors to one of four levels of magnitude, defined in Table 11.4. Finally, Table 11.5 provides the overall classification scheme for impacts on marine habitats and benthos, considering the sensitivity of the receptor and the magnitude of the impact.

Table 11.3: Definitions for sensitivity of benthic ecology

Sensitivity	Criteria
High	Species/habitats that are qualifying interests of a SAC or MPA, rare species or habitats of national importance with very restricted distribution, limited range or threatened populations; Species listed under Annex II of the EC habitat directive or IUCN red list of threatened species; A viable area of a habitat type listed in Annex I of the EC Habitats Directive or smaller areas of such habitat which are essential to maintain the viability of a large whole; The species/habitat affected has no or very limited capacity to avoid, adapt to, accommodate or recover from the impact.
Medium	Habitats listed as Priority Marine Features or listed under the UK BAP; A regularly occurring, substantial population of a nationally important species (a Priority Marine Feature species or UK BAP priority species); Areas of internationally important habitats that are degraded but are considered readily restored; Species of international importance but which are only present very infrequently or in very low numbers; The species/habitat affected has a limited capacity to avoid, adapt to, accommodate or recover from the impact.
Low	Species of national importance, but which are only present very infrequently or in very low numbers; Viable areas of UK BAP Priority Habitats or smaller areas of such habitat which are essential to maintain the viability of a larger whole; and Species or habitats of local importance e.g. those that are considered rare, uncommon or threatened in a wider context, on the edge of their range, and those that are endemic; and The species/habitat affected has some tolerance to avoid, adapt to, accommodate or recover from the impact.
Negligible	Species/habitats with little or no local importance; and Species/habitats generally tolerant of the impact and can accommodate or recover from the impact.

Table 11.4: Definitions for magnitude of effect for benthic ecology

Sensitivity	Criteria
High	An irreversible (permanent) impact on a habitat, species assemblage/community, population or group from which recovery is not possible within a reasonable timescale. Major loss or major alteration to key elements of the baseline (pre-development) conditions such that the post-development character/composition/attributes will be fundamentally changed.
Medium	A reversible (temporary) impact on a habitat, species assemblage/community, population or group from which recovery is possible within a reasonable timescale. Loss or alteration to one or more key elements/features of the baseline conditions such that post-development character/composition/attributes will be partially changed.
Low	A reversible (temporary) impact on a habitat, species assemblage/community, population or group from which spontaneous recovery is possible or that is within the range of variation normally experienced between years. Minor shift away from baseline conditions; change arising from the loss/alteration will be discernible but underlying character/composition/attributes of the baseline condition will be similar to the pre-development situation.
Negligible	Very slight change to the baseline condition; change barely distinguishable, approximating the 'no change' situation. A short-term but reversible effect on a habitat, species assemblage/community, population or group that is within the normal range of annual variation.
Positive	A change to baseline conditions deemed as being favourable for the benthic environment/ community.

Table 11.5: Assignment of impact significance for benthic ecology based on sensitivity of receptor and magnitude of effect

Sensitivity of Receptor	Magnitude of effect				
	High	Medium	Low	Negligible	Positive
High	*MAJOR*	*MAJOR*	*MODERATE*	*MINOR*	*POSITIVE*
Medium	*MAJOR*	*MODERATE*	*MINOR*	*MINOR*	*POSITIVE*
Low	*MODERATE*	*MINOR*	*NEGLIGIBLE*	*NEGLIGIBLE*	*POSITIVE*
Negligible	*MINOR*	*NEGLIGIBLE*	*NEGLIGIBLE*	*NEGLIGIBLE*	*POSITIVE*

Effects that are assessed as moderate or major are considered to be significant in this assessment.

11.9 BASELINE DESCRIPTION

11.9.1 Introduction

The Study Area is located in the Pentland Firth in the north of Scotland just off the south coast of Hoy, Orkney. Due to the strong tidal regime (in some cases exceeding 12 knots locally) the offshore AfL area is characterised by hard and rocky seabed types with occasional veneers of gravel and coarse sandy sediments in sheltered areas, such as in rock crevices and between boulders (Moore, 2009). Devices located within the AfL area will be connected by cable(s) to a number of subsea hubs before export to a terrestrial substation located on Hoy. Three potential cable routes were investigated, to the west and east of Brims Head. The seabed conditions present in the cable corridor areas will be more variable primarily due to variations in water depth and the influence of coastal features and processes.

11.9.2 General Description of Current Baseline Conditions

11.9.2.1 AfL Area

Seabed surveys of the area show that the dominant seabed type in the AfL is tidally swept circalittoral rock. The rocky substrate is covered with a range of algae, bryozoans, hydroids, sea anemones, tube building bristle worms, soft corals and sponges. The sessile epifaunal communities support a range of motile epifauna including starfish, urchins and crabs. Species recorded in this area included *Balanus sp*, *Flustra foliacea*, *Nemertesia antennina*, *Sertularia argentea*, *Pomatoceros triqueter*, *Urticina felina* and *Alcyonium digitatum*. Motile fauna included *Crossaster papposus*, *Asterias Rubens* and *Echinus esculentus*.

These data suggest that there are two biotopes present within the AfL area which are representative of their exposure to tidal flow. More exposed areas conform to the biotope *CR.HCR.FaT.BalTub*, however no evidence of *Tubularia indivisa* was observed. Fauna present in this biotope were dominated by the barnacles (mostly *Balanus crenatus*), especially in the most tidally exposed areas. *Alcyonium digitatum* and the anemone *Urticina felina* were sparsely present in this biotope. The second biotope was characteristic of more sheltered surfaces, in crevices or between boulders and was classed as *CR.HCR.FaT.CTub*. This biotope is similar to *CR.HCR.FaT.BalTub,* however cushion sponges, *U. felina*, and *A. digitatum* became much more abundant. Bryozoans also appeared to be abundant in this biotope.

The variability between the two biotopes appears to be mainly driven by changes in small-scale differences in seabed topography i.e. barnacles dominating in areas where bedrock is fully exposed to the tide and anemones/sponges colonising crevices and gaps between boulders. Therefore the different biotopes recorded in the AfL area are likely to be present as a mosaic rather than extensive discrete areas. The biotopes recorded are typical of tide swept areas that occur widely throughout the Pentland Firth area (Moore, 2009).

The Old Head to Tor Ness water body (WB ID 200222) has been identified as overlapping with the BTAL AfL and has been classified by SEPA as having an overall status of Good with High confidence in 2013 with overall ecological status of Good and overall chemical status of Pass. SEPA set environmental objectives for this water body over future river basin planning cycles in order that sustainable improvements to its status can be made over time, or alternatively that no deterioration in status occurs, unless caused by a new activity providing significant specified benefits to society or the wider environment (SEPA 2016).

11.9.2.2 Cable Corridors

In shallow areas of the cable route corridors (less than 20m depth) the dominant biotope is characterised by medium to fine sand with bedrock outcrops and with varying densities of kelp and other seaweed. Kelp (*Laminaria hyperborea*) is most abundant in areas of exposed bedrock in the shallow water areas surveyed (e.g. close to the Melsetter coast on the west side of Brims Head) and in these areas large numbers of *Echinus esculentus* can be observed. Decreasing seaweed coverage is observed as water depth and the proportion of sandy sediment increase.

The seabed observed in moderate water depths of around 20-40m is dominated by gravelly sands with frequent bedrock outcrops and boulders. The rocky substrate supports a range of biota including *Flustra foliacea, Pomatoceros triqueter, Urticina felina* and *Alcyonium digitatum*. The burrowing polychaete *Lanice conchilega* is also observed in the sandy areas and a range of echinoderms are present including *Crossaster papposus, Asterias rubens* and *Echinus esculentus*. In deeper water areas (greater than 50m) in the southern parts of the cable routes the seabed biotopes are more typical of tidally-swept rocky areas. Two distinct areas of sand waves are present in the vicinity of the Melsetter and Sheep Skerry corridors. These features are composed of sandy sediments and are likely formed by eddies generated by the physical interaction between tidal currents and the Brims Ness and Tor Ness headlands.

11.9.2.3 Summary

In summary, each of cable corridors show a progression from kelp/seaweed communities on bedrock and/or areas of medium to fine sediment in shallow water to circalittoral mixed sediment dominated by robust fauna in deeper water. The AfL area is dominated by hard and rocky seabed types. The likely distribution of the various biotopes present in the area, estimated using a combination of seabed video and bathymetric survey data, is shown in Figure 11.1.

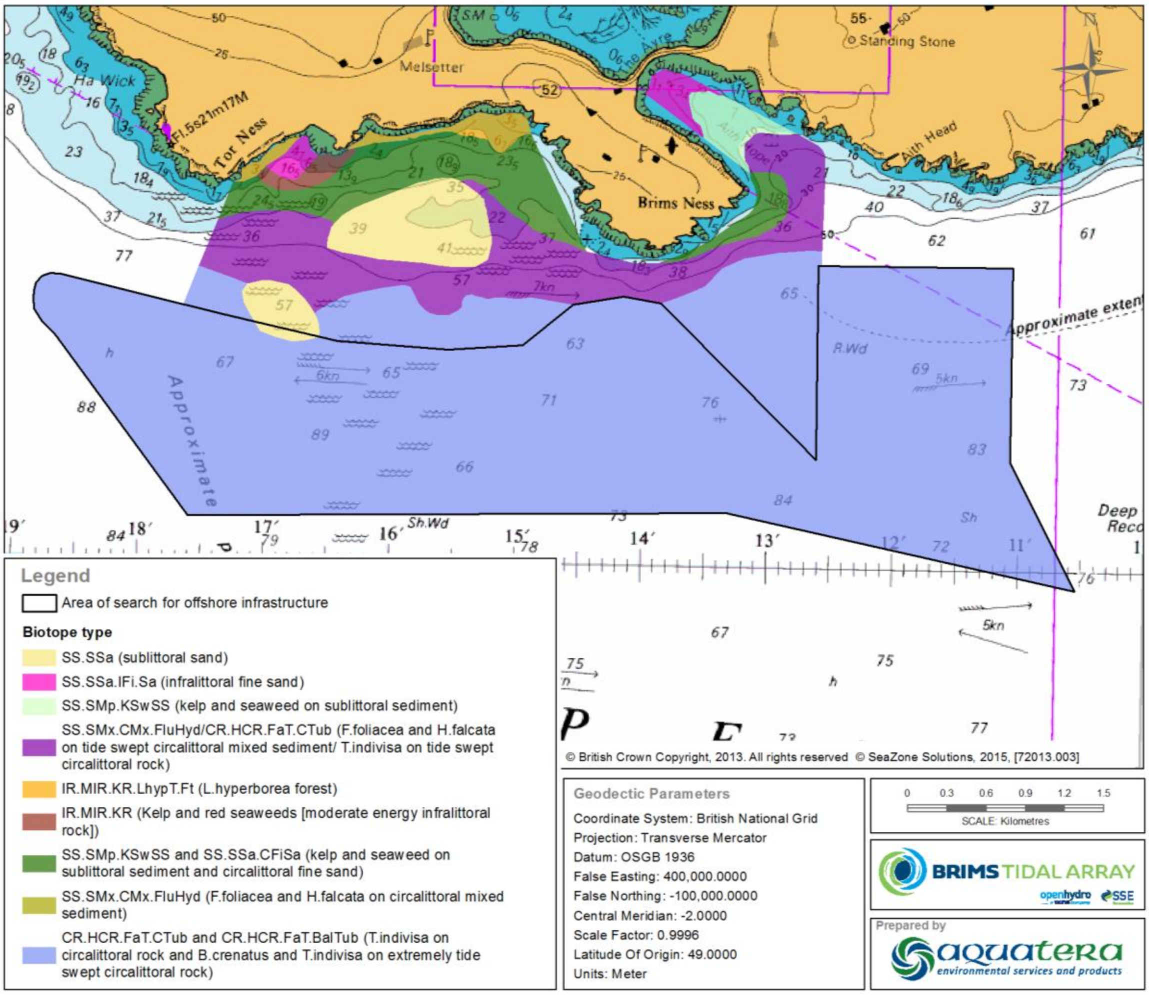

Figure 11.1: Designated biotopes in AfL and cable corridors

11.9.3 Assessment of Habitats and Species of Conservation Interest

Special Areas of Conservation (SACs) and Marine Protected Areas (MPAs) are the current mechanisms applied in Scotland which enable the management and protection of marine habitats and species in line with the requirements of the EU Habitats Directive. The Scottish Government has also developed a list of Priority Marine Features (PMFs), including both species and habitats, as part of a nature conservation strategy to be used as a tool to aid in the identification of potential MPAs. Independently, a series of priority habitats and species have also been designated as part of the UK Biodiversity Action Plan (UK BAP) to help identify and focus management and research effort throughout the UK. Special Protection Areas (SPAs) are focussed on the conservation of bird species in line with the EU Birds Directive and may cover the marine environment (note that any indirect impacts on birds from direct impacts on seabed habitats shall be addressed in Chapter 14 Ornithology). Sites of Special Scientific Interest (SSSI) are used to designate areas of significant natural heritage but extend only to Low Water Spring Tide (LWST) and are not relevant to the sublittoral benthos.

11.9.3.1 SACs

The AfL area and potential cable corridors do not overlap with any currently designated or proposed SACs. An area of Hoy is designated as a SAC due to the presence of a number of terrestrial habitats and vegetated cliffs. None of these features have any relevance to the benthic environment.

11.9.3.2 MPAs and SPAs

There are no MPAs that could be affected by the proposed Project. The closest MPA is North-west Orkney (NWO), recommended for its importance for biodiversity (sandeels) and geodiversity (marine geomorphology of the Scottish Shelf Seabed including sand banks, and sand and sediment wave fields), approximately 50km to the north west of the AfL area. A section of the marine environment covering the north, west and southern coast of Hoy is protected by a SPA. This however does not have any relevance to the benthic environment.

11.9.3.3 EU Habitats Directive: Annex I Habitats

There are no designated Annex I habitats in the Project study area. However the JNCC interactive predictive habitat map suggests that the AfL area, both cable route corridors and most of the Pentland Firth area is a potential Annex I habitat due to the presence of rocky reefs. Survey data indicated that the cable route corridors do not possess a rocky reef habitat in water depths less than 60m. The biotopes *CR.HCR.FaT.CTub* and *CR.HCR.FaT.BalTub* were however observed in deeper parts of the cable route corridors (where water depths were greater than approximately 60m) and across the entire AfL area, confirming that the seabed exhibits the characteristics of a rocky reef habitat. It should be noted that the seabed communities found within the AfL area are widespread throughout the Pentland Firth area and around the coast of the UK; it is therefore considered unlikely that this particular area would be formally designated as an area of Annex I habitat.

11.9.3.4 Priority Marine Features (PMFs)

PMFs based on rock substratum are focussed on the following species: blue mussel, cold water corals, horse mussel, calcified anemones such as *Caryophyllia smithii,* sea fans e.g. *Swiftia pallida*, deep sea sponges, turfs of hydroids and large ascidians. The tidal currents present in the AfL area are too strong to allow for the presence of large communities of these species. As a result there is no evidence to suggest that these PMF species are present within the AfL area, potential cable corridors or wider Pentland Firth area.

The biotope *SS.SMp.KSwSS* (kelp and seaweed communities on sublittoral sediment) is classified as a PMF and was present in the cable corridors between depths of approximately 7 and 23m. No other PMF habitats were identified. The only PMF species residing in sedimentary habitats possibly to be found in the cable corridors is the ocean quahog *Arctica islandica* - a long-lived and large burrowing bivalve living in medium to fine sands and mud from the extreme lower shore down to the circalittoral. No evidence of the presence of this species was observed in the seabed video collected in the sandy areas of the cable routes, however, since this organism lives buried in the sediment it is not possible to conclusively rule out its presence in the area.

11.9.3.5 UK BAP Habitats and Species

The Pentland Firth can be classified as a 'Tide Swept Channel' priority habitat specified in the UK Biodiversity Action Plan (*http://jncc.defra.gov.uk/page-5155*).

Although the habitat present is suitable for the European spiny lobster (*Palinurus elephas*), a priority species for the UK Biodiversity Action Plan, no individuals of this species were recorded during benthic surveys of the area.

11.9.3.6 Benthic Species of Commercial Interest

The predominantly rocky habitats present in the AfL make it unlikely that large numbers of sediment dwelling shellfish will be present. The commercial benthic shellfish found in this area will be dominated by mobile crustaceans such as crab (edible brown *Cancer pagurus*; velvet *Liocarcinus puber*) and the common lobster (*Hommarus gammarus*).

The mixed sediments found in the parts of the cable route corridors may provide a suitable habitat for commercial species such as whelk (*Buccinum undatum*), scallops (queenies, *Aquipecten opercularis*; king, *Pecten maximum*) and razor shells (*Ensis siliqua*; *Solen marginatus*). These organisms live either completely or partially buried in the sediment therefore it is not possible to confirm presence/absence based on seabed video. Further consideration is given to shellfish in the Chapter 16 Commercial Fisheries.

11.9.3.7 Summary

The seabed habitats and species present in the AfL area are typical of strong tidally swept areas, consisting of a hard rocky substrate colonised by a range of algae, bryozoans, hydroids, soft corals and sponges. The seabed in the cable corridors exhibits a progression from kelp/seaweed communities on bedrock and/or medium to fine sediment communities in shallow water to circalittoral mixed sediment dominated by robust fauna in deeper water.

There are currently no protected areas located within 50km of the AfL area or cable corridors. The seabed present in the AfL area and the deeper sections of the cable corridors could be classified according to the EU Habitats Directive Annex I as a Rocky Reef habitat. However, the common species making up the community present and its widespread occurrence across the Pentland Firth makes it unlikely that the AfL area would be formally designated as a protected area. The cable corridors contain kelp and seaweed communities on sublittoral sediment, a biotope that is classified as a PMF by the Scottish Government and the AfL area can be classified as a Tide Swept Channel priority habitat under the UK BAP.

The commercially important benthic species present in the area (primarily the AfL) are crabs and lobsters and these are discussed further in the Chapter 16 Commercial Fisheries.

11.10 POTENTIAL IMPACTS

A list of potential impacts that the proposed Project may have upon the benthic environment were identified during the scoping process. No revisions of the potential impact list were provided by key stakeholders during consultation.

The potential impacts identified for each phase of the Project are:

11.10.1 Construction and Installation

- Increased suspended sediment and turbidity from installation of subsea infrastructure; and
- Substrate/habitat loss/damage from cable landfall installation.

11.10.2 Operation and Maintenance

- Substrate/habitat loss/damage from placement of devices, cable hubs and cables on the seabed;
- Seabed scour around devices, cable hubs and inter-array cables and vessel mooring cables;
- Colonisation of subsea infrastructure;
- Impact to benthic communities from EMF and thermal load arising from the cables during operation; and
- Changes in water flow rates leading to changes in benthic habitat.

11.10.3 Decommissioning

- Increased suspended sediment and turbidity from removal of seabed infrastructure; and
- Substrate/habitat loss/damage from removal of cable landfall.

11.11 MITIGATION MEASURES

11.11.1 Project Design and General Mitigation Measures

All Project Design Mitigation and General Mitigation measures are set out in Chapter 5 Project Description, Table 5.15 and 5.16 respectively. These are standard practice measures based on specific legislation, regulations, standards, guidance and recognised industry good practice that are put in place to ensure significant impacts do not occur.

11.11.2 Specific Mitigation

The following mitigation measures will be implemented specifically to minimise the impacts on the benthic ecology (Table 11.6).

Table 11.6 Mitigation measures specific to benthic ecology

Ref	Mitigation Measure Description
BE01	Pre-construction cable route surveys will be conducted prior to determining the final cable route option and will confirm whether any sensitive habitats are present. BTAL will take all necessary actions to avoid any sensitive habitats identified (e.g. alteration of cable routes). Should disturbance of the habitat be unavoidable BTAL shall undertake consultation with key stakeholders, SNH and MSS, to assess the potential impact significance and agree the best practicable options to minimise impacts to the habitat.
BE02	Cable protection management measures will be in place to ensure that any rock placement that is required will be kept to a minimum to reduce seabed disturbance.

BE03	Marine standard anti-fouling coatings on turbines and associated infrastructure will only be used where necessary.

11.12 RESIDUAL EFFECTS

This section provides a description of each impact and presents relevant Project-specific information in order to demonstrate the magnitude/scale of the impact. Any mitigation that has been incorporated into the design of the Project to remove/reduce the likelihood of significant impacts occurring is also included.

For the purpose of this assessment the benthic communities present within the AfL and cable corridor areas are designated as having medium sensitivity due to the presence of designated PMF and UK BAP priority habitats (see Table 11.3).

11.12.1 Construction and Installation

11.12.1.1 Increased Suspended Sediment and Turbidity from Installation of Subsea Infrastructure

Suspended sediment falling through the water column as a result of installation activities has the potential to smother benthic organisms by blocking feeding and respiratory apparatus or by burying them beyond a level from which they can recover. It therefore has the potential consequence of temporarily reducing the biodiversity of the affected area.

Given the widespread absence of surface sediments in the AfL area, the deployment of gravity base TSSs and subsea hubs will not give rise to the suspension of large quantities of sediment. This will also be the case for the surface laid inter-array connection cables. Some discharge of rock cuttings into the water column, and subsequent settlement on the seabed, will occur if monopile or drilled pin options are selected as TSS. The installation of monopiles will generate the highest volume of rock cuttings (estimated as 74m^3 per TSS, making a total of around 14,771m^3 if the maximum number are installed). The technique that will be used to drill the necessary holes in the seabed is not known at present but it is expected that each hole will be drilled sequentially. The timing between drilling activities at each monopile location will result in smaller volumes of drill cuttings being released at any one time, enabling the rapid and wide dispersal of any drill cuttings during peak tidal velocities before further activities resume. The physical properties of the drill cuttings released from installation activities will depend on the technique used and the properties of the subsurface rock formations but they are likely to be generally finer than natural surface sediments and therefore susceptible to transportation by tidal currents. Due to the relatively high current velocities typically present in the AfL area no long-term deposits of resettled drill cuttings material would be expected to occur and the overall magnitude of this impact has therefore been assessed as negligible.

Cable laying activities are likely to cause only local, short-term increases in turbidity, however they are unlikely to suspend large amounts of sediment over wide areas. The seabed in both cable corridor routes is composed of variable proportions of sandy gravels with outcrops of rock and irregular patches of finer sand. The dominance of coarser sediments further reduces the probability of large amounts of suspended particles and any sediment that is suspended is likely to settle out of the water column relatively quickly. There is therefore a limited potential for sediment suspension and as a result it is unlikely that benthic organisms will be significantly affected by smothering or burial. Export cable installation will involve the deployment of cable protection (the options under consideration are rock dump, mattresses or grout bags). Periods of increased suspended sediments will occur during the installation of the export cable protection but any potential impacts are likely to be minor, relatively localised and short lived therefore the magnitude of this impact can be considered as being low.

The installation of the cable landfall (described in Section 11.12.1.2) will generate relatively large increases in suspended sediments in the area around the selected location during operations. As was the case for export cable laying, the potential impacts are likely to be minor, relatively localised and short lived therefore the magnitude of this impact can be considered as being low. Through implementation of the mitigation measures listed in Section 11.11 any residual impacts on the ecological status of the Old Head to Tor Ness water body are considered to be not significant (Table 11.7).

Table 11.7: Increased suspended sediment and turbidity from installation - impact assessment summary

Installation Activity	Receptor Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Seabed drilling for monopiles and drilled pin TSS	Medium	GM14, PD12	Negligible	Minor
Cable installation on seabed including cable protection		GM13, GM14, PD01, BE01, BE02	Low	Minor
Cable landfall installation		GM17, PD01	Low	Minor
Overall			**Low**	**Minor**

11.12.1.2 Substrate/Habitat Loss/Damage from Cable Landfall Installation

Under the worst case scenario it is assumed that the export cables landfall will be achieved by preparing an open cut trench in the intertidal zone into which the cables will be placed. The exact methodology that would be used is not specified at this time, however based on current worst case assumptions the maximum width of the required trench would be in the order of 80m.

The near-shore benthic habitats present in the potential cable corridors under consideration differ. In Aith Hope and Sheep Skerry the near-shore seabed primarily consists of rippled sands in contrast to the dense kelp communities on bedrock and mixed sediment present near the potential Moodies Eddy landfall. The habitat present within the Aith Hope/Sheep Skerry near-shore zone is categorised as having low sensitivity, while the kelp-dominated community at Moodies Eddy has medium sensitivity based on the criteria presented in Table 11.3.

The scale of habitat loss would be similar in both areas although the impact would be expected to be temporary. In Aith Hope/Sheep Skerry the re-establishment of native benthic communities within the disturbed area would be expected to begin immediately following completion of the cable laying operations and infill of the trench. The near-shore kelp-dominated community present at Moodies Eddy is a widespread habitat of Scottish coastlines (covering approximately 3,600km^2 (MacLeod *et al.* 2014)) and the proportion potentially impacted during the installation of the export cables landfall is not likely to be significantly above beyond natural disturbance occurring during storm events every year. Kelp forests can typically recover to original canopy height and cover within 2-5 years of a disturbance event and associated understorey flora and fauna within 1-6 years (Christie *et al.* 1998, Kain 1975 in MacLeod *et al.* 2014)). The magnitude of the potential impact of cable landfall construction activities can be classified as low. Through implementation of the mitigation measures listed in Section 11.11 any residual impacts on the ecological status of the Old Head to Tor Ness water body are considered to be not significant (Table 11.8).

Table 11.8: Cable landfall installation - impact assessment summary

Cable corridor option	Receptor Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Aith Hope/Sheep Skerry	Medium	GM17, PD01	Low	Minor
Moodies Eddy	Low	GM17, PD01	Low	Negligible

11.12.2 Operation and Maintenance

11.12.2.1 Substrate/Habitat Loss/Damage from Installation of Devices, Cable Hubs and Cables on the Seabed

This impact will begin at the initial construction stages and continue throughout the lifetime of the array. For the purposes of this assessment it is assumed that the placement of any equipment on the seabed will result in an initial loss of the existing natural habitat within the footprint of the infrastructure being deployed. A summary of the maximum likely seabed footprints of the various infrastructure to be deployed (expressed as area and as a percentage of the AfL) is provided in Table 11.9.

Table 11.9: Maximum, worst case scenario, seabed footprint of project infrastructure for full Project

Infrastructure type	Maximum footprint (km^2)	Maximum footprint (expressed as % of AfL)
TSS (flat bottomed GBS)	0.24	2
Inter-array cables (including protection)	0.36	3
Subsea hubs	<0.001	<0.01
Export Cables (including protection)	0.52	5
Total	1.02	10

All of the TSS structures will be placed within the AfL area which is characterised by hard substrate supporting a wide range of sessile and mobile epifauna typical of strong tidally swept areas across the UK (see Section 11.9.2). The flat bottomed GBS TSS have the largest seabed footprint of the options under consideration for the Project and the placement of these structures on the seabed will result in a minor shift in these baseline conditions and a temporary loss in habitat that is common to the wider Pentland Firth (initially impacting approximately 2% of the AfL area). Spontaneous recovery of seabed communities is likely to occur to some degree within the Project lifetime as a result of colonisation of seabed structures (discussed in Section 11.12.2.3) and following the decommissioning of the Project. The magnitude of the potential impact due to the presence of TSS devices is therefore assessed as Low.

Inter-array cables will be surface laid and anchored to the seabed to hold them in position during operation. The cables may include armour protection to provide mechanical protection and add additional weight to the cables which will help to hold the cables in position. Given that the final configuration for inter-array cables is not yet known, it has been assumed for the purpose of this assessment that as a worst case (making allowance for complete cable protection with footprint width of 5m if required) inter-array cables will occupy approximately $0.36km^2$ of the seabed (3% of the AfL). As was the case for the TSS there is some scope for colonisation of the cables (and protection) during the Project lifetime and recovery back to typical baseline conditions following decommissioning would be expected. The magnitude of the potential impact due to the presence of the inter-array cables is therefore assessed as Low.

The potential seabed footprint of the subsea cable hubs is relatively small compared to the other project infrastructure and consequently, although a proportion of the organisms directly beneath the infrastructure will be lost initially, it will occur on a scale that is unlikely to have a detrimental effect on the habitat or species. The magnitude of the potential impact due to the presence of the cable hubs (subsea or surface piercing) is therefore assessed as Negligible.

Under the worst case scenario it was assumed that the export cables will be surface laid along the entire length of the cable route and since the range of habitats present within each of the potential cable corridors is broadly similar, the longest export cable route was selected (Aith Hope option). In this case it is also assumed that cable protection may be required along the full length of the export cables. The total maximum area of seabed occupied by export cable infrastructure (including protection) has been estimated as 0.52km^2 for the full Project using subsea hubs (requiring 16 cables).

In the offshore areas (the AfL and deep water sections of the cable corridors) the export cables will run through areas of hard substrate typical of strong tidally swept areas of the Pentland Firth. Further inshore the seabed becomes more variable transitioning from areas of mixed sediment with rocky outcrops through to mixed and sandy sediments with associated kelp/seaweed communities. The kelp/seaweed habitat is classed as a PMF and it is present in the shallower waters of both cable route corridors (typically in water depths of less than 20m). The various habitats present within the cable routes are all considered to have medium sensitivity based on the criteria presented in Table 11.3.

In the areas of cable corridor characterised by hard substrate and mixed sediments the recovery of seabed communities is likely to occur to some degree within the Project lifetime as a result of colonisation of deployed infrastructure (discussed in Section 11.12.2.3) and recovery back to baseline conditions would be expected following the decommissioning of the Project. As described in Section 11.12.1.2, kelp communities would be expected to recover from any disturbance event within 2-5 years.

The scale of the habitat loss due to the presence of the export cables and associated cable protection within the cable corridors is reversible and would only be expected to cause a minor shift away from current baseline conditions. The magnitude of this potential impact has therefore been assessed as Low.

The overall scale of the benthic habitat loss due to the presence of all of the infrastructure required for full Project assuming worst case scenario values for estimation of seabed footprints is assessed as being Low since the impacts are reversible and would only be expected to cause a minor shift away from current baseline conditions in the area. In addition, spontaneous recovery of the seabed communities would be expected to occur via colonisation of the deployed infrastructure (Table 11.10).

Table 11.10: Substrate/habitat loss/damage - impact assessment summary

Infrastructure type	Receptor Sensitivity	Mitigation	Residual Magnitude	Residual Significance
TSS (flat bottomed GBS)	Medium	GM14	Low	Minor
Inter-array cables (including protection)		GM13, GM14, PD01	Low	Minor
Subsea hubs		GM14	Negligible	Minor
Export Cables (including protection)		GM13, GM14, BE01, BE02, PD01	Low	Minor
Overall			**Low**	**Minor**

11.12.2.2 Seabed Scour around Devices, Cable Hubs, Inter-array Cables and Vessel Moorings

Scour is caused by turbulent flow induced by the presence of structures on the seabed; this has the potential to change habitats by selecting for scour resistant species surrounding the structure.

In areas of sediment cover scour suspends and redistributes sediment in the area immediately adjacent to the structure. Resultant scour pits are formed and any benthic fauna previously inhabiting the area are likely to be displaced. In areas of little or no sediment cover, such as the AfL, the turbulent flow causes the loss of the more delicate species, selecting for more resilient organisms such as barnacles.

The placement of support structures and subsea hubs on the seabed are likely to result in some scour from water turbulence, however, due to the lack of sediment cover in the AfL area, any current scour caused by the presence of the subsea infrastructure is unlikely to cause a major change in the physical environment. The impact of scour processes on the physical environment around a prototype turbine deployed using a tripod gravity base support structure in the Bay of Fundy area showed only minor changes to the seabed. In this case the only observable change was the apparent erosion of small (approximately 1m in diameter) depressions in the bedrock where two of the gravity platforms were located. No other changes in the morphology or gravel distributions of the seabed were detected (Fader, G., 2011).

Any such phenomenon is likely to result in changes to the benthic species composition of the affected area. Species selection based on small scale changes in exposure to tidal currents is something that occurs naturally in the area. More tidally-exposed areas are dominated by barnacles, whereas more sheltered areas host sponges, bryozoans, anemones and hydroids (see Section 11.9.2.1). These localised changes in sessile benthic fauna may in turn influence the distribution of mobile omnivore and predatory species present in the area around the structures (Broadhurst & Orme, 2014). Hence, current induced scour around the TSSs and inter-array cables installed in the AfL area will influence the benthic communities present in the vicinity of seabed structures but it is unlikely to have an effect outside the limits of natural variation in the area and the magnitude of the impact is negligible. No scour protection measures are proposed due to the seabed types present within the AfL area, which consists of cobbles, boulders and exposed rocks.

Scour can also be caused by the movement of structures placed on the seabed; in this case all organisms exposed to the abrasive movement of the structure are likely to be lost. Cables are the only piece of equipment that are present on the seafloor that may move. Scour induced by this movement is therefore unlikely to occur on a large scale and will be reduced by the placement of protection on top of the cable and the magnitude of this potential impact can therefore be considered as being Negligible.

In areas of sediment cover (such as the shallower sections of the cable corridors) scour suspends and redistributes sediment in the area immediately adjacent to the structure. Resultant scour pits are formed and any benthic fauna previously inhabiting the area are likely to be displaced. Scour pits may be formed in the cable corridor due to the presence of sediment, making the effects of scour much more visible. The tidal velocity in the cable corridor where sediment is present, however, is likely to be much less than in the AfL, and may not be high enough to induce large amounts of sediment suspension and cause scour. In addition the potential effect will only occur until a ramp of sediment forms to enable ‘bypassing’ over the obstruction. If any scouring does occur, it is likely to have only a minor and reversible effect upon the benthic community and the potential impact is therefore Low.

The temporary deployment of anchors and moorings by vessels operating in the area may also lead to some disturbance of benthic communities via the motion of cables on the seabed caused by the actions of tides and waves. The spatial extent of any scouring from this source is likely to be highly localised and will occur only for relatively short periods of time therefore the magnitude of this potential impact is considered as being Negligible (Table 11.11).

Table 11.11: Seabed scour - impact assessment summary

<table>
<tr><th>Infrastructure type</th><th>Receptor Sensitivity</th><th>Mitigation</th><th>Residual Magnitude</th><th>Residual Significance</th></tr>
<tr><td>Support structures and subsea hubs</td><td rowspan="4">Medium</td><td>-</td><td>Negligible</td><td>Minor</td></tr>
<tr><td>Inter-array cables (including protection)</td><td>BE01, BE02, PD01</td><td>Negligible</td><td>Minor</td></tr>
<tr><td>Export Cables (including protection)</td><td>BE01, BE02, PD01</td><td>Low</td><td>Minor</td></tr>
<tr><td>Vessel moorings</td><td>GM07, PD12</td><td>Negligible</td><td>Minor</td></tr>
<tr><td>Overall</td><td></td><td></td><td>Low</td><td>Minor</td></tr>
</table>

11.12.2.3 Colonisation of Subsea Infrastructure

Throughout the lifespan of the Project, the presence of TSSs, subsea cable hubs and cables (with or without cable protection) positioned on the seabed have the potential to provide new hard surfaces for colonisation by benthic species.

In the AfL and deeper parts of the cable corridors, the introduction of new hard surfaces onto existing natural substrate is unlikely to alter the local benthic community structure as the organisms that will colonise the infrastructure are likely to be very similar to those inhabiting the natural environment. The placement of such structures on the seabed in these areas will, to some extent, mitigate the substrate lost directly beneath the infrastructure as the new surfaces are colonised over time. It is possible that some of the surfaces of the seabed deployed equipment will be treated with antifouling coatings therefore the likely scale of any colonisation is difficult to determine accurately but the overall magnitude of this potentially positive impact would be expected to be Negligible. Placement of the cable and associated protection measures in the cable corridors may have a slightly larger effect. The placement of hard structures in an area of sediment (such as the shallow water/more sheltered areas of the cable corridors) will introduce a new habitat potentially leading to a change in the local benthic community structure. It is possible that such a change would increase biodiversity in the area but again the magnitude of this potential impact is considered as being Negligible (Table 11.12).

Table 11.12: Colonisation of subsea infrastructure - impact assessment summary

Infrastructure type	Receptor Sensitivity	Mitigation	Residual Magnitude[(1)]	Residual Significance
Support structures and subsea hubs	Medium	BE03	Negligible	Minor
Inter-array cables (including protection)		-	Negligible	Minor
Export cables (including protection)		-	Negligible	Minor
Overall			**Negligible**	**Minor**

[(1)] Potentially positive impact

11.12.2.4 Impact to Benthic Communities from EMF and Thermal Load Arising from the Cables during Operation

The electricity produced by each tidal turbine will be transmitted to shore along seabed-laid AC inter-array and export cables. The electric current that is carried by these cables will generate electro-magnetic fields (EMF) that have the potential to interact with marine species and affect their behaviour, since magnetic cues are relied upon by many marine organisms for a number of reasons e.g. migratory navigation, orientation, prey detection and mate detection. EMFs are emitted by cables that carry electricity and consist of two component parts, an electric field (E field) and a magnetic field (B field). Industry standard cables contain shielding to stop the emission of E fields outside the cable. It is not currently commercially viable to incorporate magnetic shielding into cables; hence the magnetic component of the EMF is emitted when the cable is operational. Movement of water or organisms through the emitted magnetic field can produce an induced electrical field (iE field) which may be detected and alter the behaviour of marine organisms. There is also the potential for the operational cables to emit heat into the surrounding environment.

Throughout the operational life of the array electricity will be transferring constantly along the export and inter-array cables. A maximum of sixteen export cables will be used to connect the array to the onshore substation and will be in contact with the seafloor for a maximum length of 6.5km. Each cable will have a voltage of at least 33kV, but potentially up to 132kV. Spacing between the cables of 2-3 times the water depth may be applied. Cables may be installed in pairs to decrease the width of the required cable corridor value by 50%. Due to the lack of sediment in most of the AfL and deeper parts of the cable corridor, it is expected that the cable will not be buried along any of its length, except for when being brought to landfall near-shore. In addition, up to 200 33kV inter-array cables will also be laid on the seabed within the AfL area. The configuration and degree of cable protection for both types of cable has not yet been confirmed but the maximum seabed footprint for all surface laid cables assuming full protection will be 0.9km^2.

The cables will conform to the industry standard specifications which include shielding technology to prevent the direct emission of E fields. The magnetic component B field of the EMF however will not be contained and will penetrate the surrounding environment. Previous studies suggest that the magnitude of these emissions in a 33kV cable is in the order of 1.5 µT, a value much lower than the 30 to 70µT range that is produced naturally by the earth (Gill *et al.* 2005). Despite this low value emission, the movement of water and organisms through the B field cause the production of an induced electric field (iE field). A 33kV cable carrying a current load of 530A buried 1.5m below the surface in clean sand has been modelled to produce an iE field which has the maximum strength of 40 μVm^{-1} in the seabed (Gill, 2005). EMFs are not affected by clean sand, and therefore travel through them unhindered. As the cables in the proposed Project are not to be buried, it can be assumed that a very similar strength of field will be emitted into the adjacent seabed and water column. Both iE and B fields dissipate rapidly from the source; therefore effects are confined to a local area of water or seabed.

Inter-array cables are likely to be surface laid within in the AfL area where the substrate is scoured rock, hence epifauna are the only group of benthic organisms likely to be exposed to EMFs from these cables. Infauna are likely to be present in the parts of the cable corridors where there is sediment cover and export cables laid on the sediment surface may expose these organisms to EMFs. If the protection placed on top of the export cable extends beyond the limits of the generated EMF epifauna are likely to be less exposed than those resulting from the unprotected inter-array cables. Since the cables will be predominately laid on the seabed surface any heat generated by the cables during operation will be rapidly dispersed into the water column and therefore unlikely to significantly influence benthic communities.

There are very few data relating to the effect of EMFs benthic invertebrate species; some limited experimental work has been carried out with conflicting outcomes. Detrimental effects upon sea urchin and barnacle larvae exposed to high frequency static B fields have been observed in laboratory studies. Tested fields were in the order of 10µT - 1T (Levin & Ernst 1994; Leya *et al.* 1999), magnitudes at least eight times greater than the EMF expected to be reached by the planned deployment. Bochert & Zettler (2004) concluded from experimental investigations that static magnetic fields from power cables do not influence the orientation movement or physiology of benthic species. By contrast, a study by Rosario & Martin (2010) suggests that some species, such as the freshwater crab *Barytelphusa cunicularsis*, do show sensitivity to low frequency magnetic fields, causing increased aggregation and aggressive behaviour. Overall, there is insufficient data to reach a firm conclusion on the effect of EMFs on any particular benthic invertebrate species but the outcome of limited benthic-EMF research appears to place benthic species in a category of least concern. The literature indicates that the greatest effect will be upon fish species that use electroreception for benthic prey detection (discussed in Chapter 12 Fish Ecology).

The magnitude of EMF and heat generated by operational cables has the potential to cause a minor and reversible effect on a small proportion of the benthic fauna present in the Project site therefore the magnitude of this potential impact has been classified as Low (Table 11.13).

Table 11.13: EMF and thermal load - impact assessment summary

Infrastructure type	Receptor Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Inter-array cables (including protection)	Medium	BE01, PD09	Low	Minor
Export Cables (including protection)		BE01,PD09	Low	Minor
Overall			**Low**	**Minor**

11.12.2.5 Changes in Water Flow Rates Leading to Downstream Change in Benthic Habitat

The benthic communities found in tidally swept areas such as that seen in the AfL are adapted to living in highly energetic conditions and many of the species are dependent upon the high tidal velocities for oxygen supply, food supply and/or reduction of competition. The installation of devices that are designed to extract energy from the water column therefore has the potential to alter the benthic community structure in the vicinity of the array and associated seabed infrastructure.

It is possible that energy extraction by the array may reduce tidal velocities to levels lower than the tolerances of the current benthic community and drive a shift to a community representative of less severe tidal flows. The magnitude of reductions in baseline currents would be expected to be greatest for the full Project of Stages 1 and 2 combined. Hydrodynamic modelling conducted as part of the assessment of physical processes (Chapter 9) indicated that despite some localised higher reductions in baseline currents immediately adjacent to some individual turbines (e.g. of the order of 0.5m/s locally), the magnitude of the extent of the wake of decreased current velocity derived from the turbines (typically <0.3m/s) remains largely within the boundaries of the AfL and dissipates to baseline conditions within 3km of the boundary. This change represents a relatively small percentage reduction in the generally high baseline flow conditions present in the area where peak tidal flows of 2-4m/s are encountered throughout the AfL.

The modelling results also show that there is an associated acceleration of flow around the edges of the arrays. The magnitude of change in baseline currents is relatively small compared to baseline values (with accelerations typically of 0.1 – 0.2m/s). At the time of peak ebb, the zone affected by these changes approach the shoreline between The Mares (west of Brims Ness) and Tor Ness (and the near-shore zone further west of Tor Ness), while at the time of peak flood the zone affected by these changes extends from around Tor Ness further east, past Brims Ness.

The current benthic environment in the AfL is predominantly made up of a patchwork of two biotopes; CR.HCR.FaT.BalTub is characteristic of more tidally-exposed areas and dominated by barnacles, whereas CR.HCR.FaT.CTub is dominated by sponges, anemones and hydroids and is characteristic of sheltered cracks, crevices and in and around boulders. These habitats are typical of the extensive tidal rapids habitat that is seen throughout the Pentland Firth and are likely to be tolerant to minor changes in current speed hence it is unlikely that the presence of the array will cause a large scale change in benthic community structure. If any change were to occur it is likely to be characterised by areas of the highly-exposed CR.HCR.FaT.BalTub habitat shifting towards a habitat more representative of CR.HCR.FaT.CTub currently found in more sheltered areas.

The changes in hydrodynamic regime in and around the AfL would not be expected to significantly alter the overall characteristics of the benthic communities present in the Project site and cable corridors therefore the magnitude of this potential impact has been assessed as Negligible (Table 11.14).

Table 11.14: Changes in water flow rates – impact assessment summary

Infrastructure type	Receptor Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Turbine Array	Medium	PD06	Negligible	Minor

11.12.3 Decommissioning

11.12.3.1 Increased Suspended Sediment and Turbidity from Decommissioning of Subsea Infrastructure

The mechanism and scale of the potential impacts associated with the recovery and decommissioning of seabed cables will be similar to those discussed previously in Section 11.12.1 (Construction and Installation). Potential impacts arising from the removal of monopiles and drilled pin TSSs are likely to be smaller than those related to installation since there will be no seabed drilling required.

11.13 ACCIDENTAL AND UNPLANNED EVENTS

In addition to the potential impacts identified during the scoping process there may be additional impacts resulting from accidental or unplanned events occurring during operations at the site. In the case of benthic ecology two potential events were identified:

- Accidental release of chemical contaminants from devices or vessels; and
- Accidental introduction of alien invasive species from vessel operations.

11.13.1 Accidental Release of Chemical Contaminants from Devices or Vessels

There is potential for accidental release of contaminants from vessels in all phases of the Project, although it should be noted that vessel management plans are designed to limit the potential for this impact occurring, and provide measures for managing any spillage should an incident occur.

Accidents on and between vessels can lead to the release of large quantities of chemicals, most notably hydrocarbons (fuels and lubricants). The magnitude of any potential impacts to benthic ecology will depend on a range of factors including the quantity and type of material spilled, the tidal currents, sea state and weather conditions at the time of the spill. The highly energetic environmental conditions typically encountered in the area will tend to rapidly disperse and dilute spilled materials prior to any interactions with benthic communities thus reducing potential impacts to some extent; however the scale of potential impacts may be major. As noted above the risk of such a spill occurring shall be strictly controlled through the application of vessel management and environmental management plans and therefore the potential magnitude of this impact taking into account these procedures is considered to be Low.

Each turbine may contain up to 1000 litres of lubricant and other oils therefore potentially harmful releases may occur during device failure incidents. As is the case for vessel operations, the operation of the turbines will be controlled and monitored as part of the Environmental Management Plan for the Project and, taking this into account, the potential magnitude of the impact associated with this type of event is also considered as being Low. Through implementation of the mitigation measures referenced in Section 11.11 any residual impacts on WFD objectives, will be not significant (Table 11.5).

Table 11.15: Accidental release of chemical contaminants from devices or vessels - impact assessment summary

Infrastructure type	Receptor Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Vessels	Medium	GM05, GM07, GM11	Low	Minor
Turbines	Medium	PD02, PD15	Low	Minor

11.13.2 Accidental Introduction of Invasive Species from Vessel Operations

Invasive species from other parts of the world may be introduced into the area via vessel ballast water or as biofouling on hulls. The project shall implement vessel management plans that will contain appropriate measures compliant with current International Maritime Organisation (IMO) regulations to minimise the risk of the introduction of non-native species into the Project site. The residual magnitude for this potential impact has therefore been categorised as Low (Table 11.16).

Table 11.16: Accidental introduction of invasive species - impact assessment summary

Infrastructure type	Receptor Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Vessels	Medium	GM09	Low	Minor

11.14 SUMMARY

For the purposes of this assessment the benthic communities present within the AfL and cable corridor areas are designated as having medium sensitivity due to the presence of designated PMF (kelp and seaweed communities on sublittoral sediment) and UK BAP (Tide Swept Channel) priority habitats.

Rock cuttings created during the installation of monopile or drilled pin TSS will disperse rapidly. The magnitude of this potential impact on benthic communities is therefore considered negligible. Installation of cables (seabed installation and landfall construction) will generate relatively localised, short-lived plumes of suspended sediments; the magnitude of this impact is low.

The maximum area of seabed potentially impacted by the full Project is approximately 1km^2 accounting for around 10% of AfL area. The magnitude of this impact is therefore considered Low.

Seabed scour in the bedrock-dominated AfL area will be very localised around the seabed infrastructure therefore the magnitude of this impact is Negligible. The magnitude of potential seabed scour impacts around export cables routed through areas of mobile surface sediments is considered as having a Low magnitude.

Colonisation of seabed infrastructure will occur on non-treated surfaces and the magnitude of this potentially positive impact was considered low.

Based on the current understanding of effects from EMFs and heat generated by operational cables the potential impact on benthic communities is considered to be Low.

Decommissioning impacts are likely to be of similar scale to that of installation activities i.e. Negligible-Low.

In summary, based on the worst case scenario, the significance of the potential impacts to benthic ecology arising from the proposed Project is considered as being Minor.

The potential for accidental incidents involving vessels and turbines will be carefully controlled though the application of appropriate project management systems. The residual impact significance associated with these events is considered Minor.

No cumulative impacts on benthic ecology from other nearby projects are anticipated.

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Fish Ecology

Chapter 12

12 FISH ECOLOGY

12.1 INTRODUCTION

This chapter of the Environmental Statement (ES) considers the potential effects of the proposed Brims Tidal Array Project (the Project) on fish ecology. Potential impacts on basking sharks are covered in Chapter 13 Marine Mammals and are not assessed here.

In order to provide context to the baseline and to quantify the spatial and temporal variation of fish population, populations are described at both the local and wider regional level. Key stages in the life cycle of both commercial and non-commercial species, such as spawning and the juvenile nursery stages are given particular prominence due to higher sensitivity to environmental changes. By characterising the existing environment the potential ecological impacts arising from the Project can be identified and assessed.

A number of different specialists have contributed to this assessment:

- Aquatera – Benthic survey, video footage analysis, biotope mapping, seabed survey reporting; and
- Xodus Group – Baseline description, underwater noise technical assessment and collision risk modelling for Atlantic salmon (the latter two studies are provided on the supporting documents DVD).

To gain a better overall understanding of the baseline and potential impacts associated with fish ecology, consideration should also be given to the following chapters in the Environmental Statement (ES); Chapter 11 Benthic Ecology, Chapter 13 Marine Mammals, and Chapter 16 Commercial Fisheries.

12.2 STUDY AREA

The focus of the impact assessment is potential impacts on any fish ecology using the Project site and adjacent waters. The area over which an impact may occur can vary significantly between species based on their ecology and the range over which their populations can be found. Therefore, potential impacts have been set in the context of a wider study area over which the fish encountered in the Project site are thought to range (e.g. spawning grounds, migration routes).

The following areas are referred to in this impact assessment:

Project study area (see Chapter 4 Figure 4.9), which comprises:

- The Brims Agreement for Lease (AfL) area; and
- Three export cable corridor options:
  - Sheep Skerry;
  - Moodie’s Eddy; and
  - Aith Hope.

12.3 DESIGN ENVELOPE CONSIDERATIONS

In line with the design envelope approach, this assessment considers the maximum ('worst case') Project parameters. The identification of the worst case scenario for each receptor (i.e. fish ecology) ensures that impacts of greater adverse significance would not arise should any other development scenario be taken forward in the final scheme design. With regards to the assessment of impacts on fish ecology, the assessment parameters are detailed in Table 12.1:

Table 12.1: Design envelope parameters for fish ecology assessment

Project parameters relevant to the assessment	Maximum Project parameters for the impact assessment	Explanation of maximum Project parameters
TSS and turbines		
Agreement for Lease area	11.1km^2	-
Number of turbines	Up to 30 turbines for Stage I and up to 200 turbines with a total capacity of 200MW for Stage II	Turbine number dependent upon which technology is selected.
Noise output	200 turbines	Assessment based on the maximum number of turbines using the maximum output from the most powerful device.
Minimum clearance between sea surface at LAT and turbine tip	30m minimum clearance	Subject to NRA consultation but 30m minimum should be considered the worst case.
Minimum clearance between seabed and turbine tip	4m	Clearance may be more depending on turbine and support structure configuration.
Number of blades	3 or 10	-
Rotor diameter	23m (3 bladed turbine) or 12.8m (10 bladed turbine)	-
Maximum blade width	1.8m (3 bladed turbine) or 1.9m (10 bladed turbine)	-
Blade pitch	0degrees (3 bladed turbine) or 30degrees (10 bladed turbine)[6]	-
Rotation speed	10rpm (3 bladed turbine) or 8rpm (10 bladed turbine)	-
% time not operational	14.4	The proportion of time the turbine is not operational (e.g. current speeds too high or low or for maintenance reasons)
Total Swept area per turbine	415m^2	Unshrouded device.
Number of turbines per row	15 turbines per row.	This will depend on selected turbine type and rating, resource

[6] 'Worst case' refers to the worst case for collision risk modelling carried out for Atlantic salmon (Xodus Group, 2016)

Project parameters relevant to the assessment	Maximum Project parameters for the impact assessment	Explanation of maximum Project parameters
		availability within the AfL area and seabed conditions. Number of turbines per row will vary on a row by row basis.
Total number of rows	40 rows	Depends on turbine type and rating, resource availability and seabed conditions.
Turbine Support Structures (TSSs)	Gravity Base Structures (GBSs) and drilled monopile foundations.	Gravity bases have been used as worst case for habitat loss, drilled monopile with regards to smothering and monopile foundations with regards to noise impacts on fish and shellfish.
Gravity base structures (GBSs) combination of steel and concrete with a flat bottomed GBS that sits on the seabed	The footprint of the flat bottomed GBSs is 30m by 40m and therefore will have a maximum footprint of 1,200m^2 per gravity base.	-
Total Project footprint for 200MW	240,000m^2 (30m x 40m = 1,200m^2 x 200)	Based on 200 devices using flat bottomed gravity bases.
Volume of drill cuttings based on drilled monopile TSS	Maximum total of 16,964m^3 drill cuttings for 200 monopile TSS.	Based on 84.82m^3 per monopile assuming 3m diameter 12m deep.
Maximum fuel inventory	800 to 1,000 litres	Volumes (per device) are approximate covering range of liquids including mineral oil, grease, hydraulic fluid, low toxicity biodegradable oil, biodegradable ethanol.
Maximum number of inter-array cables.	32 (Stage 1), 208 (Stage 1 & 2)	Worst case based on one cable per turbine.
Footprint of inter-array cables	Stage 1 - 0.07km^2 (approximately 0.6% of total AfL area) Stage 1 & 2 - 0.36km^2 (approximately 3% of total AfL area)	-
Maximum number of export cables	Maximum of 16.	-
Maximum export cable corridor width	Maximum affected seabed width of 80m (5m for each cable including protection). Maximum width of corridor in which cables will be installed is 4,840m	Cable protection may be required along the full length of the export cable. This will be in the form of rock placement, concrete mattresses and/or grout bags. The total width of seabed directly affected by the 16 cables is estimated at 80m (5m per cable). Allowing for a spacing of 2-3 times water depth between each cable. Maximum depth is 100m therefore

Project parameters relevant to the assessment	Maximum Project parameters for the impact assessment	Explanation of maximum Project parameters
		the maximum width of corridor in which cables will be installed is 4,840m (80m + (16 x 300m)).
Maximum export cable corridor length	Maximum length to Aith Hope 6.5km	Sheep Skerry 2.5km Moodies Eddy 2.6km
Cable protection methods	Rock placement Concrete mattresses Grout bags Burial where possible 1m depth (minimum) by 2m width.	Cable burial will only be feasible in areas of softer sediment.
Channel depth	70m	The average depth in the area in which the turbines will be located
Mean current speed	$1.82ms^{-1}$	The average current speed in the turbine deployment site
Channel width	13,180m	Distance from the most southerly point of the Brims area to East Mey
Vessel requirements		
Vessels required for installation of the TSSs and turbines.	DP construction vessel with 250 to 400 tonne crane lift capacity plus DP construction vessel with 150 tonne crane lift capacity; Purpose built twin hulled three point heavy lift deployment barge; and/or Jack-up barge/moored barge depending on site conditions and selected TSS. Support vessels: small DP vessels with ROV on board, crew transfer vessels (RIBS), dive vessels (RIBS), tug boats.	This applies to GBSs, monopiles and pin pile tripods.
Vessel fuel inventory	For the purpose of the assessment vessel fuel inventory is based on the amount of marine diesel carried on board a standard large DP installation vessel. Large DP vessels carry between 6,000,000 and 8,000,000 litres of marine diesel in a number of separate tanks. The worst case scenario for assessing accidental spillages of fuel from vessels is to assume leakage of one tank (approximately 600,000 litres of marine diesel).	Vessels likely to be on site from 2024 for maintenance duties.
Method to be used to bring cables ashore at landfall	Open Cut Trench or Horizontal Directional Drill (HDD).	-
Vessels required during decommissioning	Requirements will be similar to those used during installation.	-

Project parameters relevant to the assessment	Maximum Project parameters for the impact assessment	Explanation of maximum Project parameters
Duration of vessel presence in the AfL area/along export cable corridor (note these timescale are indicative and are dependent on weather and site conditions).	Initial commissioning of the first installed turbines could take up to 2 months. Overall commissioning is expected to take 15 weeks for each stage. 30 weeks in total.	Commissioning of Stage 1 is expected to start at the end of Q2 2019 for completion at the end of Q3 2019. Commissioning of Phase 2 will commence Q2 2021 for completion by end of Q3 2023.
During operation it is likely that vessels will be present in the AfL area throughout the year. On average this is expected to be one vessel per day. However, there may be periods when there are more vessels e.g. two or three or no vessels depending on weather conditions and maintenance works required. Maintenance activities will include:	Routine inspections: these are expected to occur over one to two days every two years per turbine (based on 20 minute ROV inspections per turbine); and General maintenance – either at site (depending on weather conditions) or activities related to the removal and re-deployment of turbines removed for general maintenance at onshore facility.	-
Timescale of decommissioning activities	Expected to occur over similar timescales/duration to installation.	-

12.4 LEGISLATIVE FRAMEWORK AND POLICY CONTEXT

An integral aspect of the assessment of potential impacts on fish ecology is the identification of habitats and species of conservation importance in the Project site and assessment of potential impacts on these. There are a number of different statutes and guidance that are relevant in this regard. These are listed below:

- The Habitats Regulations 1994 (as amended in Scotland) and the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 which implement species protection requirements of the EU Habitats Directive (92/43/EEC) in Scotland, on land, inshore and offshore waters;
- Wildlife and Countryside Act 1981;
- The Nature Conservation (Scotland) Act 2004;
- Marine (Scotland) Act 2010; and
- UK Biodiversity Action Plan (UKBAP); UK Governments response to the convention on Biological Diversity (CBD), to which the UK signed up in 1992 in Rio de Janeiro.

Under the Habitats Regulations, fish species listed in Annex II of the European Union (EU) Habitats Directive which are native to the UK should be conserved through the designation of Special Areas of Conservation (SACs). Atlantic salmon and lampreys (including sea, river and brook lampreys) are considered native to the UK. Atlantic salmon are afforded protection via a number of SACs in the north east of Scotland (Section 12.9.4.26, Table 12.13, Figure 12.4) and are also included in Schedule 4 of the Habitats Regulations as animals which may not be captured or killed in certain ways.

A list of Priority Marine Features (PMF) in inshore waters adjacent to Scotland, including those for which future Marine Protected Areas (MPA) will be designated under the Marine (Scotland) Act 2010, has been drawn up and circulated for consultation (Scottish Natural Heritage, 2014). The list includes a number of fish species that may be present in the Project site, such as those detailed in Table 12.7, Table 12.9 and Table 12.10.

In addition to the legislative protection detailed above:

- The UK Biodiversity Action Plan (UKBAP) identifies a list of species of conservation concern in response to the Convention on Biological Diversity. There are a number of sea fish species listed in the UKBAP that have the potential to be present in the Project site as detailed in Table 12.7, Table 12.8, Table 12.9 and Table 12.10.
- The International Union for Conservation of Nature (IUCN) has compiled a Red list of threatened species that are facing a high risk of global extinction. The list (IUCN, 2014) includes fish species that are potentially or known to present in the Project site and identifies their conservation status, as detailed in Table 12.7, Table 12.8, Table 12.9 and Table 12.10.
- A list of marine habitats and species considered to be under threat or in decline within the north east Atlantic has been produced by OSPAR (2008). A number of fish species on the list may be present in the Project site, as detailed in Table 12.7, Table 12.8, Table 12.9 and Table 12.10.
- ICES has published advice on fishing opportunities, catch, and effort Greater North Sea Ecoregion. The guidance note provides guidance towards activities that may negatively impact spawning habitat of herring (ICES, 2015).

Whilst providing no specific legal protection, inclusion on these lists ensures due consideration in impact assessments.

12.5 SUPPORTING SURVEYS AND STUDIES

To inform the impact assessment, a desk-based review of existing data sources was conducted. The ultimate aim of this exercise was, in association with local experience of the area, to provide details of the habitats and species present in the AfL area and wider region, including any of conservation concern. Collision Risk Modelling (CRM) was carried out to support the impact assessment; it assessed the potential collision rates of Atlantic salmon with the tidal array. Data sources and supporting studies which relate to the fish ecology impact assessment are detailed in Table 12.2.

Table 12.2: Supporting studies

Survey/study	Date of survey/study	Description
Results of the site specific benthic surveys	2013 – 2014	Baseline information on the benthic communities and sediments in and adjacent to the proposed Project.
	July 2015	Benthic survey report for a third cable route option from the AfL to Sheep Skerry (Supporting Document: Aquatera, 2015b).
Highland, Hebrides and Orkney Marine Environment: A GIS resource	2010	Detailed predictive mapping of the biotopes and habitats of inshore waters around Orkney (Foster-Smith, 2010).
UKSeaMap 2010 project	2010	Predicted seabed habitats map for habitats within the UK continental shelf classified under the European Nature Information System (EUNIS).

Survey/study	Date of survey/study	Description
Underwater noise technical report	May 2015	Technical study undertaken by Xodus Group to assess the impacts of underwater noise produced by the proposed Project on fish and marine mammals. (Supporting Document: Xodus, 2015)
Migratory routes of Atlantic salmon	2010	A study reviewing the 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
Depth use of Atlantic salmon	2014	Two tagging studies were undertaken by Godfrey *et al.* (2014a; 2014b) which looked at the depth use and movements of Atlantic salmon around the coast of Scotland. A modelling study was also undertaken in 2014 by Guerin *et al.* (2014) which has also been used to inform this assessment.
Review of MeyGen modelling	2013	Marine Scotland and SNH undertook a critical review of the collision risk modelling undertaken for MeyGen. The results of this process have been used to inform elements of this assessment.
Cefas – a GIS resource of spawning and nursery grounds	1998; 2012	Distribution of spawning and nursery grounds as defined in Coull *et al.* (1998) Fisheries Sensitivity Maps in British Waters, and in Ellis *et al.* (2012) Mapping spawning and nursery areas of species to be considered in Marine Protected Areas (Marine Conservation Zones).
Marine Scotland Science fisheries sensitivity maps.	2014	An update to fisheries sensitivity maps by Aires *et.al*. (2014), detailing hotspots for group 0 aggregations[7] of juvenile fish in UK waters.
ICES - Results of the International Herring Larvae Survey (IHLS) (ICES, 2014a)	2008 – 2012	The main purpose of the programme is to provide quantitative estimates of herring larval abundance which are used as a relative index of changes in herring spawning stock biomass in the assessment.
Collision Risk Modelling – Atlantic Salmon (Xodus Group, 2016)	2016	This modelling was carried out to assess the risk associated with the tidal development on migrating populations of Atlantic salmon, a protected species.

12.6 DATA GAPS AND UNCERTAINTIES

12.6.1 Distribution of Spawning and Nursery Grounds

The spawning and nursery grounds described in this chapter are primarily based on the information presented in Ellis *et al.* (2012) and Coull *et al.* (1998). The limitations of these sources of information should, however, be recognised. These publications provide an indication of the general location of spawning and nursery grounds. They do not define precise boundaries of spawning and nursery grounds, particularly in the context of the relatively small footprint of the Project site ($11km^2$). Similarly, the spawning times given in these publications represent the maximum duration of spawning on a species/stock basis. In some cases, the duration of spawning may be much more contracted, on a site specific basis, than

[7] Group 0 fish are defined as fish in the first year of their lives

reported in Ellis *et al.* (2012) and Coull *et al.* (1998). Therefore, where available, additional research publications have also been reviewed to provide site specific information. Despite the limitations, there is still sufficient data to establish a robust baseline to inform the impact assessment.

A review of the juvenile fish data was undertaken by Aires *et al.* (2014) taking into account the findings of Ellis *et al.* (2012) and Coull *et al.* (1998) together with findings from the National and International Bottom Trawl Surveys (IBTS), the Beam Trawl Survey (BTS), International Herring Larval Surveys (IHLS) and other standalone surveys. The findings summarise the probability of aggregations of juvenile, group 0, fish present around the UK Continental Shelf (UKCS). However, the data does not cover the Brims AfL or cable route options. Available data in adjacent waters show that levels for group 0 aggregations of juvenile fish for all species are low (*Aires et al.* 2014).

12.6.2 Knowledge Gaps

It is recognised that there are gaps in the understanding of the distribution, behaviour and ecology of certain fish species. This is particularly evident for a number of migratory species including several species of known conservation importance (e.g. salmonids). For migratory species, the exact routes they will take on their movements to and from feeding and spawning grounds are not always known. Where information is available it has been used to determine whether species travel through the Project site or to make assumptions on the migratory routes taken. Where no such data are available, it has been conservatively assumed that migration through the Project site does occur. With regards to the potential for migratory fish to collide with the tidal turbines work undertaken in support of the MeyGen Project (both the initial Xodus Group work (Xodus Group, 2012) and the reparameterised work by Marine Scotland Science and SNH (Marine Scotland and SNH, 2014) indicate that impacts were unlikely to be significant. Further work with regards to understanding both Atlantic salmon migration through the Pentland Firth and potential collision risk have been ongoing since 2012. This work has included the development of a draft model by SNH to predict collision risk (SNH, 2015) which was released during the period over which the Project EIA has been undertaken. As the latest development in work relating to fish collision risk, it has been used to inform the fish ecology impact assessment.

12.7 CONSULTATIONS

A list of feedback from all consultees is summarised in Chapter 6 Consultation Process. The key points raised by stakeholders regarding fish ecology are presented in Table 12.3.

Table 12.3: Key issues raised by stakeholder during consultation

Stakeholder	Comment	Response/Action taken	Section cross-reference
MS-LOT	The main diadromous fish species of concern and the potential impacts of the Project on these need to be fully explored in the Environmental Statement.	This is covered in the EIA.	Section 12.9.6
MS-LOT	Assess the potential impacts of deployed devices on diadromous fish during deployment, operation and decommissioning phases.	This is covered in the EIA.	Sections 12.12.1, 12.12.2 and 12.12.3
MSS	Additional data sources including site specific surveys and recent fisheries sensitivity maps should be used to inform the baseline and impact assessment on fish and elasmobranch species.	Results from the benthic surveys used to inform the assessment and covered in the EIA.	Sections 12.9.2, 12.9.3, 12.9.4, 12.9.5, 12.9.6, 12.9.7
MSS	There is both a clear need to consider fully the combined impact of the proposed development along with other proposed tidal developments in the same area of Scotland and consider more widely in-combination effects with various other types of development which could be much further from the Project site.	This is covered in the EIA.	Chapter 22 Cumulative Impacts Assessment
MSS	Some analysis of the habitat maps to determine suitable areas of sediment for both herring and sandeels and for this analysis to be ground truthed with some of the underwater TV work/sediment analysis where possible.	Undertaken as part of habitat preference sections for these species.	Sections 12.9.3.1, 12.9.4.1
SNH	The study area should be clearly defined and recent findings of salmon tagging studies should be used to inform the assessment.	This is covered in the EIA and HRA screening note.	Sections 12.2, 12.9.6.1, 12.12.2.3 and 12.12.2.5
SNH	Cumulative impacts with other renewables developments in the PFOW and Moray Firth will be an important consideration, as may other non-renewables activities.	This will be covered in the EIA.	Chapter 22 Cumulative Impacts Assessment
SNH	Swimming depths of migratory species.	This will be covered in the EIA.	Section 12.12.2.3
SNH	Impacts on Priority Marine Features (PMF).	This will be covered in the EIA.	Sections 12.12.2.4

Stakeholder	Comment	Response/Action taken	Section cross-reference
SNH	The potential for the infrastructure to act as Fish Aggregating Devices (FADs).	This will be covered in the EIA.	Section 12.12.2.4
SNH	Impacts of underwater noise on species including salmon.	This will be covered in the EIA.	Sections 12.12.1.3 and 12.12.2.6
SNH\MSS	Collision risk modelling for fish is required	This will be covered in the EIA.	Section 12.12.2.3
SNH	It is not possible to undertake site-specific HRA for migratory Atlantic salmon, or other migratory fish, due to the difficulties in apportioning impacts correctly to SACs and a lack of information on SAC populations to inform decisions on site integrity. For this assessment we advise that potential impacts to migratory fish and freshwater pearl mussel are considered under EIA rather than HRA.	This will be covered in the EIA.	Section 12.12

12.8 ASSESSMENT METHODOLOGY

12.8.1 Assessment Criteria

The EIA process and methodology are described in detail in Chapter 7 EIA Scope and Methodology. However, each assessment chapter is required to develop its own criteria for the sensitivity and value of receptor and magnitude of impact aspect since the definition of these will vary between receptors. Different species are likely to be the receptor depending on their sensitivities and vulnerabilities detailed in the baseline description (Section 12.9). The sensitivity and value of the receptor and magnitude of impact criteria specific to fish ecology are defined in Table 12.4 and Table 12.5 respectively.

Value is presented as a component of sensitivity to allow a judgement to be made according to either a receptor's sensitivity to a particular effect or its value under international, national, or regional legislation. Value should therefore be applied inherently when considering the sensitivity of a receptor to a particular effect. Where the sensitivity rating for tolerance and designation are not in agreement, expert judgement is used to determine the most appropriate sensitivity ranking. This is explained though the narrative of the assessment.

Mitigation is applied to the sensitivity and value of receptor to provide a residual magnitude of the impact and presented alongside a qualitative understanding of the likelihood (using the criteria detailed in Chapter 7). The definitions for impact significance are also presented in Chapter 7, Section 7.7. The residual significance of the impact is then considered by reference to the relevant criteria in the EIA Regulations. Definitions for impact significance are presented in Chapter 7, Section 7.7.

Table 12.4: Definitions for sensitivity of fish ecology

Sensitivity	Criteria
High	Sensitivity: Receptor with little or no capacity to accommodate a particular effect with no ability to recover or adapt. Value: Fish species affected are designated under international legislation (e.g. IUCN red list, EU Habitats Directive). In the context of a particular impact, species which are considered highly sensitive to the impact[1]
Medium	Sensitivity: Receptor with very low capacity to accommodate a particular effect with low ability to recover or adapt Value: Fish species affected are designated under UK and Scottish legislation (e.g. PMF). In the context of a particular impact, species which are moderately sensitive to the impact[1].
Low	Sensitivity: Receptor has some tolerance to accommodate a particular effect or will be able to recover or adapt. Value: Fish species affected are designated under local legislation (e.g. Local BAP species) and are vulnerable to the impacts in question. In the context of a particular impact, species which are not very sensitive to the impact[1].
Negligible	Sensitivity: Receptor is generally tolerant and can accommodate a particular effect without the need to recover or adapt. Value: Fish species with little or no local importance or sensitivity to the impacts in question. In the context of a particular impact, species which show no sensitivity to the impact[1].
Note: [1] In the context of some impacts, certain species may be very sensitive to the impact (e.g. herring and noise) but are not designated under certain legislation that would make them of very high sensitivity. In addition there may be some receptors that are very high sensitivity due to their designation under international legislation but in the context of the particular impact they demonstrate no sensitivity to the impact and can be considered of low sensitivity. In such cases expert judgment is used to determine the most appropriate sensitivity ranking and this is explained through the narrative of the assessment.	

Table 12.5: Definitions for magnitude of effect for fish ecology

Sensitivity	Criteria
Major	Prolonged/widespread disturbance to fish species to the baseline condition, with long-term or permanent effects on any or all of the following: spawning grounds, nursery grounds, and migration routes and/or feeding grounds. These would result in long-term changes in population size. Impact highly likely to occur.
Moderate	Medium-term and localised disturbance or change to the baseline condition to fish species, with short-term and recoverable effects on: spawning grounds, nursery grounds, migration routes and/or feeding grounds. Populations would recover in the medium-term. Impact likely to occur.
Minor	Short-term and localised disturbance or change to the baseline condition to fish species, with short-term and recoverable effects on: spawning grounds, nursery grounds, migration routes and/or feeding grounds. Populations would show recovery in the short-term. Impact will possibly occur.
Negligible	Imperceptible or no changes to the baseline condition including to: spawning grounds, nursery grounds; migration routes; and/or feeding grounds. No changes experienced at the population level. Impact highly unlikely to occur.
Positive	An enhancement of an ecosystem or population parameter.
Note: Magnitude of impact is presented as a variety of parameters including duration, timing, size and scale, and frequency. Definitions in this table may not be appropriate for all impacts, for example there may be an impact which is over a very small area (minor or moderate) but is repeated a large number of times during a particular phase of the Project (major or severe). In such cases expert judgment is used to determine the most appropriate magnitude ranking and this is explained through the narrative of the assessment.	

Table 12.6: Assignment of impact significance for fish ecology based on sensitivity of receptor and magnitude of effect

Sensitivity of Receptor	Magnitude of effect			
	Major	Moderate	Minor	Negligible
High	*MAJOR*	*MAJOR*	*MODERATE*	*MINOR*
Medium	*MAJOR*	*MODERATE*	*MINOR*	*MINOR*
Low	*MODERATE*	*MINOR*	*NEGLIGIBLE*	*NEGLIGIBLE*
Negligible	*MINOR*	*NEGLIGIBLE*	*NEGLIGIBLE*	*NEGLIGIBLE*

12.9 BASELINE DESCRIPTION

12.9.1 Introduction

The fish ecology baseline description is based upon a comprehensive desk based study, surveys of large fish species and consultation with relevant organisations. The main focus of the fish ecology assessment is to consider impacts on important fish habitat, in particular key spawning and nursery grounds which are essential for sustaining fish populations and potential impacts on individual fish species, their migration routes and their contribution to local biodiversity and wider food webs. The assessment therefore considers impacts on the following fish groups:

- Pelagic species;
- Demersal species;
- Elasmobranch fish species;
- Diadromous fish species; and
- Other relevant PMF or Annex II[8] species.

12.9.2 Benthic Environment

In the shallower end of the three cable corridor options (Sheep Skerry, Moodies Eddy and Aith Hope), the sediment is characterised by medium to fine sand with bedrock outcrops and varying densities of kelp and other seaweed. As the water depth increases the proportion of sandy sediment increases in relatively sheltered areas and the prevalence of seaweed decreases (Supporting Document: Aquatera, 2014).

The seabed observed in depths of 20 – 40m is classified as circalittoral mixed sediment and dominated by gravelly sands with frequent bedrock outcrops and boulders. In the southern region of the cable route corridor, where water depths are greater than 50m, the seabed biotopes were more typically tidally-swept rocky areas.

In the AfL area the seabed is characterised as extremely tide swept circalittoral rock consisting of primarily rocky with occasional veneers of gravel and coarse sandy sediments in the more sheltered areas such as in rock crevices and between boulders (Supporting Document: Aquatera, 2014).

More detail of the benthic habitats present and biotope classifications are provided in Chapter 11 Benthic Ecology.

12.9.3 Pelagic Fish Species

Pelagic fish inhabit the water column including the near-surface. Their distribution is strongly affected by hydrographic conditions and can vary significantly from year to year. The principal pelagic species found in the region are typical of the wider North Sea including herring *Clupea harengus*, sprat *Sprattus sprattus* and mackerel *Scomber scombrus*. Herring and sprat play an important ecological role as principal prey items for several larger species, marine birds and mammals. A brief summary of herring biology with regard to the North Sea population is presented below, with a view to identifying species key life stages likely to be particularly sensitive to noise from construction and operation of the tidal array.

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[8] Species listed on Annex II of the Habitat's Directive

12.9.3.1 Herring Ecology

Data from Coull *et al.* (1998) indicates that herrings spawn all around the Orkney coastline and across the Pentland Firth to the north of Scotland, coinciding with the Project site (Figure 12.1). Herring are reported to deposit their sticky demersal eggs on a variety of substrates ranging from boulders, rock, small stones, coarse sand, shell fragments, macrophytes and man-made structures such as lobster pots. Gravel is widely considered to be the preferred spawning substrate (Drapeau, 1973; Rogers and Stock, 2001).

Herring around the UK have been divided into sub populations based on the timing and region of spawning. Those that spawn around the coast of Orkney are known as the Orkney/Shetland and Buchan components. The Orkney sub population spawns in September and October (Coull *et al.* 1998). The survival and development of herring eggs have been reported to be insensitive to even high concentrations of suspended sediment, but studies have concluded that smothering is likely to be detrimental unless the material is removed rapidly by the current (Birklund and Wijsam, 2005).

After hatching, larvae are pelagic and drift with the currents and the juvenile nursery grounds tend to be close inshore. The results from the IHLS corroborate this, as presented in Figure 12.1. After approximately one year they migrate further offshore to join the adult population at feeding grounds before returning to spawning in their well-defined areas. Herring play an important ecological role as principal prey items for several larger fish species, marine birds and mammals and occur throughout Scottish waters.

Herring Habitat Preferences

Herring have very specific habitat requirements, generally requiring clean gravelly sediment in waters of less than 40m depth (ICES, 2014b) with sediment containing less than 2% fine particles (Saetre, 1999). As a consequence, their spawning grounds are relatively limited and potentially vulnerable to seabed disturbance and change. The gravelly sands recorded between 20 – 40m in the three cable route corridors are not suitable herring spawning ground because of the silt/clay and very fine sand content (JNCC, 2015). Preferred herring spawning grounds are tide-swept circalittoral coarse sands, gravel and shingle, and probably offshore (deep) circalittoral habitats with coarse sands and gravel or shell (Personal Communication, David Donnan and Chris Leakey, SNH, 2015). There are no habitats of this kind within the Project site and herring spawning grounds will therefore not be impacted.

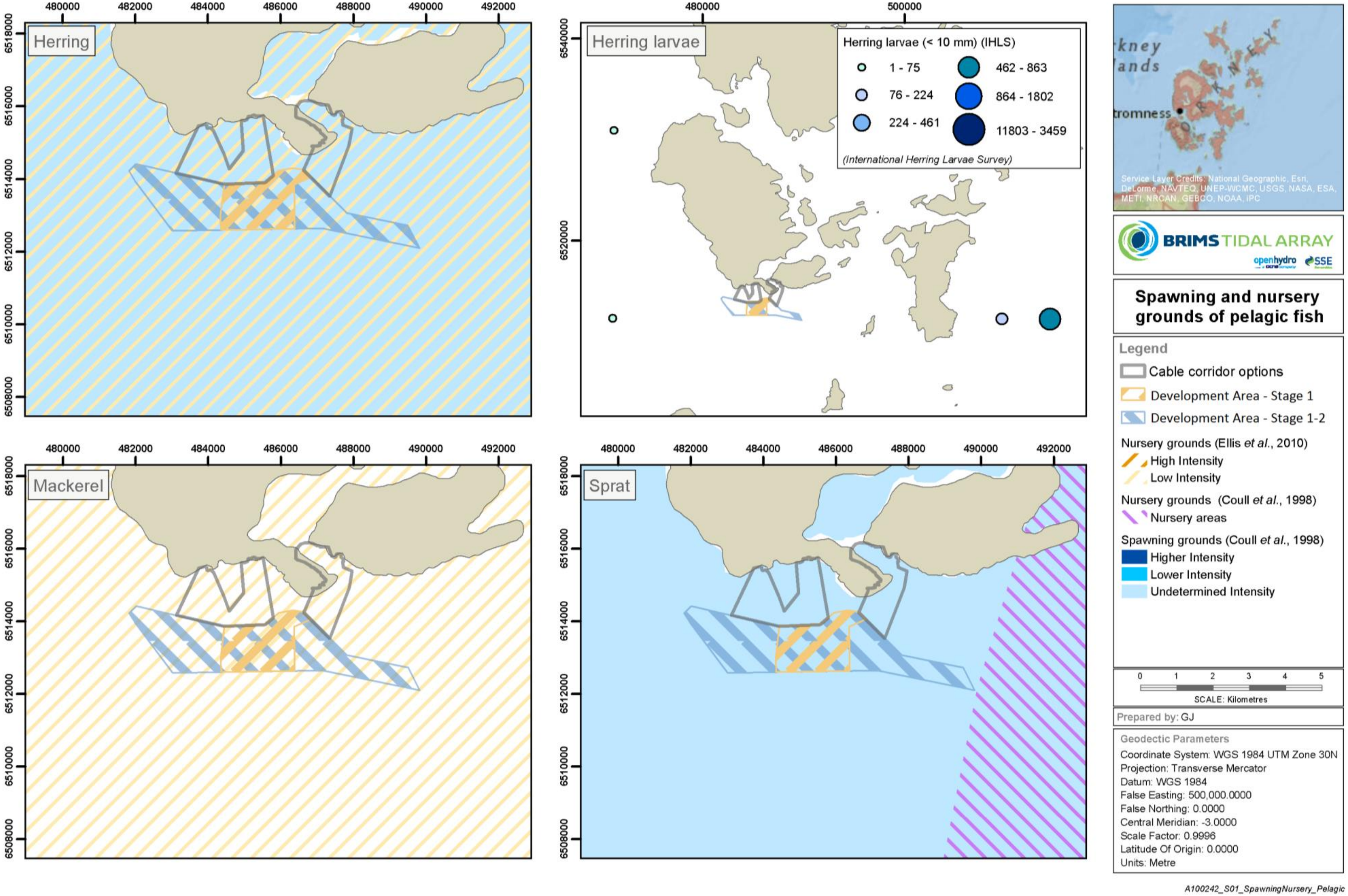

Figure 12.1: Spawning and nursery grounds of pelagic fish, including herring larvae abundance 2008-2012

12.9.3.2 Pelagic Spawning and Nursery Areas

Data from Coull *et al.* (1998) indicate that in addition to herring, sprat spawn around all of the Orkney coastline and across the Pentland Firth to the north of Scotland, overlapping with the Project site (Figure 12.1). Sprat spawn from May to August, during which May and June are peak spawning periods. Mackerel do not spawn in the AfL area or any of the export cable corridor options.

Data from Coull *et al.* (1998) and Ellis *et al.* (2012) also show that nursery grounds of herring, sprat and mackerel coincide with the Project site as shown in Figure 12.1. Coull *et al.* (1998) found sprat to be ubiquitous across the region during nursery periods; however, data for specific nursery periods are not readily available as they vary annually depending on numerous factors (Cefas, 2001).

The IHLS (ICES, 2014) show that there are no herring larvae within the Project site (as shown in Figure 12.1).

12.9.3.3 Seasonal Sensitivities and Vulnerabilities of Key Pelagic Species

Research shows that the main issues for pelagic fish are noise and suspended sediment concentration levels (ICES, 2006). The relative mobility of pelagic fish may allow localised avoidance of some of the above aspects, such as suspended sediments (Birkuland and Wijsman, 2005). However, effects such as noise may be unavoidable as they can be detected from relatively long distances.

Herring and sprat, unlike most other fish, have specialised adaptations connecting the swim bladder and oesophagus to the inner ear. These morphological adaptations make them one of the most sensitive fish species to noise (ICES, 2006). Herring and mackerel may also be disturbed by, and avoid, suspended sediment levels (Birkuland and Wijsman, 2005). Table 12.7 details the key pelagic species, their conservation status and seasonality of spawning activity.

Table 12.7: Pelagic species with defined spawning and nursery grounds within the Project site (Coull *et al.* 1998; Ellis *et al.* 2012)

Species	Spawning grounds		Nursery grounds		Conservation and commercial importance
	AfL area	Cable	AfL area	Cable	
Herring	Sept - Oct	Sept - Oct			UK BAP IUCN Red List (Least Concern) Priority Marine Feature
Mackerel	n/a	n/a			UK BAP IUCN Red List (Least Concern) Priority Marine Feature
Sprat	May-Aug	May-Aug			None

Key	
	High intensity
	Low intensity
	Undefined Intensity
n/a	Insufficient information available

12.9.4 Demersal Fish Species

Demersal fish are bottom feeders that live on or near the seabed. In coastal waters they are found on or near the continental shelf, whereas in deep waters they are more associated with the continental slope or continental rise. Their distribution is related to abiotic factors such as sediment type (which is usually important as a refuge in predation avoidance or for cryptic behaviour), hydrography, biotic processes (e.g. predator prey interactions), and competition for space. Demersal species found in the region include gadoids (soft finned fish species of the family Gadidae), flatfish, sandeel and elasmobranchs (elasmobranchs are discussed in Section 12.9.5 and are therefore not listed here).

The following demersal species are present in the area according to Coull *et al.* (1998) and Ellis *et al.* (2012):

- Anglerfish *Lophius piscatorius*;
- Blue whiting *Micromesistius poutassou*;
- Cod *Gadus morhua*;
- European hake *Merluccius merluccius*;
- Lemon sole *Microstomus kitt*;
- Ling *Molva molva*;
- Saithe *Pollachius virens*;
- Sandeel *Ammodytidae spp.*; and
- Whiting *Merlangius merlangus*.

12.9.4.1 Sandeel Ecology

Sandeel are major predators of zooplankton and play a key role in the North Sea food web and are the principal prey of many top predators including other demersal fish (Collins and Pierce 1996; Greenstreet *et al.* 1998; Wright & Kennedy 1999; Olsen and Holst, 2001; Mills *et al.* 2003; Santos *et al.* 2005; ICES, 2006; ICES, 2008; Walters, 2010; Walters, 2011), marine mammals (McConnell *et al.* 1999; Pierce *et al.* 2004), and birds (Wright and Bailey 1996; Furness, 1999; and Wanless *et al.* 2005).

They have highly specific habitat requirements meaning that in addition to patchy spawning grounds, the distribution of post-settled sandeel is very irregular (Wright and Kennedy, 1999; Jensen *et al.* 2011). Sandeel are most active in late spring and early summer, during which time they move freely, on a diurnal basis, between the seabed and the water column. During autumn and winter, sandeel lie dormant in the sediment except for a brief midwinter emergence to spawn (November to February) (Greenstreet *et al.* 2010). Post settled sandeel are very rarely found at depths greater than 15m and the maximum distance travelled by tagged fish displaced from grounds was 64km (Jensen *et al.* 2011).

Sandeel Habitat Preferences

The North-west Orkney Nature Conservation Marine Protected Area (NCMPA) which is located approximately 30km north west of the Project site is designated for the protection of sandeels. The Project will not impact this protected area. Sandeel are particularly sensitive because they spawn in very specific habitats. Holland *et al.* (2005) found that *A. marinus* require a very specific substratum, favouring seabed habitats containing a high proportion of medium and coarse sand (particle size ≥ 0.25 to < 2mm) and low silt content. Overall, sandeels are considered to be rare in sediments where the silt content (particle size < 63μm) is greater than 4%, and absent where the silt content is greater than 10% (Holland *et al.* 2005). Work by Greenstreet *et al.* (2010) has characterised this further into four preferences based on % of coarse sands by weight contained within the sediment composition. Table 12.8 details the preferences based on the % of coarse sands within sediments.

Table 12.8: Sandeel sediment preference and categorisation of the seabed sediments (Greenstreet *et al.*, 2010)

Preference	Coarse sands range (% by weight)	Upper limit of silt and fine sand (% by weight)
Prime	70 -100%	20%
Sub-prime	50 – 69%	30%
Suitable	20 – 49%	50%
Unsuitable	< 19%	> 50%

As discussed in Section 12.9.2 and in Chapter 11 – (Figure 11.1, biotope map) shallower areas of the Moodies Eddy and Aith Hope cable landfall options were found to contain coarse sands and were consistent with the JNCC biotope of sublittoral sediment (SS.SMp.KSwSS – See Chapter 11). JNCC (2015) criteria show that this biotope has on average 47% coarse gravel content and 46% silt and fine sand. This therefore shows that the inshore areas of these two landfall options are classed as 'suitable' habitat for sandeels. No other areas of the Project (AfL or cable corridors) were found to be within preferential sediment content limits.

12.9.4.2 Demersal Species Spawning and Nursery Areas

Data from Coull *et al.* (1998) and Ellis *et al.* (2012) indicate that two demersal fish species spawn in the vicinity of the Project site: sandeel and lemon sole (Figure 12.2). Spawning grounds of unknown intensity for sandeel, which spawn from November to February, and spawning grounds of unknown intensity for lemon sole, which spawn from April to September.

Many demersal species, including lemon sole, have buoyant eggs that are released into the water column where they remain for several weeks until the pelagic larvae emerges (van Damme *et al.* 2011). Sandeel eggs are laid in clumps that stick to coarse sandy substrata until they hatch during February and March, after which the larvae are found in the water column.

Data from Coull *et al.* (1998) and Ellis *et al.* (2012) indicate that within the Project site there are high intensity nursery grounds of anglerfish and blue whiting and there are low intensity nursery grounds of cod, European hake, ling, sandeel and whiting. Nursery grounds of unidentified intensity for lemon sole and saithe also overlap with the Project site (Figure 12.2).

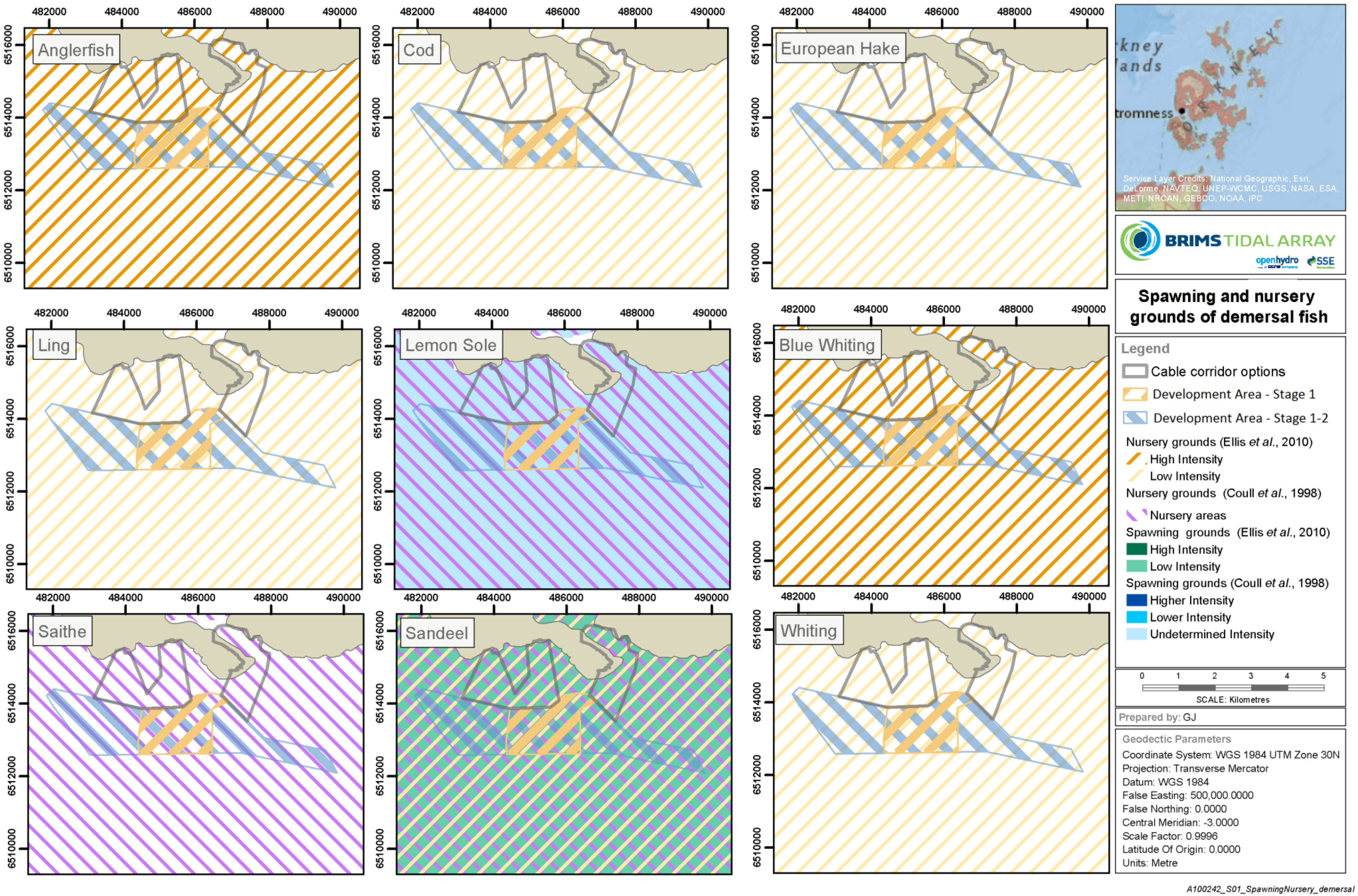

Figure 12.2: Spawning and nursery grounds of demersal fish

12.9.4.3 Seasonal Sensitivities and Vulnerabilities of Key Demersal Species

Several demersal species of fish may be sensitive and/or vulnerable to effects arising from construction, operation and maintenance of the Project, including disturbance of spawning grounds, disturbance of habitat for demersal species, noise, collision risk, electro-magnetic fields (EMF) and changes to existing habitat.

Sandeel are the most sensitive demersal species as described above. The pelagic spawn of lemon sole is also a key sensitivity. Spawn in the water column may be affected by suspended sediment which could cause it to sink, thus affecting survivability. Anglerfish and blue whiting have high intensity nursery grounds in the AfL area and surrounding area.

Juvenile stocks of demersal fish are considered to be more vulnerable than adults to some of the effects associated with tidal array development, such as habitat loss, due to their adaptability and tolerance by way of their less mobile nature and specialist feeding behaviour. However, adult stocks are reliant upon successful spawning, nursery and migratory phases; therefore, loss of habitats for spawning and nursery grounds will be reflected in future adult fish populations.

Impacts from increased noise on demersal fish are similar to those for pelagic fish and range from behavioural changes (e.g. changes in swimming speed and direction) (Mueller-Blenkle *et al.* 2010), to lethal effects at very close range (e.g. haemorrhage of internal organs) (Halvorsen *et al.* 2011).

Table 12.9 details the sensitive periods and conservation status of the key demersal species likely to be present in the Project site.

Table 12.9: Demersal species with defined spawning and nursery grounds within the Project site (Coull *et al.* 1998; Ellis *et al.* 2012)

Species	Spawning grounds		Nursery grounds		Conservation and commercial importance
	AfL area	Cable	AfL area	Cable	
Anglerfish	n/a	n/a			UK BAP Priority Marine Feature
Blue whiting	n/a	n/a			Priority Marine Feature UK BAP
Cod	n/a	n/a			UK BAP OSPAR Species (stock depleted and in danger of collapse) IUCN Red List (Vulnerable) Priority Marine Feature
European hake	n/a	n/a			UK BAP
Lemon Sole	Apr – Sep	Apr – Sep			None
Ling	n/a	n/a			UK BAP Priority Marine Feature

Species	Spawning grounds		Nursery grounds		Conservation and commercial importance
	AfL area	Cable	AfL area	Cable	
Saithe	n/a	n/a			Priority Marine Feature
Sandeel	Nov - Feb	Nov - Feb			UK BAP Priority Marine Feature
Whiting	n/a	n/a			UK BAP Priority Marine Feature

Key	
	High intensity
	Low intensity
	Undefined Intensity

12.9.5 Elasmobranch Species

Sharks and rays are particularly sensitive to disruption because they have slow growth rates and low reproductive output compared to other species groups (Camhi *et al.* 1998). This results in slow rates of stock increase and low resilience to fishing mortality (Holden, 1974). Directed fisheries have caused stock collapse for many species (Musick and Musick, 2005), although at present mortality in mixed species fisheries and by-catch appears to be a more significant threat (Bonfil, 1994). As a result the stocks of most elasmobranch species are currently at low levels and spatial management measures have been introduced to protect the remaining stocks (ICES, 2008).

The following demersal species are likely present in the area (Coull *et al.* (1998) and Ellis *et al.* (2012)):

- Common skate complex *Dipturus batis*, now split provisionally into *D. cf. flossada* and *D. cf. intermedia*;
- Spotted ray *Raja montagui*;
- Spurdog *Squalus acanthias*;
- Thornback ray *Raja clavata; and*
- Tope shark *Galeorhinus galeus.*

12.9.5.1 Key Elasmobranch Species

Data from Ellis *et al.* (2012) indicate that no elasmobranch species spawn in the vicinity of the Project site and export cable route (Figure 12.3). There are, however, low intensity nursery areas for the common skate complex, spotted ray, spurdog, and tope shark which overlap with the Project site and thornback ray (~11km to the east) (Figure 12.3).

The common skate complex occupy sandy and muddy bottom habitats from 10 to 100m deep. Younger individuals are more often found in shallower waters than adult. Data from the Orkney Skate Trust shows that common skate can occur within Orkney waters, and benthic habitats in the area of the Project are considered suitable for common stake. However, no records from the Skate Trust or video analyses from the benthic survey were found within the AfL, cable route corridor or immediate surrounding (200m). The closest record occurred within approximately 7km north east of the Project boundary.

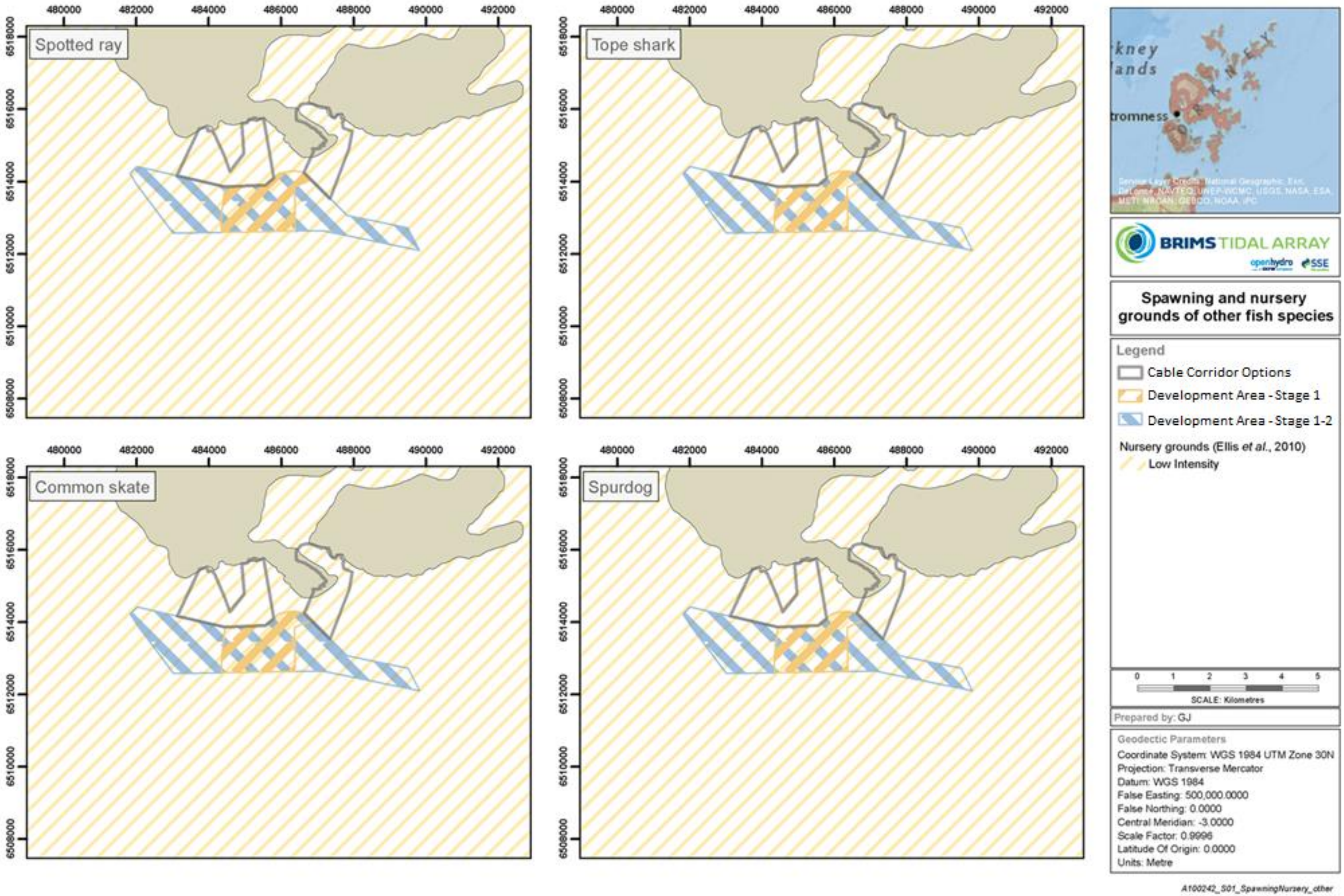

Figure 12.3: Spawning and nursery grounds of other fish species

12.9.5.2 Seasonal Sensitivities and Vulnerabilities of Key Elasmobranch Species

Elasmobranch species may be sensitive and/or vulnerable to several effects associated with the Project such as sediment disturbance, noise from construction and operation and electromagnetic fields generated by subsea cables.

Experimental studies have provided evidence that some elasmobranch species (the lesser spotted dogfish and the thornback ray) can respond to the presence of electromagnetic fields that are of the type and intensity associated with sub-sea cables (Gill *et al.* 2009). EMF can be detected by some species over tens of metres decreasing in intensity with increasing distance from the source (Gill *et al.* 2009). The reaction of the fish was unpredictable and did not always occur. When a reaction occurred it appeared to be species specific and, in some cases, individual specific, behavioural activity associated with foraging (Gill *et al.* 2009). Thornback rays were reported to be more likely to move around within the electromagnetic field generated by an operating cable, whereas the lesser spotted dogfish were reported to have more restricted movements within the electromagnetic field generated by an operating cable (Gill *et al.* 2009).

Table 12.10 details the sensitive periods and conservation status of the key elasmobranch species likely to be present in the area. Of key concern are the common skate complex and spurdog as they are listed as critically endangered on the IUCN Red List (Table 12.10).

Table 12.10: Elasmobranch species with defined spawning and nursery grounds within the Project site (Coull *et al.* 1998; Ellis *et al.* 2012)

Species	Spawning grounds		Nursery grounds		Conservation and commercial importance
	AfL area	Cable	AfL area	Cable	
Common skate complex	n/a	n/a			OSPAR species (stock depleted and in danger of collapse) IUCN Red List (critically endangered) UK BAP Priority Marine Feature Scottish Nature Conservation MPA Search feature (marine life stages)
Spotted Ray	n/a	n/a			IUCN Red List (Least Concern) OSPAR
Spurdog	n/a	n/a			OSPAR species (stock depleted and in danger of collapse) IUCN Red List (critically endangered) UK BAP Priority Marine Feature Scottish Nature Conservation MPA search feature (marine life stages)
Thornback ray	n/a	n/a			IUCN Red List (Near Threatened) OSPAR species (stock depleted and in danger of collapse)
Tope shark	n/a	n/a			IUCN Red List (Vulnerable) UK BAP

Key	
	High intensity
	Low intensity
	Undefined Intensity
n/a	Insufficient data

12.9.6 Diadromous Migratory Species

The following diadromous species are expected to transit the Project site on an occasional basis:

- Atlantic salmon *Salmo salar*;
- Sea trout *Salmo trutta*; and
- European eel *Anguilla anguilla*.

Several species of fish living in Scottish rivers migrate between the sea and the upper reaches of rivers during their life cycle. Atlantic salmon and sea trout are anadromous, meaning they spend the majority of their adult lives in the oceans but return to freshwater to reproduce. European eel are also migratory diadromous fish, but their lifestyle differs from anadromous fish; adult eels migrate out to sea to spawn and their larvae make the return journey (termed catadromous).

12.9.6.1 Atlantic Salmon and Sea Trout

Atlantic salmon are widely distributed in Scotland and salmon populations are recognised as being of national and international importance. Sea trout are the migratory form of brown trout and have a very similar life history to Atlantic salmon. A comparison of the life histories of the two species is detailed in Table 12.11.

Table 12.11: Atlantic salmon and sea trout life histories

Species	Juvenile stage (smolts)	Adult stage	Time in fresh water	Time at sea	Location offshore	Spawning season	Proportion return to sea following spawning
Atlantic salmon	Fresh water	Marine	Up to four years	Up to five years	Undergoes extensive migrations offshore	October to January	20-36%
Sea trout	Fresh water	Marine	Up to three years	May over winter in fresh water	Remains in near-shore areas	October to January	75%

Data from the Orkney Biological Records Centre (presented on the NBN Gateway) contain records of Atlantic salmon at the mouths of four burns on Hoy: Rackwick, Pegal, Ore and Burnhouse. The closest of these is the Ore burn, which is located approximately 7.5km north of the AfL area. There are also records of Atlantic salmon at six locations on mainland Orkney and numerous records at rivers along the north coast of mainland Scotland, the closest to the Project being the River Thurso approximately 24.5km south west (Figure 12.4). Data from the same source contains records of sea trout at the same burns on Hoy in addition to Greenheads, which is approximately 3.5km north of the AfL area. There are also records of sea trout at 11 locations on mainland Orkney and numerous records at rivers along the north coast of mainland Scotland, the closest to the Project being the River Ling approximately 290km south west.

The juvenile life stage of salmon takes place in fresh water, which typically lasts between one to four years before surviving fish migrate to the sea as smolts. Following entry to the sea, fish are known as post-smolts until the spring of the following year. Atlantic salmon grow rapidly by feeding at sea before returning to their native rivers to spawn. The length of time a salmon spends in the sea before returning to their river of origin to spawn varies from one to five winters (Marine Scotland, 2011). Salmon that return after one winter are known as grilse or 1SW (1 winter at sea) whilst salmon that remain offshore for two to five years are known as MSW (multiple winters at sea).

The adult fish may spawn in quite small headwater streams as well as in suitable areas in larger water courses. Adult fish enter rivers from the sea at almost any time of year, but they migrate into smaller spawning streams on elevated flows following rainfall in the autumn. Spawning takes place between late October and early January (Cefas, 2004), after which a small proportion of the adult fish return seaward over a period of up to several months (salmon returning to the sea following spawning are termed kelts). The proportion of adults returning to the sea following spawning is in the region of 20 to 36% (Hendry and Cragg-Hine, 2003).

Atlantic salmon have been identified as a species of conservation importance as detailed in Table 12.13. In recognition of the importance of UK salmon populations, 17 rivers have been designated SACs for Atlantic salmon in Scotland. The nearest designated SAC salmon river to the Project site is the River Thurso, located on mainland Scotland, approximately 25km to the south west of the Project (Figure 12.4 and Table 12.14). The river supports a higher proportion of multi sea-winter salmon than is found in many rivers further south in the species' range. The northerly location of the river leads to cooler ambient water temperatures than are observed in salmon rivers elsewhere, which causes slower growth in juveniles. Consequently, they smolt at an older age and tend to return to the river to spawn as older MSW salmon.

Findings presented by Malcolm *et al.* (2010) suggested that up to 90% of smolts migrate from Scottish east-coast rivers through the Pentland Firth on their way to feeding ground in the Atlantic Ocean. However, more recent research by Godfrey *et al.* (2014a, 2014b) and Guerin *et al.* (2014) have suggested that distribution may be spread wider than just the Pentland Firth with some fish travelling through or north of Orkney.

The review by Malcolm *et al.* (2010) of tagging studies of adult salmon found that as well as Atlantic salmon from the east coast moving through the Pentland Firth in a easterly direction towards their natal rivers, movement from the east to the north coast in a westerly direction may be relatively common for both grilse and MWS salmon. However, the numbers involved in the westerly movement are likely to be lower than the main movement east. Some fish tagged on the east coast of Scotland, including near Montrose and the Black Isle, have been later recaptured on the north coast of Scotland, indicating that these fish would have passed through the Pentland Firth area. The coastal tagging studies identified by Malcolm *et al.* (2010) reported very few re-captures within the Pentland Firth. For the purposes of the following assessment, the worst case draws on the findings of Malcolm *et al.* (2010) and assumes most adults returning to Scotland pass through Pentland Firth.

Table 12.12 details the likely population size of Scottish Atlantic salmon at different life stages and the numbers of fish that are assumed to migrate through the Pentland Firth. These values were used to inform the Atlantic salmon CRM for the Project. The number of smolts is based on the number that could come from rivers on the east coast of Scotland and half of the north coast rivers. Smolt density form the North Esk is used to calculate the number of smolts per river based on the area of suitable habitat. Adult salmon and grilse populations are a ten year average using salmon population's numbers reported by ICES (2015). It is assumed that 88% of the total salmon population returning to Scotland return to east coast rivers. Of these it is assumed that 90% of the fish that return to the east coast rivers migrate through the Pentland Firth with the remainder migrating through the Orkney Isles or north of Orkney (Marine Scotland, 2013).

Table 12.12: Scottish salmon population size (ICES, 2015b; Xodus Group, 2012)

Salmon life stage	Population size	Number of individuals migrating through Pentland Firth
Smolt	7,341,461	6,607,314
1SW	315,284	249,705
MSW	237,844	188,372

The fact that many smolts are caught in surface trawls also suggests that smolts spend most of their time in the top few metres of the water column (Malcolm *et al.* 2010; Godfrey *et al.* 2014a & b).

Whilst at sea salmon typically spend most of their time close to the surface, they do often dive, sometimes to depths of over 250m (Malcolm *et al*. 2010; Godfrey *et al.* 2014b). The complex near-shore directional movements of salmon remain poorly understood and their behaviour at this stage may be linked to a range of local environmental conditions such as tidal movements, home river discharges, diurnal rhythms and other biological and physical cues.

With regard to sea trout, there is limited information on swimming depths for adult sea trout, although data from Norway suggests shallow swimming depths (<3m) with frequent dives to approximately 30m (Malcolm *et al.* 2010).

Despite Malcolm *et al.* (2010) concluding that given the data available to date, no reliable conclusions can be drawn on the marine distribution of adult sea trout, given the proximity of sea trout sightings to the Project site and their known behaviour, a precautionary approach assumes that sea trout will pass through coastal areas of the Pentland Firth. It is also assumed that Atlantic salmon pass through the Project site.

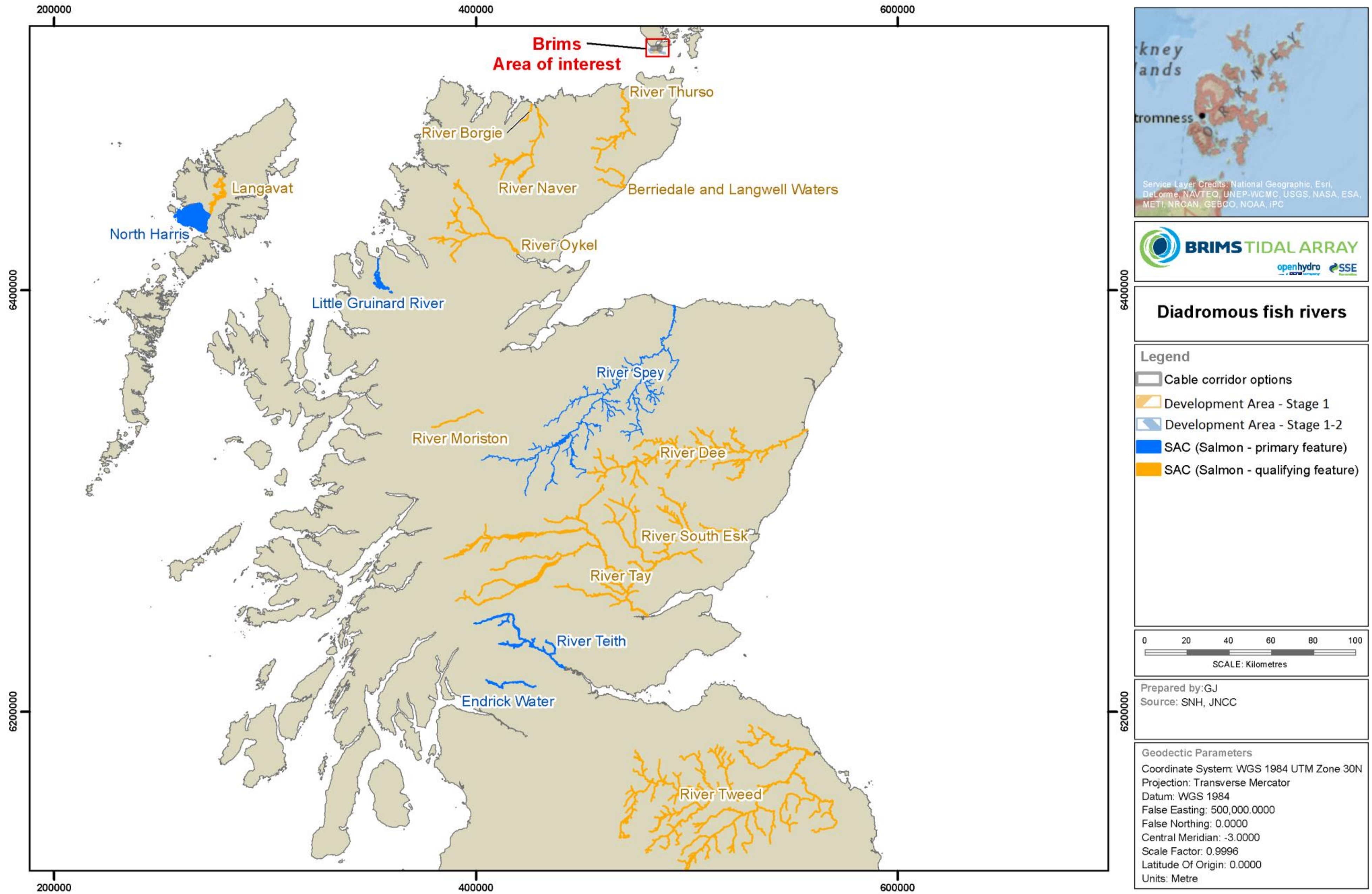

Figure 12.4: Diadromous fish rivers

12.9.6.2 European Eel

There is evidence to suggest that the Pentland Firth is well used by European eel (Malcolm *et al.* 2010) and that this species occurs in rivers close to the Project site. As such, it must be assumed that both juveniles and adults will transit the Project site.

Data from the Orkney Biological Records Centre (presented on the NBN Gateway) contain records of European eel at the mouths of five burns on Hoy: Rackwick, Pegal, Ore, Greenheads, and Summer. The closest of these, Greenheads, is located approximately 3.5km north of the AfL area. There are also records of European eel at 11 locations on mainland Orkney and numerous records at rivers along the north coast of mainland Scotland, the closest to the Project being the River Ling approximately 290km south west.

The life cycle of the European eel is well known. Spawning occurs in the Sargasso Sea (in the mid-Atlantic Ocean), after which larval eels cross the Atlantic Ocean. After the continental growth stage which can last from 30-60 years, the eels begin the return migration to the Sargasso Sea (Malcolm *et al.* 2010).

Very little is known about the routes undertaken or the nature of eel migrations as juveniles and as adults. However, for both migrations it is possible that a significant proportion of the total European population may pass through the seas around Scotland (Malcolm *et al.* 2010). The timing of migration peaks in Scottish waters is poorly recorded but Malcolm *et al.* (2010) inferred that glass eels pass through Scottish waters principally from September to December. In addition, glass eels destined for Scottish rivers must remain in coastal regions until April to May before river temperatures rise sufficiently for them to enter fresh water. The majority of return eel migration is likely to take place between September and January.

Both juvenile and adult eels can be found throughout the water column (up to depths of 300m) and the depth selected can vary with the time of day and the state of the tide.

12.9.6.3 Seasonal Sensitivities and Vulnerabilities of Key Diadromous Species

The migratory behaviour of diadromous species means that they are likely to be sensitive to certain effects associated with the Project, specifically noise generated during construction and operation and EMF generated by subsea cables. Behavioural avoidance is an important consideration during migration of salmonids. In terms of onset of physiological effects, salmon are not the most sensitive and other fish with a swim-bladder not connected to the ear have been shown to recover.

Some species (salmonids and anguillid eels) are likely to utilise electromagnetic fields for navigation purposes during long distances migrations, which occur at specific life stages of their life cycle (Gill *et al.* 2005). Table 12.13 details the sensitive periods and conservation status of the key diadromous species likely to be present in the area.

Table 12.13: Sensitive periods and conservation status of the key diadromous species likely to be present in the area (based on SNH website)

Species	Time of migration to and from natal rivers												Conservation and commercial importance
	J	F	M	A	M	J	J	A	S	O	N	D	
Atlantic salmon													Habitats Directive Priority Marine Feature UKBAP Bern Convention OSPAR species IUCN Red List (Lower risk/least concern)
Sea trout		•	•										Priority Marine Feature UKBAP IUCN Red List (Least concern)
European eel													Priority Marine Feature UKBAP OSPAR species IUCN Red List (Critically endangered)

12.9.7 Other Relevant PMF or Annex II Species

In addition to the fish species above, the following species have been included in the assessment due to their presence in the study area and status as a PMF or Annex II species:

- Spiny lobster Palinurus elephas.
- Freshwater pearl mussel Margaritifera margaretifera; and
- Lamprey species (Sea lamprey Petromyzon marinus, River lamprey Lampetra fluviatilis and Brook lamprey Lampetra planeri).

12.9.7.1 Spiny Lobster

Spiny lobster typically feed on echinoderms, small gastropods and bivalves, microalgae, shrimp larvae, bryozoans and annelids (Jackson *et al.* 2009). They spawn between June and October and are known to undertake migrations to deeper water in the Atlantic and can therefore be sensitive to EMF. Females move to deeper waters during egg development and return inshore prior to egg hatching. Males are also thought to make onshore-offshore migrations (Jackson *et al.* 2009).

Spiny Lobster Habitat Preferences

Spiny lobster are generally found in circalittoral/infralittoral rock/boulders on exposed coasts between 20m and 100m depth (Personal communication, David Donnan and Chris Leakey, 2015). The rocky habitat creates crevices for their protection. Suitable substrate for spiny lobsters is present within the AfL and the three cable route options within the biotopes circalittoral rock and circalittoral mixed sediment (see Figure 11.1 Biotope map in Chapter 11 Benthic Ecology). No spiny lobsters were recorded during the benthic site survey.

12.9.7.2 Freshwater Pearl Mussel

The freshwater pearl mussel is an Annex II Species of the EU Habitats and Species Directive. The freshwater pearl musselThis species typically burrows into sandy sediments, often between boulders and pebbles, in fast flowing rivers and streams. It requires cool, well oxygenated soft water free of pollution or turbidity. They spawn in early summer with fertilised eggs being held by the female and released in late summer or early autumn as larvae. The larvae must attach to the gills of juvenile salmonids to survive, where they remain for up to a year (Skinner et al., 2003). The freshwater pearl mussel is an Annex II Species of the EU Habitats and Species Directive.

PDue to the conservation status of the freshwater pearl mussel is the primary reason for the designation of eight SACs (Table 12.14). The closest one is the River Naver, 65km to the south west of the Project site (Figure 12.4).

Although they are a freshwater species and therefore do not occur in the Project site, the reliance of the larval stage on juvenile salmonids means the freshwater pearl mussel could be indirectly affected by the Project if it has significant impacts on salmonid populations. The potential indirect impacts on freshwater pearl mussel are discussed in Table 12.14.

Table 12.14: SACs designated for fish and freshwater pearl mussel connected to the Project

SAC name	Distance from Project site	Annex II species that are a primary reason for selection (fish)	Annex II species present as a qualifying feature, but not a primary reason for site selection (fish)	Potential impact
Berridale and Langwell waters (SAC)	80km	Atlantic salmon	-	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment.
Oykel (SAC)	150km	Freshwater pearl mussel	Atlantic salmon	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment. Atlantic Salmon are a key species in the lifecycle of the freshwater pearl mussel.
River Moriston (SAC)	310km	Freshwater pearl mussel	Atlantic salmon	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment. Atlantic Salmon are a key species in the lifecycle of the freshwater pearl mussel.
River Spey (SAC)	120km	Freshwater pearl mussel Sea lamprey Atlantic salmon	-	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment. Scoped out for sea lamprey as no records for sea lamprey in the Project site.

SAC name	Distance from Project site	Annex II species that are a primary reason for selection (fish)	Annex II species present as a qualifying feature, but not a primary reason for site selection (fish)	Potential impact
River Thurso SAC	25km	Atlantic salmon	-	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment.
Naver SAC	65km	Freshwater pearl mussel Atlantic salmon	-	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment.
River Dee SAC	215km	Freshwater pearl mussel Atlantic salmon	-	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment.
Little Gruinard River SAC	200km	Atlantic salmon	-	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment.
Langavat SAC	230km	Atlantic salmon	-	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment.
River Evelix SAC	145km	Freshwater pearl mussel	-	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment. Atlantic Salmon are a key species in the lifecycle of the freshwater pearl mussel.
Abhainn Clais an Eas and Allt a' Mhuilinn SAC	160km	Freshwater pearl mussel	-	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment. Atlantic Salmon are a key species in the lifecycle of the freshwater pearl mussel.
River South Esk SAC	271km	Freshwater pearl mussel Atlantic salmon	-	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment.
River Tay SAC	340km	Atlantic salmon		It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment.

SAC name	Distance from Project site	Annex II species that are a primary reason for selection (fish)	Annex II species present as a qualifying feature, but not a primary reason for site selection (fish)	Potential impact
River Teith SAC	409km	Sea lamprey Brook lamprey River lamprey	Atlantic salmon	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment. Scoped out for sea, brook and river lampreys as no records for them in the Project site.
Endrick Water SAC	734km	Brook lamprey River lamprey	Atlantic salmon	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment. Scoped out for brook and river lampreys as no records for them in the Project site.
River Tweed SAC	365km	Atlantic salmon	Sea lamprey Brook lamprey River lamprey	It is theoretically possible that Atlantic salmon from this SAC pass through the area proposed for deployment. Scoped out for sea, brook and river lampreys as no records for them in the Project site.

12.9.7.3 Lamprey species

There are three species of lamprey present in the UK which are designated for protection as Annex II species. Brook lamprey are non migratory freshwater species and therefore do not occur in the Project site (JNCC, 2016a). River lamprey occurs in coastal waters, estuaries and accessible rivers. The closest river with a protected population of river lamprey is River Tweed, 365km to the south of the Project site as detailed in Table 12.14 and Figure 12.4 (JNCC, 2016b). The sea lamprey is the largest of the lampreys and occurs in estuaries and easily accessible rivers over much of the Atlantic coast. The closest site designation for the sea lamprey is River Spey, 120km to the south of the Project site (Table 12.14 and Figure 12.4). The river lamprey and the sea lamprey are not known to occur in the Project site (NBN Gateway, 2016). As none of the lamprey species are likely to occur in the Project site as a result of the incompatible habitat they have been scoped out of the impact assessment.

12.9.8 Summary

Based on information presented in the previous section the following fish species have been identified as requiring further consideration as part of the impact assessment:

- Atlantic salmon and sea trout and European eel (including migration through the proposed Project site);
- Spawning grounds for lemon sole, sandeel and sprat;
- Nursery grounds for anglerfish, blue whiting, herring, lemon sole, tope shark, spurdog, spotted ray, common skate, cod, hake, ling, saithe, whiting and mackerel;

- Atlantic cod and herring (including migration through the proposed Project site);
- Sandeels; and
- Spiny lobster.

Commercially important species including scallops and velvet swimming crab are covered in Chapter 16 Commercial Fisheries. Indirect effects on freshwater pearl mussel are discussed in Section 12.9.7.2

12.10 POTENTIAL IMPACTS

The following impacts have been established through scoping and the consultation process as requiring assessment as part of the EIA:

12.10.1 Construction and Installation

- Substratum loss;
- Smothering; and
- Effects of noise and vibration.

12.10.2 Operation and Maintenance

- Smothering;
- Electro Magnetic Fields (EMF);
- Collision risk (turbines);
- Changes to available habitat;
- Barrier to movement; and
- Effects of noise and vibration.

12.10.3 Decommissioning

- Smothering; and
- Effects of noise and vibration.

12.11 MITIGATION MEASURES

12.11.1 Project Design and General Mitigation Measures

All Project Design Mitigation and General Mitigation measures are set out in Chapter 5 Project Description, Table 5.15 and Table 5.16 respectively. These are standard practice measures based on specific legislation, regulations, standards, guidance and recognised industry good practice that are put in place to ensure significant impacts do not occur.

12.11.2 Specific Mitigation

No mitigation measures will be implemented specifically to minimise the impacts on fish ecology over and above those already outlined in project design or general mitigation.

12.12 RESIDUAL EFFECTS

12.12.1 Construction and Installation

12.12.1.1 Substratum Loss

Spawning Grounds

Lemon sole and sandeel have been identified as potentially having spawning grounds within the Project site. These are demersal spawners (laying eggs on the seabed) and therefore are sensitive to substratum loss. Sprat is also known to spawn in the area. However being a pelagic spawner (i.e. produces pelagic eggs that remain within the water column), substratum loss in relation to spawning grounds is not relevant to this species.

The assessment has been based on the worst case scenario whereby 200 devices are secured by the flat bottomed gravity base TSS. This would result in a direct habitat loss and potential loss of up to 0.24km^2 (approximately 2% of the AfL) of suitable spawning ground for lemon sole and sandeel. However, spawning grounds for these species are known to extend around the Scottish north coast into the North Sea and into the Atlantic Ocean around Ireland, therefore any loss is unlikely to result in a significant reduction of fish populations.

Lemon sole have a longer spawning window than sandeel so there may be some overlap with the installation phase but as detailed above, no significant impact is expected.

The sensitivity of the receptor (lemon sole) has been assessed as low given they are of low commercial and ecological value but vulnerable to the impacts in question; however, as spawning grounds for these species extend around much of the north coast of Scotland and beyond, the residual magnitude of the impact has been assessed as negligible. No significant impact is considered likely as a result of substratum loss under the worst case scenario for development.

Nursery Grounds

The AfL and cable route corridors overlap with high intensity nursery grounds for anglerfish, blue whiting and low intensity grounds for herring, lemon sole, topeshark, spurdog, spotted ray, common skate, cod, hake, ling, saithe, whiting and mackerel. Juvenile stocks of fish are considered to be less sensitive to loss of habitat than spawning fish due to their increased adaptability and tolerance by way of their mobile nature. Although the AfL compromises part of the main nursery ground for anglerfish and blue whiting, the area impacted is extremely small relative to the extent of the main nursery ground which stretches from the Atlantic Ocean south west of Ireland, north to Iceland and east into the northern North Sea towards Norway.

In comparison, shellfish are much less mobile some spending most of their time half buried in the sediment but have also been considered to have low sensitivity to physical disturbance based on the fact that even if high numbers of individuals are impacted as a result of direct habitat loss the whole local population is unlikely to be affected due to their widespread nature within the wider geographical context. Therefore, any loss would likely recover quickly on cessation of disturbance.

Evidence suggests that the introduction of artificial structures or introduction of new substrate can enhance local populations of some species. New habitats may enhance nursery grounds for species where habitat has been lost as a result of the installation phase. The assessment of introduced substrata is discussed further in Section 12.12.2.4.

The sensitivity of the species using the Project site as a nursery ground is considered negligible in view of the very small scale of the area affected in relation to overall nursery grounds and their adaptability and tolerance due to their mobile nature. Due to the temporally and spatially restricted nature of any of the three cable options and TSS installation activities, any impacts are likely to be highly localised. As a result, it is unlikely that any change to the baseline condition of these species caused by the Project will be detectable against natural variations in juvenile and population numbers and the residual impact magnitude will be minor. The overall significance is negligible, giving an overall significance of not significant.

Table 12.15: Summary of residual effects of the substratum loss on fish ecology

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
Flat gravity base TSS	Spawning grounds (lemon sole)	Low	-	Low	Not significant	Minor
Flat gravity base TSS	Nursery grounds	Negligible	-	Minor	Not significant	Negligible

12.12.1.2 Smothering

There is potential for installation activities such as drilling (monopile and pin-pile tripod TSS) and cable installation to lead to the creation of sediment plumes in the Project site though sediment resuspension. However, given that the AfL is largely rocky with boulders, installation activities are unlikely to result in significant sediment plumes (see also Chapter 9 Physical Processes). Although areas of gravel and coarse sand are present any disturbance is likely to be quickly dispersed with the currents, rather than accumulate locally.

There is potential for the release of drill cuttings as a result of the installation of the TSSs. Re-deposition of the cuttings on the seabed could result in localised temporary smothering of important fish habitats. In most instances the worst case impacts would arise from the installation of drilled monopile. The volume of drill cuttings generated would be 74m^3 cuttings per monopile, in addition to a small amount at the cable landfall (where HDD is required). There could be up to 200 monopiles installed which would result in a total cuttings volume of 14,771m^3. The physical processes impact assessment (Chapter 9) found that due to the highly dynamic nature of the AfL area, any deposition of sediment on the seabed is likely to be rapidly dispersed rather than accumulate in measureable quantities. This confirms the findings of predictive mapping undertaken by McBreen *et al.* (2011) which found that in areas with high kinetic energy due to currents, as in the AfL, fine sediment particles would be rapidly dispersed.

Lemon sole and sandeel have the potential to be impacted by the effects of smothering. As sprat is a pelagic spawner, it is unlikely to be sensitive to the potential impacts of smothering. Buried crustaceans (e.g. brown crab and lobster) are likely to be more vulnerable to smothering than demersal spawners as the eggs carried by these species require regular aeration (Faber Maunsell and Metoc, 2007).

The overall vulnerability of crab and lobster in relation to the Project is assessed to be medium, particularly in view of the occurrence and distribution of these species. Due to the relatively limited spatial and temporal extent and intermittent frequency, the residual magnitude of the smothering effect of the drill cuttings following mitigation (Table 12.16, PD12) is assessed as being negligible. Considering this medium sensitivity and negligible magnitude, the overall impact of increased smothering is predicted to be of minor significance and overall not significant.

The impacts on sediment dynamics is covered further in Chapter 9 Physical Processes.

Table 12.16: Summary of residual effects of the smothering on fish ecology

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
Drilled monopile TSS	Lemon sole, sandeel, crab and lobster	Medium	PD12	Negligible	Not significant	Minor

12.12.1.3 Effects of Noise and Vibration

The potential impact of underwater noise on fish populations within the proposed Project site and cable route is associated with installation activities including piling and use of other specialist equipment, and vessels involved in the installation of the export cable (trenching and protection). Many marine animals use sound during their everyday lives to track prey, avoid predators, navigate, and communicate with one another (e.g. Hawkins and Myrberg, 1983). Even species that do not communicate by sound use the acoustic scene (or soundscape) to learn about and exploit their environment (Fay and Popper, 2000). Therefore, anything in the environment that may result in interference with the ability of a fish to detect and use sounds of biological relevance, could have a substantial impact on its fitness and survival.

An underwater noise technical assessment was undertaken by (Supporting Document: Xodus, 2015) to provide an overview of the potential impacts on fish from noise produced during construction and installation. The report detailed the criteria for injury and behavioural responses of fish and has been used to inform this assessment. The criteria, largely based on the Acoustical Society of America guidelines (Popper *et al.* 2014) are qualitative so have been supplemented where necessary by other references. The report also provides predictions of potential injury and disturbance zones from installation and operational phases of the Project. A full and detailed explanation of the methodology used is provided in the underwater noise technical report (Supporting Document: Xodus, 2015).

In setting sound exposure criteria there are a number of scientific options. It has been commonplace in the past to specify those sound levels that result in injury to animals, especially if these are likely to result in death. However, with regards to fish, on the basis that adult fish are generally able to vacate the area and avoid physical injury, it is the effects of noise on behaviour that are considered most relevant in terms of effects upon populations (Popper *et al.* 2014). Impacts on behaviour can occur at much greater distances from the source than sound levels that can do physical harm, and they almost always involve a lower onset threshold than tissue injury or damage to the auditory system. Significant changes in behaviour might include abandonment of spawning behaviour or spawning sites, movement away from preferred habitats, disruption of feeding, increased energy consumption, and diversion or delay of migrations.

Lethal/Injury Effects from Noise

Interim criteria for the onset of tissue damage due to sound exposure have been recently published by the Acoustical Society of America (Popper *et. al*., 2014). From this, and together with the marine noise assessment carried out to inform this assessment which used very worst case scenario levels (200 turbines, double the output) (Supporting Document: Xodus, 2015) it is concluded unlikely that fish mortality will occur as a direct result of noise from the Project. This is on the basis that, although the potential zone of injury for fish with swim bladders (most sensitive to noise) is up to 10m for even the largest construction vessel, fish would require 48 hour exposure to continuous noise for the onset of non-recoverable injury to occur. This is highly unlikely given that most adult and juvenile fish are mobile and hence will be able to move away from the localised areas where lethal and injury effects could occur.

Although eggs and larvae are less mobile and are likely to be exposed to noise, their sensitivity is considered low. Lethal injuries are only likely to occur when they are in the immediate vicinity of the highest source of high energy sound such as blasting or percussion piling, neither of which are under consideration for this Project. The main source of noise for this Project is noise from large construction vessels or cable lay vessels. Noise from these vessels is unlikely to result in any lethal injury to eggs or larvae even if they are present within the immediate vicinity of the vessel. The residual magnitude of impact following mitigation (Table 12.17, PD13) is therefore considered negligible given the low potential for lethal injury to occur due to the low level and temporary nature of potential noise sources. The overall significance is negligible, giving an overall significance of not significant.

Behavioural Response from Noise

Although there is unlikely to be fish mortality during installation, there is potential for noise from construction vessels to lead to behavioural avoidance. Avoidance behaviours will vary in significance depending on the resulting outcome of the behaviour. For example, it may be significant if it causes a migratory species to be held up or prevented from reaching areas of biological importance, e.g. spawning and feeding areas, migratory routes. In other cases, the movement of species from one area to another may be of no consequence other than a possible increase in energetic expenditure for the fish.

The construction and installation phase may result in the exclusion of adult sprat from certain areas which could have adverse effects on populations by reducing access to suitable spawning habitats. However, none of the notable species detailed in Section 12.9.3 and 12.9.4 spawn exclusively in the Project site and suitable spawning grounds for each species extend around much of the Scottish north coast, Atlantic Ocean and around the coast of Ireland. Therefore, only a small proportion of the spawning stock will be affected and will therefore not significantly affect the adult sprat population during construction.

As detailed in Section 12.12.1.1 (nursery grounds), the Project site overlaps with low intensity grounds for lemon sole and cod. Juvenile stocks of fish are considered to be less sensitive than spawning stages to noise avoidance behaviours in terms of their adaptability and tolerance by way of their mobile nature. Furthermore, based on their extensive occurrence within the wider geographic context any potential disturbance to these areas as a consequence of construction operations is not predicted to have a significant impact on future local fish populations.

Migratory diadromous fish species including salmon and sea trout are considered to be of medium sensitivity given their lack of pressure receptors in the ear and the conservation status of salmon. They also exhibit strong and significant avoidance behaviour to noise emissions particularly in tidal streams, such as the area of the Project.

The Project specific underwater noise assessment was undertaken using a very worst case scenario (Supporting Document: Xodus, 2015) and found that the potential zone of disturbance as a result of installation would be 185m based on the noise from larger construction and installation vessels. Whilst the overall sensitivity of fish species to underwater noise disturbance is considered to be medium, due to the small areas of effect around the installation activities, and the temporarily and spatially restricted nature of the cable and TSS installation activities, the residual magnitude is considered to be negligible (Table 12.17, PD13). The level of impact is therefore assessed to be negligible and not significant.

Table 12.17: Summary of residual effects of noise and vibration on fish ecology

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
All options - construction vessels or cable lay vessels	Lethal/injury effects from noise	Low	PD13	Negligible	Not significant	Negligible
All options - construction vessels	Behavioural response from noise	Medium	PD13	Negligible	Not significant	Minor

12.12.2 Impacts during Operation and Maintenance

12.12.2.1 Smothering

The impact from smothering during operation and maintenance is not considered to exceed that for the construction and installation phase (see Section 12.12.1.2).

12.12.2.2 Electro Magnetic Fields (EMF)

Electromagnetic (EMF) field emissions are generated from the transmission of electricity through cables, such as the AC inter-array and AC export cables proposed for this Project. The cables produce electromagnetic fields which have both electric components (E) measured in volts per metre (V/m) detected by species at distances greater than 30cm, and magnetic components (B) measured in tesla (T) which reduce to background levels beyond 20m from the source (Gill *et al.* 2005) The direct electric field is mostly blocked with the use of conductive sheathing and therefore the magnetic field and the resultant induced electric field are emitted into the marine environment. Impacts on ecology as a result of EMFs are unknown but it has been suggested that they may be detected by marine organisms (Inger *et al.* 2009). Current understanding in the literature suggests that the magnitude of impact on fish behaviour due to the effects of EMF as a result of subsea cables will be closely related to the proximity of the animal to the source of the EMF.

Vision is generally limited by both limited light availability and turbidity in the underwater environment, therefore other senses such as hearing, chemoreception and electroreception are used by animals to interpret their surroundings. Some animals rely on natural magnetic fields for orientation or navigation and some animals may be electro-sensitive to facilitate detection of predators/prey or for social or reproductive behaviours. Thus the introduction of anthropogenic EMFs associated with offshore cabling may interfere with these natural behaviours.

Elasmobranchs are ten thousand times more electrosensitive than most teleost fish detecting B fields far weaker than the earth's magnetic field. They use their electroreceptors to detect bioelectric fields produced by their natural prey and as a result are particular sensitivity to anthropogenic sources of EMF. Gill and Taylor (2001) found that spurdog (a critically endangered species likely to occur within the Project site) avoided electrical fields at 10µV/cm. Studies involving the spiny lobster *Panulirus argus* have demonstrated they use a magnetic map for navigation (Boles and Lohmann, 2003). However, it is uncertain if other crustaceans including commercially important lobster and edible crab are able to respond to magnetic fields in this way.

A study published in 2011 supporting an increasing body of evidence found that marine vertebrates and invertebrates can sense the earth's magnetic field and can use this information for orientation, navigation and sourcing rich prey patches (Normandeau *et al.* 2011). Potential impacts from development may arise where anthropogenic electric fields can attract and disorientate animals reducing foraging time and therefore daily energy intake (Normandeau *et al.* 2011). Species monitoring at the Robin Rigg Wind Farm observed no significant difference in the distribution of electrosensitive species along the export cable corridor after two years of monitoring, however it was noted that the survey station may be too far from the corridor to observe an effect (Malcolm *et al.* 2013). The vulnerability of migratory fish to the barrier effects of EMF are assessed in Section 12.12.2.5.

Cable burial is commonly recommended to increase the distance between the cable and the electro-sensitive species (Gill *et al.* 2005) and DECC recommends that cables be buried to at least 1.5m, depending on the suitability of the substrates (DECC, 2011). For much of the Project site, burial of the inter-array and export cables is not an option due to the nature of the seabed (hard bedrock with cobbles and boulders) therefore cable protection will be used to provide mechanical protection and secure the cables in place to avoid movement (Table 12.18, PD09). The use of these methods will also increase the distance between marine species sensitive to EMF and the EMF source.

At a worst case the inter-array cabling will occupy 0.36km^2 of the total AfL area (approximately 3%). There will also be a maximum of 6.5km of export cable linking the tidal array to shore (Aith Hope). The maximum transmission voltage of the cables will be potentially up to 132kV . Therefore with the inclusion of the cable protection measures described above it is expected that any magnetic field from the cables will be 1.6µT well below that of the Earth's magnetic field which is between 30 and 70µT and is therefore not likely to be detectable by the fish species that are present in the area as they move across the cables (Scottish Executive, 2007; CMACS, 2005).

For the purpose of the assessment of EMF impacts, elasmobranchs are considered to be most sensitive to EMF due to the reliance on electric fields for a number of fundamental behaviours and are therefore assessed as being of medium sensitivity. However, the residual magnitude of impact is considered negligible based on the highly localised nature of potential impacts due to rapid attenuation of EMF with distance coupled with the small footprint of the Project. The overall significance is negligible, giving an overall significance of not significant.

Table 12.18: Summary of residual effects of EMF on fish ecology

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
All options – inter-array and export cables	Elasmobranchs	Medium	PD09	Negligible	Not significant	Minor

12.12.2.3 Collision Risk (Turbines)

Potential interactions between marine wildlife and operating turbines are still not fully understood. In relation to migratory fish, a number of studies have been carried out to investigate the potential risk of collision between fish and marine renewable energy technologies. These include studies by Wilson *et al.* (2007) as part of the Scottish Marine Renewables SEA, ABPmer (2010) as part of the Marine Renewable Energy Strategic Framework for Wales (MRESF) and encounter modelling carried out by Xodus as part of the MeyGen Tidal Array EIA (Xodus, 2011). CRM was carried out for the Project using the draft model developed by SNH (SNH, 2015) which determines the collision risk associated with Atlantic salmon and the tidal turbines under differing levels of avoidance (Xodus Group, 2016).

The studies by Wilson *et al.* (2007) and ABPmer (2010) focused on understanding fish avoidance reactions to operational tidal turbines. It was found that structures in the water column tend to attract fish and their predators similar to the behaviour found with regards to the deployment of 'Fish Aggregation Devices' (FAD) used in numerous countries to aid fishing (Wilson *et al.* 2007; Food and Agricultural Organisation (FAO), 2014). However, for certain species, noise generated by operational devices can have the opposite effect, eliciting an avoidance response (ABPmer, 2010). The extent to which this avoidance response occurs depends on the hearing sensitivity of different fish species to noise. For example in hearing sensitive fish (e.g. herring) analysis suggests that they may be able to detect and avoid individual operational tidal stream devices at distances between 120 and 300m (depending on the depth of water) even when background noise levels are comparatively high. However, for hearing insensitive fish (e.g. sharks and mackerel), the Projected source noise levels of tidal devices are likely to be below levels at which these species might exhibit an avoidance reaction.

The extent to which fish might exhibit close range evasion of tidal turbines depends on a number of factors including:

- Device design – e.g. shape, size, colour and position in water column;
- Environmental conditions e.g. turbidity and flow rate; and
- Fish characteristics - visual acuity, maximum swimming speeds, body size, social behaviour (e.g. schooling), foraging tactics, curiosity, habitat use, underwater agility, sensory capabilities, age and experience.

Broadhurst *et al.* (2014) recently published a paper documenting the findings from an observational pilot study conducted within the European Marine Energy Centre (EMEC) looking at interactions between fish and an operational tidal device. The study used video footage and ADCP survey techniques to examine presence of fish and velocity flow rates within the vicinity of a deployed tidal energy device. Results from the pilot trials which were carried out over two 15 day periods in summer 2009 and 2010 observed fish (Pollock) aggregating in shoals temporarily round the deployed device with a larger abundance in 2009 than 2010. The abundance of fish (Pollock) was significantly associated to velocity rate for both trial years. There was increased abundance related to a reduction in velocity rate for both years, with shoals potentially using the device for temporary protection or feeding strategies. Responses to tidal velocity also differed between years. No other species were identified from the surveys.

In order to inform the collision risk impact assessment collision modelling using the draft SNH collision risk model was carried out. A 10 year average of the Atlantic salmon population around Scotland was used for numbers of adult salmon (ICES, 2015b). It also utilised analysis carried out for the MeyGen Tidal Array for the likely number of smolts passing through the Pentland Firth (Xodus Group, 2012; Xodus Group 2016). The model utilised Atlantic salmon population alongside turbine parameters and channel depth and width to assess the likely collision risk. Full details of the modelled Scenarios (including input data) are available in the modelling report (Xodus, 2016 on supporting documents DVD). The worst case scenario involved the 10 bladed turbine which resulted in the greatest collision risk to Atlantic salmon. This option concluded that 32 smolts, 3 1SW and 2 MSW Atlantic salmon would potentially collide with the tidal array per year during Phase I. Once Phase II was deployed 211 smolts, 17 1SW and 15 MSW Atlantic salmon would potentially collide with the tidal array per year. This represents 0.007%, of the annual number of grilse and adult fish passing through the Pentland Firth and 0.003% of the smolts (Xodus Group, 2016). This is a very small proportion of the total Scottish salmon population and is unlikely to have significant effects on the Atlantic salmon population.

These modelling results and the overall conclusion that impacts on Atlantic salmon will not be significant are in line with the results found for the MeyGen development

With regard to the Project, each turbine will have a minimum clearance from the blade tip to the seabed of 4m and therefore it is expected that demersal and benthic species will pass under the device without encountering the device. In addition the turbines will have a minimum clearance of 30m from the blade tip to the sea surface, and species such as Atlantic salmon, are likely to pass over the structures (impacts on basking shark are covered in Chapter 13 Marine Mammals) (Table 12.19, PD04). As a result it is generally considered that pelagic and bentho-pelagic fish will be the most likely to be at risk of collisions with operational turbines as their diurnal vertical migration behaviours forces them to occupy all depths of the water column at some time during the day or night (Faber Maunsell and METOC, 2007).

Given the conservation status of Atlantic salmon combined with other pelagic and bentho-pelagic species that may be present in the Project site including cod and sea trout, for the purpose of assessing this impact species are assessed as medium sensitivity. However, as the AfL covers a relatively small area footprint of the Pentland Firth (11.1km^2) and based on findings of modelling undertake to estimate encounter and collision risk, the proportion of any fish population passing through/present in the area that will potentially be affected is likely to be imperceptible, the residual magnitude of the impact is therefore considered to be negligible. The overall significance is minor, and the impact is not significant.

Table 12.19: Summary of residual effects of collision risk (turbines) on fish ecology

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
Operational turbines	Pelagic and bentho-pelagic species including Atlantic salmon	Medium	PD04	Negligible	Not significant	Minor

12.12.2.4 Changes to Available Habitat

Potential impacts on fish species in relation to the change of habitats as a result of habitat loss is covered in Section 12.12.1.1.

As mentioned in Section 12.12.2.3, tidal turbines can act as FADs resulting in a positive effect on fish populations through fish stock recovery should certain types of fisheries be excluded from operating within the AfL. As the substrate within the two cable route options, is unlikely to be suitable for cable burial, the introduction of novel substrata including rockdump and concrete mattresses may be colonised by various marine organisms. Of particular concern is the colonisation of Invasive Non-Native Species which can attach to the devices, which may offset any benefit of increasing productivity. Commercially important species such as crab, lobster and PMF species such as the spiny lobster as well as other demersal species are likely to utilise the artificial reefs created by the cable protection. This has been observed at wind farms off the south eastern coast of Sweden (Wilhelmsson *et al.* 2006). Colonisation by fauna on the structures could result in an increase in food availability and the physical structures of the foundations may attract some fish species as they could provide protection against predation or the prevalent current and thus save fish energy (OSPAR, 2004).

Evidence of colonisation of tidal turbine structures and areas within a tidal array was recently reported by Broadhurst and Orme (2014). An examination of species biodiversity, composition and habitat type was carried out surrounding a tidal energy device installed at the EMEC test site, Orkney. Using commercial fishing and towed video camera techniques over three temporal periods from 2009 to 2010, the examination found increased species diversity and compositional differences within the device site compared to a control site. Both sites largely comprised crustacean species, omnivore and predatory feeding regimes and marine tide swept EUNIS habitat types which varied over time. The study concluded that the device could act as a localised artificial reef structure, but that further investigations are required (Broadhurst and Orme, 2014).

Artificial refuges created by cable protection or tidal devices, potentially increases localised foraging resources that congregate around the devices which could result in increased productivity (Table 12.20, PD10). Post monitoring studies at offshore windfarms have found that fish faunal diversity increases post construction (Leonhard & Pedersen, 2004). However, increases in shellfish populations are expected to be imperceptible in the context of the wider population.

The sensitivity of the receptor is considered to be low to medium dependent upon the species concerned. The residual magnitude of the impact is expected to be minor (positive) on the basis that while there is potential for the colonisation of turbine structures, the likelihood that this will lead to significant increases in shellfish populations is considered to be low. The significance is minor (positive), with an overall positive significance.

Table 12.20: Summary of residual effects of the changes to available habitat on fish ecology

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
All options	Shellfish populations	Low-Medium	PD10	Positive (minor)	Positive	Positive (minor)

12.12.2.5 Barrier to Movement

Arrays of tidal turbines have the potential to form a physical and/or noise barrier in the water column which could hinder usual migration or transit patterns of marine, elasmobranch and diadromous fish species. Some fish species such as cod utilise the energy from tidal streams to conserve energy during transit and therefore it is important to consider the potential for the Project to form a barrier and assess the impact this may have on fish populations in the area.

Table 12.21 presents the maximum proportion of the total cross sectional area of the Pentland Firth that would be taken up by the tidal array therefore resulting in a potential barrier to movement of migratory or transiting fish. The area occupied by the array assumes a maximum total swept area per turbine of 415m^2 and total swept area for the array of 6,225m^2 based on a maximum of 15 turbines per row (on a north to south alignment). Overall the tidal array is expected to occupy at most approximately 0.9% of the total available cross sectional area within the Pentland Firth.

Table 12.21: Percentage area of Pentland Firth taken up by the tidal array

Swept area of one turbine	Maximum swept area of the tidal array	Approximate area of the Pentland Firth*	% of Pentland Firth taken up by the tidal array
415m^2	6,225m^2	657,585m^2	0.9%
*Area of the Pentland Firth taken from Brims Ness, Hoy to Tang Head, Caithness			

Atlantic Salmon, Sea Trout and European Eel

There is limited information on the movement of sea trout. For the purpose of this assessment potential impacts on sea trout are considered in context of potential impacts on Atlantic salmon.

Due to physical presence of turbines, noise and EMF, the Project has the potential to act as a barrier for post-smolt migrating salmon as the move to offshore feeding grounds and return as adults to their natal rivers to breed. However, the behaviour of salmon during the coastal phase of their migrations has been relatively sparsely documented (Guerin *et al.* 2014, Thorstad *et al.* 2012, Malcolm *et al.* 2010).

Post-Smolt Migration

It is thought that salmon post-smolts will use near-shore areas at the commencement of migration, but their initial dependence on near- and off-shore areas is currently unclear (Malcolm *et al.* 2010). Recent studies by Godfrey *et al.* (2014a, b) found that migrations through the Pentland Firth did not follow a prescribed route and studies by Thorstad *et al.* (2004) tracked hatchery-reared smolts in Norway. The post-smolt migrations were not strictly linked to the coast, with pop-up locations up to 100km offshore. Thorstad *et al.* (2007) also investigated potential differences in migratory behaviour of hatchery-reared and wild salmon smolts. Both types of salmon were found to utilise the full width of the fjord, further suggesting they are not reliant on the near-shore waters. Lacroix *et al.* (2005) found that fish tended to travel near to the coast when investigating the early marine migration of wild and hatchery reared Atlantic salmon post-smolts in the Bay of Fundy on the east coast of Canada.

Available evidence suggests that post-smolt salmon utilise water ranging from relatively close to shore up to several km offshore. The Brims AfL area, which lies between 0.3km and 2.5km off the coast, is not likely to present a significant barrier to movement of migratory salmon. Studies on the depth distribution of post-smolts migrating to the open sea suggest they tend to stay very close to surface, where they would not be affected by the tidal turbines. For example, Davidsen *et al.*

(2008) tracked Atlantic salmon post-smolts, and recorded swimming depths ranged between 0 and 6.5m. Similarly, Plantalech Manel-La *et al.* (2009) tagged salmon smolts and determined that the mean swimming depth was 1.7m, with regular vertical movements to a maximum depth of 5.6m. More recently, Godfrey *et al.* (2014) reports the median proportion of time spent in the upper 5m was 80.4%.

Adult Salmon Migration

As is the case for post-smolts, there is wide variability in the distribution of adult salmon during their migratory movements, and the Project is unlikely to represent a significant barrier. Studies have shown that adult salmon do not return from open water directly to their natal river, but head for their coast of origin and then track along the coast using a composite of environmental cues until they locate their destination (Guerin *et al.* 2014). The findings from Guerin *et al.* (2014) suggested that fish returning to rivers on the east coast of mainland Scotland are more likely to follow the coast of Caithness rather than the southern extent of Orkney where the tidal array is proposed. Hawkins *et al.* (1979) tagged six grilse off the coast of Scotland at Rockhall near Montrose in 1978 and found that they tracked close to shore once close to their natal river. Conversely, six fish tagged from coastal nets in 1979 by Smith *et al.* (1981) found that they primarily travelled at distances of up to 17km offshore.

In addition, studies have shown that adult salmon spend the majority of their time at the sea surface, although in contrast with post-smolts, this is punctuated by deep dives of up to 280m, a behaviour which persists late into the migration on return to home waters (Malcolm *et al.* 2010). Starlaugsson (1995) tagged 60 salmon returning to the coast of Iceland and determined that most of their time was spent within 4m of the surface, although frequent diving between 10 and 123m was observed. Similarly, Holm *et al.* (2005) tagged fish in the Norwegian Sea, and found that they generally resided within 5 – 10m of the surface. The minimum clearance of blades and the sea surface at LAT is anticipated to be between 30m.

The Project is unlikely to represent a significant barrier to the movement of migratory salmon as the array is only occupying a small area of the available space. In addition, depth distribution during migration suggests that adults and post-smolts would be likely to pass over the Project without encountering any obstacles particularly for turbines situated at the lower depths. Adults may be at slightly more risk of collision as they intermittently dive to depths that would put them within the swept area of the turbines. The CRM carried out for the project incorporates Atlantic salmon swim depths and highlights the low likelihood of the Project being a barrier to the movement of migrating fish, either adults (or smolts) (Xodus Group, 2016).

EMF

Adult Atlantic salmon, sea trout and European eel have been found to use the earth's magnetic field for orientation and direction during migrations. Responses to the earth's magnetic field have also been found in juvenile sea trout (Gill and Bartlett, 2010). It has also been suggested that salmonids or eels are neither attracted nor repulsed by anthropogenic EMF in shallower waters (<20m) despite occasional change in swimming direction during migration (Gill and Bartlett, 2010).

Given that salmon, sea trout and European eel appear to only have medium sensitivity to EMF and that with the inclusion of cable protection measures, the magnetic field from the cables (export and inter-array) will be below that of the Earth's magnetic field (Section 12.12.2.2), it is likely that the cables will not be detected by any salmon passing through the area, especially given the relatively small footprint of the Project site. Potential impacts on salmon, sea trout and European eel in terms of barriers to movement due to EMF from inter-array and export cables are expected to be negligible and not significant.

Noise

As discussed in Section 12.12.1.3, salmon are unlikely to be able to detect the array at long distances and as the expected noise emissions from the turbines is expected to be low, it is possible that detection will only occur within 1m from the array. Noise from the array is therefore unlikely to affect movement of salmon through other parts of the Pentland Firth.

Other Fish Species

Maturing cod may be impacted by potential physical barriers given that they use tidal streams for migrating between feeding and spawning grounds: fish leave the seabed at slack water and remain off the bottom for most of the ensuing tide, whilst spent fish use the opposing tidal stream to return to their feeding grounds.

Assessment

Atlantic salmon are considered to be the most sensitive species to the potential barrier effect which may be created by the Project due to their migratory movements through the Pentland Firth to and from the north and east coasts of Scotland. Migrating cod are also considered to be sensitive due to their use of tidal streams for migrating between feeding and spawning grounds and due to their conservation concern status (Section 12.9.4). However, the Project site lies outside the spawning ground for cod and is in a low intensity nursery area and has therefore been assessed as being of medium sensitivity. The residual magnitude of impact is considered to be negligible based on the localised nature of potential impacts and that 99.1% of the total cross sectional area of the Pentland Firth will not be taken up by the tidal array (Table 12.22, PD06). The overall significance is minor, giving an overall significance of not significant.

Table 12.22: Summary of residual effects of barrier to movement on fish ecology

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
All options	Atlantic salmon	Medium	PD06	Negligible	Not significant	Minor

12.12.2.6 Effects of Noise and Vibration

As detailed in Section 12.12.2.5 and 12.12.2.6, impacts of underwater noise on fish can result in injury, death or disturbance. The assessment for noise impacts on fish followed the ASA guidelines (Popper *et al.* 2014) criterion of 170 decibels (dB) re 1µPa (rms) over a 48 hour period for 200 2.2MW turbines. The assessment found that no fish, even those species whose swim bladders are involved in hearing, would experience injury as a result of exposure to the noise from the turbines.

Whilst the sensitivity of the receptor is medium, the magnitude of impact remains negligible as does the significance. The impact of noise induced injury on fish is therefore not significant.

The impact of potential disturbance to fish as a result of operational turbines and maintenance vessels was calculated using noise levels of 150 dB re 1µPa (rms) over a 48 hour period, as laid out in criteria defined by the WSDOT. (WSDOT, 2011). The assessment found that no disturbance is anticipated for any fish species, even the most sensitive. Cod are most sensitive to noise because of the connection of the swim bladder to the ear. The underwater noise impact assessment (Supporting Document: Xodus, 2015) found that no behavioural disturbance is anticipated for any fish species, even the most sensitive as maintenance vessels are much smaller than installation vessels therefore underwater noise is much lower. The sensitivity of the receptor is medium; the residual magnitude of impact after mitigation (Table 12.23, PD11) is negligible. Therefore, the impact of noise resulting in disturbance of fish is therefore not significant.

Table 12.23: Summary of residual effects of the effects of noise and vibration on fish ecology

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
All options – inter-array and export cables	Noise induced injury	Medium	PD11	Negligible	Not significant	Negligible
All options – inter-array and export cables	Disturbance of fish	Medium	PD11	Negligible	Not significant	Negligible

12.12.3 Impacts during Decommissioning

Impacts during decommissioning are likely to be the same or less than those identified for installation. There will potentially be noise generated during the removal of the TSSs and turbines from vessels and potential cutting of piled structures. However, these noise levels will be similar to those identified during installation. There will also be temporary habitat disturbance during decommissioning. However, once the TSSs and turbines are removed, these habitats will be re-established.

12.13 ACCIDENTAL AND UNPLANNED EVENTS

During all phases of the Project, there is the potential for accidental release of contaminants as a result of collision of vessels, storm damage or device failure. The discussion around this impact considers the worst case scenario: the potential impacts associated with large scale release of fuel inventory from an installation vessel. Smaller inventories of polluting substances may potentially be released during the course of the Project, but it is considered that these substances will not induce a toxic response in fish but rather insidious contaminant effects associated with the bioaccumulation of small amounts over a long period of time.

Construction vessels to be used during the installation phase are likely to have an oil inventory in the region of between 6,000,000 and 8,000,000 litres of marine diesel in a number of separate tanks. The worst case scenario for assessing accidental spillages of fuel from vessels is assumed to be the leakage of one tank (approximately 600,000 litres of marine diesel) into the marine environment.

As oil spills can have a number of environmental impacts the actual effects will vary depending on a wide range of factors including the volume and type of oil spilt. Environmental conditions such as the sea and weather conditions at the time of the spill will also alter potential impacts. Effects will also be dependent on the presence of environmental sensitivities in the path of the spill.

Adult fish are highly mobile and are able to detect pollutants therefore, even in the event that an oil spill resulted in the loss of inventory from a large installation vessel, fish would be expected to avoid areas where pollution has occurred reducing the risk of exposure to the population. In addition, whilst juvenile fish and benthic spawning grounds are not capable of the same avoidance behaviour as adult fish, the likelihood of contamination reaching the benthic environment is low due to the strong tidal currents within the Project site. This also applies to less mobile shellfish, crab and lobster, which also inhabit the seabed, and are therefore unlikely to encounter exposure to contaminants. The sensitivity of the receptor has therefore been assessed as low.

The predicted magnitude includes consideration of the likelihood of accidental spillage, defined here as the total loss of a single fuel tank (worst case scenario) as extremely unlikely to occur, therefore after mitigation (Table 12.24, GM01), the residual magnitude has been assessed as minor.

The overall impact of accidental contamination is predicted to be of negligible significance and overall not significant.

Table 12.24: Summary of residual effects of the accidental release of contaminants on fish ecology

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
All options	Spawning grounds, juvenile fish, crab and lobster.	Low	GM11	Minor	Not significant	Negligible

12.14 HABITATS REGULATIONS APPRAISAL (HRA)

Where a Project could affect a Natura 2000 site (in the case of migratory fish, an SAC), a competent authority is required to determine whether the Project will have a likely significant effect on the qualifying interests of such a site. Depending on the outcome of this determination, the competent authority will undertake an Appropriate Assessment of the implications of the Project for the Natura 2000 site's conservation objectives. The responsibility for provision of information with which to inform the Appropriate Assessment rests with the applicant.

It is usual practice that information to inform the Appropriate Assessment is presented in a separate report to the ES. However based on advice provided from SNH for this Project (and confirmed by Marine Scotland Licensing and Opertiaons Team (MS-LOT)), impacts on protected fish species and sites have been solely presented in the ES.

12.15 SUMMARY

- A number of potential impacts on fish ecology were assessed during all phases of the Project including substratum loss, smothering, EMF, turbine collision risk, accidental release of contaminants, changes to available habitat, barrier to movement and effects of noise and vibration.
- Impacts during construction and installation resulting in substratum loss focused on the spawning and nursery grounds of sensitive species and their habitat preferences. No areas were considered to be of the highest favourability for fish and due to suitable habitat in the wider area, the impacts were assessed as being of negligible residual significance and therefore not significant.
- Due to the relatively small scale of the Project combined with the dynamic nature of the tidal stream indicates that any resuspended sediment or drill cuttings released during TSS installation would be quickly dispersed and smothering impacts are not considered significant.
- Impacts on fish as a result of noise emitted from vessels and turbines that could result in injury and/or disturbance are not predicted to be significant.

- Disturbance of sensitive fish species as a result of EMF was assessed. Due to the small footprint of the Project, project level mitigation in the form of cable protection and rapid attenuation of EMF with distance, the residual significance was assessed as negligible and the impact was considered not significant.
- The assessment of collision risk with turbines was based on project specific CRM. The assessment concluded that the impacts would be of minor residual significance and therefore not significant.
- The physical presence of the turbines resulting in a physical barrier was assessed in relation to sensitive migrating fish species. Due to the small cross sectional area taken up by a 200 device array, coupled with swimming patterns of migratory species from recent research, the residual significance was assessed as minor and the impact was considered not significant.
- Changes in habitat as a result of the introduction of novel substrata within the AfL and cable corridor was found to have a potentially positive impact on fish species due to the creation of favourable habitat. The residual significance was assessed as minor positive and the impact was considered positive.
- Impacts due to accidental spillage of pollutants from either vessels or turbines, and also during drilling operations, was assessed in relation to fish sensitivity to pollutants and the likelihood of such events. No significant impacts were identified. Mitigation measures identified for this impact in relation to vessels include standard measures to prevent the risk and minimise the impact should a spill occur, and in relation to turbines the use of low toxicity and biodegradable fluids wherever possible.

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Marine Mammals and Basking Shark

Chapter 13

13 MARINE MAMMALS AND BASKING SHARK

13.1 INTRODUCTION

This chapter of the Environmental Statement (ES) considers the potential effects of the proposed Brims Tidal Array Project (the Project) on marine mammals and basking sharks during the construction, operation and maintenance (O&M), and decommissioning phases. It describes the existing environment with regard to marine mammals (pinnipeds (seals) and cetaceans (whales, dolphin and porpoise) as well as basking shark *Cetorhinus maximus*. Where appropriate, mitigation measures and residual impacts are presented.

This assessment also considers information from, and refers to, the following chapters within this ES:

- Chapter 3 Planning and Legislation;
- Chapter 5 Project Description;
- Chapter 7 EIA Scope and Methodology;
- Chapter 12 Fish Ecology; and
- Chapter 15 Shipping and Navigation.

This chapter of the ES was written by Royal HaskoningDHV, and incorporates results and advice from other contributors including Marine Ecological Research (MER), Natural Research Projects Ltd (NRP) and Xodus Group Ltd (noise assessment). Table 13.1 outlines supporting technical reports that were used in the preparation of this chapter.

Table 13.1: Supporting studies

Details of study
Brims Tidal Array Marine Mammal and Basking Shark Boat Based Visual Survey Data Analysis (Royal HaskoningDHV 2014)
Analysis of Towed Hydrophone Data Collected at Westray South and Brims Tidal Sites Between January 2012 and March 2014 (MER 2014)
Underwater Noise Technical Report (Xodus 2015)

13.2 STUDY AREA

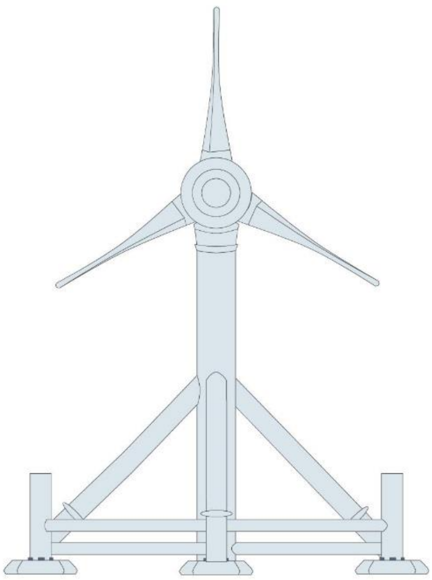
Due to the mobile and transitory nature of marine mammals and basking shark, the area of assessment for these receptors, with regard to the Project, is relatively wide; covering Orkney and Pentland Firth waters, a large portion of the northern North Sea, and for some species, the area of interest is even wider, extending to the North Atlantic. For each species of marine mammal this wider area has been defined based on current knowledge and understanding of the biology of each species, and taking account of feedback received during consultation.

The proposed reference population for each relevant species is defined in Section 13.9 based on guidance from the Inter-Agency Marine Mammal Working Group (IAMMWG 2013, 2015). In addition, the status and activity of cetaceans known to occur within or adjacent to the Project site for Lease (AfL) is considered in the context of regional population dynamics at the scale of the Orkney and North Coast of Scotland, northern North Sea, or North Sea depending on the data available for each species and the extent of the agreed reference population. A summary of the reference populations is provided in Table 13.5.

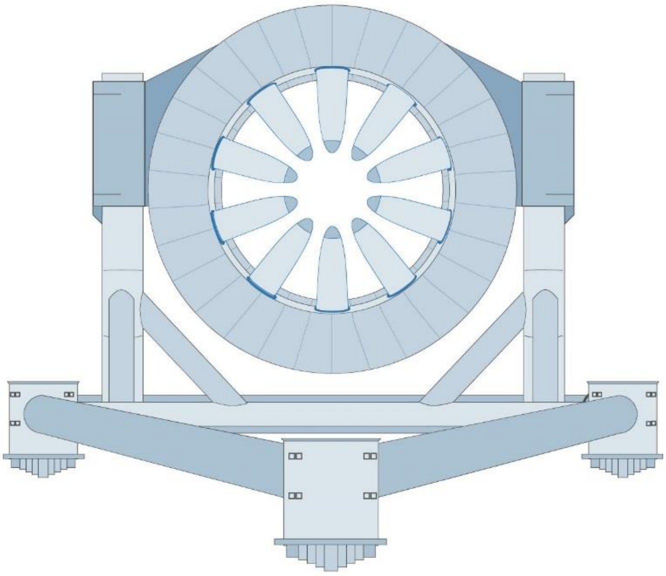
13.3 DESIGN ENVELOPE CONSIDERATIONS

13.3.1 Collision/ Encounter Rate Worst Case Scenario

As outlined in Chapter 5 Project Description, the design envelope includes shrouded and unshrouded tidal turbines (Figure 13.1). There is considerable uncertainty regarding the collision risk with all tidal turbine types and so both shrouded and unshrouded are included in the assessment, with the worst case parameters for each outlined in Table 13.2.



Unshrouded seabed mounted



Shrouded seabed mounted

Figure 13.1: Examples of turbine types

13.3.2 Vessel Collision Risk Worst Case Scenario

The worst case scenario for vessel collision risk is based on the unshrouded seabed mounted device requirements as these may be installed in two parts, foundation drilling and then turbine installation, compared with the shrouded devices that are likely to be installed as one unit. The following outlines the worst case scenario:

13.3.2.1 Stage 1 Installation (24 months)

- Foundation installation – duration up to 30 weeks
  - Dynamic positioning (DP) vessel – 1 return trip per device – **30 trips**
  - Support vessel e.g. RIB – 1 return trip per device – **30 trips**
- Turbine installation – duration up to 30 weeks
  - Small DP vessel – 1 return trip per device – **30 trips**

    - Support vessel – 1 return trip per device – **30 trips**
    - Cable connection vessel – 1 return trip per device – **30 trips**
- Export cable installation – duration up to 8 weeks
    - Cable installation vessel – slow movement along the length of each cable – **4 trips**
    - Support vessel e.g. RIB – slow movement along the length of each cable – **4 trips**
- Export cable protection installation – duration up to 8 weeks
    - 1 cable protection vessel – slow movement along the length of each cable – **2 trips**
- Landfall works – duration up to 4 weeks
    - Jack up barge – duration up to 4 weeks– **1 trip**
    - Support vessel e.g. RIB – 1 trip per day – **28 trips**
- Total – 189 trips

13.3.2.2 Stage 2 Installation (36 months)

- Foundation installation – duration up to 85 weeks
    - Dynamic positioning (DP) vessel – 1 return trip per device – **170 trips**
    - Support vessel e.g. RIB – 1 return trip per device – **170 trips**
- Turbine installation – duration up to 85 weeks
    - Small DP vessel – 1 return trip per device – **170 trips**
    - Support vessel – 1 return trip per device – **170 trips**
    - Cable connection vessel – 1 return trip per device – **170 trips**
- Export cable installation – duration up to 16 weeks
    - Cable installation vessel – slow movement along the length of each cable – **12 trips**
    - Support vessel e.g. RIB – slow movement along the length of each cable – **12 trips**
- Export cable protection installation – duration up to 16 weeks
    - 1 cable protection vessel – slow movement along the length of each cable – **6 trips**
- Landfall works – duration up to 8 weeks
    - Jack up barge – duration up to 8 weeks – **1 trip**
    - Support vessel e.g. RIB – 1 trip per day – **56 trips**
- Total – 937 trips

13.3.2.3 O&M Stages 1 and 2

It is expected that there will be one vessel on site per day on average. O&M vessel types may include:

- Small tug
- Support vessel e.g. RIB
- Large DP vessel

Further information on vessel requirements is outlined in Chapter 5 Project Description and Chapter 15 Shipping and Navigation. The level of vessel movements associated with the Project is also put into context of the existing levels of shipping activity, described in Chapter 15 Shipping and Navigation.

13.3.3 Underwater Noise Worst Case Scenario

The worst case scenarios and modelling assumptions for underwater noise are outlined in Underwater Noise Technical Report (Xodus 2015). An overview of the key parameters is shown in Table 13.2.

13.3.4 Changes to Prey Resource Worst Case Scenario

The worst case scenarios and modelling assumptions for indirect impacts on marine mammals as a result of changes to prey resource are based on the worst case scenario for the impacts on prey species. These are outlined in Chapter 12 Fish Ecology.

13.3.5 Overview of Design Envelope Parameters

Table 13.2: Design envelope parameters for the marine mammals and basking assessment

Project parameter relevant to the assessment	Maximum Project parameter for impact assessment	Explanation of maximum Project parameters
Maximum number of turbines (Stage 1)	30	Based on minimum 1MW rating
Maximum number of turbines (Stage 2)	170	Based on minimum 1MW rating
Maximum number of turbines (Stage 1 and 2)	200	Based on minimum 1MW rating
Maximum device power rating	2MW	Turbines could range in power between 1 – 2MW.
Rotor diameter	Shrouded Open Centre Turbine (OCT): 12.8m Unshrouded: 23m	12.8m is the maximum rotor diameter for the shrouded OCT and 23m for the unshrouded devices, would be the maximum diameter considered as part of the design envelope.
Blade length	Shrouded OCT: 4.35m Unshrouded: 11.5m	
Blade width	Shrouded OCT: 1.9m Unshrouded Max: 1.8m	
Blade thickness	Shrouded OCT: 0.1m Unshrouded Max: 0.3m	Average width of leading edge thickness for the shrouded OCT is 0.1m. 0.3m used for other devices, based on EMEC (2014b).
No. of rotors per device	All devices are single rotor	
No. of blades per rotor	Shrouded OCT: 10 Unshrouded: 3	Shrouded OCT: 10 blades; blade tips are retained within the outer venturi. Unshrouded turbines have 3 blades.

Project parameter relevant to the assessment	Maximum Project parameter for impact assessment	Explanation of maximum Project parameters
Pitch of the blade	Shrouded OCT: 20-30º Unshrouded: 0-10º	Some turbines with yaw function (unshrouded) also have independent blade pitching functions. Where blade pitching is included, this ranges from 0-10 degrees (generating).
Total swept area	Shrouded OCT:115m^2 Unshrouded: 415m^2	Rotor area (minus open-centre area for OCT).
Average RPM	Shrouded: 8 RPM Unshrouded: 10RPM	The rpm range is 1-21rpm. An average of 10rpm is used for 3-blade and 8rpm for OCT at open centre. Typical inner tip speed of 1.8m/s for OCT.
Cut-in flow speed	0.5 - 1m/s	
Cut-out flow speed	3.5 – 5m/s	Turbine designed to operate in all flow speeds.
Mean current speed during device operation	Shrouded: 1.56m/s Unshrouded: 1.82m/s	The current speed during operation for the shrouded device has been calculated for Brims site based on the OCT device. The current speed during operation for the unshrouded device is based on EMEC (2014b).
Water depth	70-90m	
Min clearance between blade tip and sea surface at LAT	30m minimum clearance	Subject to NRA consultation but 30m minimum anticipated.
Min clearance between blade tip and seabed	4m	Clearance may be more depending on turbine and support structure configuration.
Percentage of time not in use	14.4%	
Vessels types	Potential for various vessels during construction, maintenance and decommissioning including: Anchor handling vessel Installation/construction vessel (using DP) Decommissioning vessel (using DP) Support vessel Rock placement vessel Cable lay vessel Misc. small vessels (e.g. tugs, vessels carrying ROVs, crew transfer vessels, dive boats and RIBs)	
Vessel movements	Stage 1 – 218 return trips (see Section 13.3.2.1) Stage 2 – 998 return trips (see Section 13.3.2.2)	

Project parameter relevant to the assessment	Maximum Project parameter for impact assessment	Explanation of maximum Project parameters
Changes to prey species	Chapter 12 Fish Ecology outlines a minor impact on prey species	
Minimum cross flow spacing	80m	Cross flow spacing depends on selected turbine, but there will be a minimum spacing between turbines of 80m.
Minimum down flow spacing	150m	Minimum down flow spacing between turbines will be 150m.
Turbine noise level	152 dB re 1 Pa (rms)	Based on measurements on 2.2MW, 16m diameter device
Foundation type	Drilled monopiles of 4m diameter	Potential for Gravity Base Structure (GBS) including sub-sea bases (SSBs), drilled monopile or pin pile tripods. Drilling represents the worst case scenario for noise
Decommissioning	Use of jet cutting	Estimated maximum sound pressure levels used for jet cutting following literature review.

13.4 LEGISLATIVE FRAMEWORK AND POLICY CONTEXT

Chapter 3 Planning and Legislation describes all documents relevant to the Project. This section provides a brief outline of the policy, legislation and guidance which is specific to marine mammals and basking shark.

Cetaceans, pinnipeds and basking shark are protected under a wide range of national and international legislation. All cetaceans are European Protected Species (EPS) under Annex IV of the Habitats Directive (European Union (EU) Directive 92/43/EEC) because they are of conservation interest and protected in order to maintain or restore Favourable Conservation Status. Harbour porpoise *Phocoena phocoena* and bottlenose dolphin *Tursiops truncatus* along with grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina* are listed as Annex II of the directive as species for which a network of Special Areas of Conservation (SACs) are to be designated.

The Habitats Regulations 1994 (as amended in Scotland in 2004, 2007, 2008(a) and 2008(b)) implement the species protection requirements of the Habitats Directive in Scotland on land and inshore waters (0-12 nautical miles). Part II of the Habitats Regulations outlines protection for SACs, designated for habitats listed under Annex I of the Habitats Directive or species listed under Annex II of the Habitats Directive including harbour seal, grey seal, bottlenose dolphin and harbour porpoise. Part II of the Habitats Regulations details the protection given to EPS.

A license is required if the risk of injury or disturbance to EPS is assessed as 'likely' under regulations 41(1)(a) and (b) in The Conservation of Habitats and Species Regulations and 39(1)(a) and (b) in The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (amended in 2009 and 2010).

The Convention on the Conservation of Migratory Species (The Bonn Convention) aims to conserve migratory species and their habitats. Short-beaked common dolphin *Delphinus delphis* is afforded strict protection as an endangered migratory species, listed under Appendix 1 of the Convention. This has been ratified in the UK by the Wildlife and Countryside Act (1981). The Nature Conservation (Scotland) Act 2004 amends and improves the species protection provided by the Wildlife and Countryside Act 1981 to provide extension to existing protections for cetaceans from intentional disturbance to encompass protection from reckless disturbance as an offence. Basking sharks have full protection from intentional or reckless disturbance in Scottish waters (up to 12 miles offshore) under Section 6.

The UK has signed up to the Convention on Biological Diversity and the OSPAR Convention, and as such is committed to establishing a network of Marine Protected Areas. Of relevance to marine mammals in Scotland, the MPA network includes SACs, Nature Conservation Marine Protected Areas (MPAs) and Priority Marine Features (PMFs). A suite of MPAs were identified with the aim of conserving some of Scotland's most important marine wildlife, habitats and geodiversity. The recommendation also includes a second tranche of sites on the west coast of Scotland for basking sharks, minke whales *Balaenoptera acutorostrata* and Risso's dolphins *Grampus griseus* which has not yet been designated. In addition, Scottish Natural Heritage (SNH) and the Joint Nature Conservation Committee (JNCC) developed a list of 81 PMFs (habitats and species) considered to be of conservation importance in Scotland. Of relevance to the study are minke whale, harbour porpoise and white-beaked dolphin *Lagenorhynchus albirostris*.

The basking shark is currently listed by IUCN as "Vulnerable" globally and "Endangered" in the Northeast Atlantic and North Pacific. They were listed in Appendix II of CITES in 2002, and are on Appendix 1 and II of the Convention on Migratory Species (CMS), and Annex I of the United Nations Convention on the Law of the Sea (UNCLOS). Under the Nature Conservation (Scotland) Act, no disturbance is allowed. Under European legislation, it is prohibited for basking sharks to be fished for, retained on board, or landed by any community vessel.

Under the Marine (Scotland) Act 2010 it is an offence to kill, injure or take a seal at any time of year except to alleviate suffering or where a licence has been issued to do so by the Scottish Government. It is an offence to harass seals at haul-out sites which have been identified for protection under Section 117 of the Marine (Scotland) Act 2010. Under Section 117 of the Marine (Scotland) Act 2010, important seal haul-out sites can be designated to provide additional protection for seals from intentional or reckless harassment

Grey seal and harbour seal are also listed on Annex V of the Habitats Directive, which requires their exploitation or removal from the wild to be subject to management measures.

13.4.1 Survey Guidance

The site characterisation surveys undertaken to inform this EIA for the Project followed the SNH draft guidance on survey design and methodologies in relation to marine renewables (MacLeod *et al.* 2011 and Sparling *et al.* 2011). The impact assessment follows the latest, appropriate, guidance on Environmental Impact Assessment (EIA) and draws experience from recent examples of similar renewable energy projects in the UK and Europe.

The principal guidance documents used to inform the assessment of potential impacts on marine mammals are as follows:

- Guidance on the Assessment of Effects on the Environment and Cultural Heritage from Marine Renewable Developments. Produced by: the Marine Management Organisation (MMO), the Joint Nature Conservation Committee (JNCC), Natural England, the Countryside Council for Wales (CCW) and the Centre for Environment, Fisheries and Aquaculture Science (Cefas) (MMO 2010);
- The Protection of Marine EPS From Injury and Disturbance: Draft Guidance for the Marine Area in England and Wales and the UK Offshore Marine Area (JNCC *et al.* 2010);

- The Protection of Marine European Protected Species from injury and disturbance. Guidance for Scottish Inshore Waters. (Marine Scotland 2014);
- Guidelines for Ecological Impact Assessment in Britain and Ireland, Marine and Coastal (Institute for Ecology and Environmental Management (IEEM 2010); and
- Approaches to Marine Mammal Monitoring at Marine Renewable Energy Developments Final Report (Sea Mammal Research Unit (SMRU) Limited 2010, on behalf of the Crown Estate).

13.5 SUPPORTING SURVEYS AND STUDIES

Site specific surveys of the AfL area, completed from March 2012 to March 2014 by Natural Research Projects Ltd, provide a key source of site characterisation data which is further supplemented by available information. These surveys consist of boat based surveys with both visual and acoustic observations using dedicated marine mammal observers (MMOs), as well as European Seabirds at Sea (ESAS) observers and a towed passive acoustic monitoring (PAM) hydrophone. All surveys were undertaken in sea state 4 or less. Marine Scotland and SNH were consulted on the survey design and methodology in November 2012 and January 2013 and interim survey findings in August 2012, February 2013, January 2014, and the final results in July 2014 (see Table 13.3). The results of the visual survey data analysis are provided in Royal HaskoningDHV (2014). The results of the Passive Acoustic Monitoring (PAM) surveys are provided in MER (2014).

The site specific surveys are supplemented by published and other available data sources where appropriate. These include:

- SCANS and SCANS II (updated densities from Hammond *et al*. 2013) and CODA;
- Inter-Agency Marine Mammals Working Group (IAMMWG) Management Units June 2013 (IAMMWG 2013);
- IAMMWG Management Units for Cetacean in UK waters January 2015 (IAMMWG 2015)
- Scientific Advice on Matters Related to the Management of Seal Populations (Special Committee on Seals (SCOS) 2014);
- Jones *et al.* (2013) (grey and harbour seal density maps);
- Reid *et al.* (2003) Atlas of cetacean distribution;
- Evans *et al,* (2011) Abundance and behaviour of cetacean and basking sharks in PFOW;
- SMRU Ltd (2011) Utilisation of space by grey and harbour seals in the Pentland Firth and Orkney Waters;
- Habitats Directive Article 17 - 3rd Reporting Round (JNCC 2013);
- Marine Evidence Group (MEG) Report: An analysis of potential broad-scale impacts on two harbour porpoise from proposed pile driving activities in the North Sea (2013);
- Interim Population Consequences of Disturbance (PCOD) report. Harwood *et al.* (2014);
- Duck & Morris (2014) SNH commissioned report on harbour and grey seal in Orkney in August 2013;
- APEM (2013) Utilisation of sea space by sea birds in the Pentland Firth;
- MeyGen Tidal Energy Project Phase 1 Environmental Statement (MeyGen 2011); and
- Relevant Strategic Environmental Assessments.

13.6 DATA GAPS AND UNCERTAINTIES

The confidence in the predictions of the impact assessment will depend on any data gaps and uncertainties, and measures taken to address them. The marine mammal site specific baseline surveys were constrained by poor weather in a number of months (Royal HaskoningDHV 2014).

Table 13.3 outlines consultation with SNH and Marine Scotland on this topic and shows it was agreed that the BTAL marine mammal surveys would be supplemented with available literature and data to characterise the existing environment for marine mammals in the study area. This includes the use of alternative estimates of density where appropriate, with discussion of how they relate to the Project site.

These density estimates are fed into collision risk modelling, within which, there is also additional uncertainty associated with avoidance rates of marine mammals and basking sharks as well as the consequences of a collision. It is important to note that given the relatively slow tip speed of the rotors, of up to 12m/s or 26.8mph (based on an open rotor device of 23m rotor diameter moving at 10RPM), a collision may not result in a fatality, however, in order to provide a conservative assessment it is assumed that all potential collisions result in fatality.

As outlined in the Underwater Noise Technical Report (Xodus 2015), there is uncertainty in the noise modelling. There are limited available data for operation tidal turbines and there is uncertainty in the predicted noise associated with scaling up devices as well as use of proxies to cover all devices in the Rochdale Envelope.

Another area of uncertainty relates to the availability of suitable noise data for the vessels likely to be used during the project construction, operation and decommissioning. Where no suitable data were available, proxy noise data were used based on similar sized vessels. However, given that the noise signature of vessels can vary significantly, even for vessels in the same class, it is considered likely that this is an area of uncertainty. In order to carry out a precautionary assessment, noise levels at the upper end of the range for each vessel class were used.

Finally, there is relatively high uncertainty regarding threshold criteria for the onset of both physiological and behavioural effects, as used in underwater noise modelling. It is considered likely that the uncertainty in criteria for onset of effects is potentially the highest source of error in the underwater noise assessment. The noise impact zones in the Underwater Noise Technical Report (Xodus 2015) are considered to provide a highly precautionary worst case.

13.7 CONSULTATIONS

To inform the ES, BTAL has undertaken a pre application consultation process including:

- Scoping (submitted to MS-LOT August 2013);
- HRA Screening (submitted to Marine Scotland August 2013); and
- General ongoing consultation (including survey methods, EIA methodology and baseline characterisation).

Table 13.3 summarises general consultation activities undertaken in relation to marine mammals and basking sharks, and Table 13.4 summarises the consultation in relation to Scoping and HRA Screening.

Table 13.3: Consultation activities undertaken in relation to marine mammals and basking sharks

Topic	Stakeholder	Comment	Response/Action taken with cross-reference where applicable
HRA Screening	Scottish Natural Heritage (SNH) 02/11/12	We agree that the sites identified thus far should be taken forward for further consideration of potential LSE, but advise that other sites may also be appropriate to maintain under consideration at this stage. The Dornoch Firth and Morrich More SAC may be the most relevant of these, but SNH are also currently considering guidance on connectivity with Natura sites by marine mammals such as seals, particularly out-with the breeding season when they may range more widely. We recommend use of two recent SNH commissioned reports in proceeding with relevant sections of the EIA & HRA: SMRU Limited (2011) and Evans *et al.* (2011b).	Dornoch Firth and Morrich More SAC have been considered further in the Information to Inform HRA report (Supporting Document: BTAL, 2015c). SMRU Limited (2011) and Evans *et al.* (2011b) have been used in the Information to Inform HRA report (Supporting Document: BTAL, 2015c) and Sections 13.9.1, 13.9.2, 13.9.3, 13.9.4 and 13.9.5 of this ES chapter.
Survey methods for birds, marine mammals and basking sharks	SNH 02/11/12	We recommend a minimum of 12 survey visits per year. These need not necessarily be spread evenly across the year, but could be more frequent during the most sensitive periods for relevant taxa. There is no suggestion of passive acoustic technologies to detect marine mammals at the site. We suggest the applicants consider the options available. It is suggested that marine mammal data be combined with results from the Westray South site to support statistical analyses for species with particularly low encounter rates, however, before applying such a function it will be important to be able to demonstrate that detectability does not differ significantly between the sites as a consequence of any ecological differences. Furthermore, any differences in detectability arising from differences in observers or vessels, or the season or tidal state of observations, should be accounted for.	Consultation regarding the surveys was ongoing throughout the two years and advice taken into account. Twelve surveys per year were planned and surveys were undertaken on a total of 20 days between March 2012 and March 2014. Due to bad weather no surveys were possible during September 2012, October 2012, November 2012, January 2013, April 2013, August 2013, November 2013, December 2013 or January 2014. In addition surveys could not be completed for all transects in some months (August 2012, February 2013, May 2013, October 2013 and March 2014). Further details are provided in Royal HaskoningDHV (2014). Consultation with SNH and MS throughout the surveys agreed the approach to managing data gaps by supplementing with available information (see below, SNH consultation on 07/02/13).

Topic	Stakeholder	Comment	Response/Action taken with cross-reference where applicable
			Passive Acoustic Monitoring (PAM) was also conducted during the surveys. Further details are provided in Supporting Document: MER, 2013. Survey data from the Westray South site was used to estimate grey seal density. The same survey methods, observers and vessels were used at both sites. As outlined in (Supporting Document: RHDHV, 2014c) the same detection function (g(0)=22) and analysis were conducted using data up to and including sea-state 3, but excluding sea-states 4 and 5.
Approach to noise assessment and noise monitoring	SNH 02/11/12	The approach described, only considers seals (grey and harbour) and bottlenose dolphins in an acoustic impact study, as these are the qualifying features of the identified SACs. However, the noise assessment will not only inform the HRA, but also the EIA. Consequently, as European Protected Species, all cetacean species that may be found in these areas should also be considered (see Evans *et al.* 2011a). We welcome the commitment to designing post-consent monitoring in consultation with Marine ScotlandMS-LOT and SNH. It would also be advisable for us to provide comment on a more detailed methodology for the pre-consent monitoring.	The noise modelling considers seals, high frequency cetaceans, mid frequency cetaceans, low frequency cetaceans and fish, including basking shark – see Underwater Noise Technical Report (Supporting Document: Xodus, 2015). SNH will be consulted during development of the Marine Mammal Management Plan (MMMP).
Survey methodology	Marine Scotland Science (MSS) 21/01/13	Because the bulk of the survey effort is in the 4km buffer area there is likely to be bias in results away from the lease area, and the data's ability to characterise the development area may be lessened. Survey effort should be focused on the Project footprint and any anticipated impact footprint. A buffer may also provide opportunity to increase sample sizes for less frequently encountered species. A more appropriate approach may be a reduction in buffer size with the addition of transects within the lease area. These	It was agreed with Marine Scotland in April 2013 that no changes to the survey methodology should be made (See Marine Scotland Licensing Operations Team (MS-LOT) 16/04/13 written response to Survey methodology below). It was agreed that a consistent methodology was important and should be maintained, with survey data supplemented by other available information, which is provided in Section 13.9.

Topic	Stakeholder	Comment	Response/Action taken with cross-reference where applicable
		additional transects should be spaced as close together as is practical without causing disturbance of birds on adjacent transects. To be clear, the original transects through the lease area would be retained. These additional transects could be completed before or after the main transects, with the reduced length of the main transects resulting from reducing the size of the buffer ensuring that total survey time was not increased. The advantage of zigzag transects would be that they eliminate off-effort time transiting between transects. Analysis of all data within the lease area would provide much tighter confidence limits. If any changes are made to the survey design then the monthly effort (km surveyed and number of transects) should be presented separately for both the lease area and the buffer area.	
Interim wildlife survey reports	SNH 07/02/13 letter 26/02/13 meeting 12/03/13 written response	The amount of rest provided to observers should be described and quantified in future reports. We suggest that serious consideration be given to the use of additional observers in rotation, for both birds and mammals. It is noteworthy that sea conditions were sometimes more than sea state 3, the threshold generally considered to worsen detectability issues for marine mammal surveys. Consequently, it may be expected that abundances are underestimated from these survey visits and data should be corrected accordingly.	It was agreed with Marine Scotland in April 2013 that no changes to the survey methodology should be made (See Marine Scotland Licensing Operations Team (MS-LOT) 16/04/13 written response to Survey methodology below). Instead, as outlined in (Supporting Document: RHDHV, 2014c), data analysis were conducted using data for sea-states up to 3, but excluding sea-states 4 and 5.
Survey methodology	Marine Scotland Licensing Operations Team (MS-LOT) 16/04/13 written response	MS-LOT advises that no change in survey methodology is adopted at this late stage. However, due consideration must be given within the Environmental Statement to the potential biases that may result from the relatively limited survey effort within the Project site and immediate surrounds. (Also discussed 07/02/13 by letter and at a meeting on 26/02/13).	Section 13.9, Baseline description draws on a variety of data and information sources to provide context and avoid issues of bias.

Topic	Stakeholder	Comment	Response/Action taken with cross-reference where applicable
Data	SNH 07/02/13 letter 26/02/13 meeting 12/03/13 written response	There is a considerable deficiency of year-1 data in the autumn period, due to poor sea conditions. For marine mammals there are a number of potential data sources that could be explored, as detailed below. It is stated that a literature review will be completed, including a review of abundance estimates where available, from sources such as APEM aerial survey data, the Joint Cetacean Protocol, SCANS II data and EMEC survey data. We agree that this information will be useful in providing context to the understanding of mammal use of the site, but the respective limitations of these data-sets should also be adequately acknowledged. We recommend further discussion on the appropriate modelling approach for encounter/collision risk modelling. Based on data presented so far we will expect modelling to be completed for grey seals, harbour seals, harbour porpoise and minke whale, but the final species scope will need to be agreed following completion of survey work. We agree with the proposed reference populations to be used in impact assessments for harbour porpoise (North Sea population) and white-beaked dolphin (UK population), but suggest that appropriate choice for minke whale be at the scale of 'British and Irish' waters. Our view is currently based on a draft Management Unit paper for Marine Mammals currently being prepared across all of the UK Statutory Nature Conservation Bodies (SNCBs). This paper is not yet published and so may be subject to change.	As above, Section 13.9, Baseline description, draws on a variety of data and information sources. Section 13.6 also describes data gaps and uncertainties associated with the marine mammal and basking shark assessment. Within Section 13.6, and relevant sections for each species, alternate estimates of density have been sourced as appropriate, with discussion of how they relate to the Project site. As outlined in Section 13.12.2.2, grey seal, harbour seal, harbour porpoise, minke whale and basking shark were modelled to estimate potential encounter/collision risk. The assessment was based on the agreed reference populations for each species, based on the most recent report for Management Units for cetaceans in UK waters (IAMMWG 2015) and Management Units for seals (IAMMWG 2013; SCOS 2014).
Survey	SNH 17/01/14	Our continuing concern is that it is uncertain whether the current level of survey effort will generate sufficient data for the analysis required for site characterisation and assess the likely impact of the Project. The survey protocol has the ESAS surveyors and the MMOs both recording marine mammal sightings, but there is no detail as to	As above, it was agreed with Marine Scotland in April 2013 that no changes to the survey methodology should be made. Supporting Document: RHDHV, 2014c outlines the approach for analysis, confirming that density estimates were calculated, where possible using the

Topic	Stakeholder	Comment	Response/Action taken with cross-reference where applicable
		how or if these data sets will be incorporated (as some may be of the same animal). In which case, what data will be taken forward to analysis. We recommend that the dedicated MMO observations are considered first, with the ESAS observations as supporting.	MMO data with the ESAS marine mammal sightings providing additional information.
Collision risk assessment	SNH 17/01/14	In our scoping response of the 31st October 2013, we stated that for the Project collision risk assessment the ERM was preferred. However, considering the open-centre tidal turbine is the preferred device, and our recent collision risk assessment for EMEC Falls of Warness, it may be preferable to use the modified CRM as used for the recent EMEC collision risk assessment. We welcome further opportunity to discuss the approach taken to assess collision risk for the proposed Brims Tidal Array and the species that require assessment.	Section 13.12.2.2, within this chapter of the ES, details how both of these approaches were used in the assessment: ERM was applied to the unshrouded devices (based on the 'SNH (2015) underwater collision spreadsheet and the EMEC (2014b) modified ERM to the open centre tidal devices (OCT)
Approach to assessment (response to position paper)	SNH 30/07/14 meeting 21/08/14 written response	Additional data may include the MeyGen Environmental Statement and APEM digital surveys of the Pentland Firth and Orkney Waters. North Rona SAC should be incorporated into the list of designated sites. See recent guidance on designated haul out sites. For cumulative assessment we advise that for all current and planned activities in the MU to be accounted for where possible. We agree with the use of PBR for context purposes and for consideration in the cumulative assessment. We note that the applicant suggest that there are alternative mechanisms to provide context, but there is no detail included. We would welcome the opportunity to explore this further. We do not agree that the missing surveys are unlikely to have affected the species composition as we do not have the information to make that claim. We would refer you to Evans *et al.* (2011b) for context.	As above, Section 13.9, Baseline description draws on a variety of data and information sources. Section 13.6 describes data gaps and uncertainties associated with the marine mammal and basking shark assessment. North Rona SAC has been included in the Information to Inform HRA (Supporting Document: BTAL, 2015c). The cumulative assessment has included all current and planned activities that were confirmed with MS-LOT and SNH (12/06/2015). The PBR has been used for context purposes and interim PCoD also be conducted for the Project– see Sections 13.12.2.2 As outlined above, Section 13.9 Baseline description draws on a variety of data and information sources, including Evans *et al.* (2011b) – for example, see Sections 13.9.4.1, 13.9.4.2, 13.9.4.3 and 13.9.5.4.

Topic	Stakeholder	Comment	Response/Action taken with cross-reference where applicable
		The Project site is almost on the boundary of two management units for harbour porpoise. Given their wide ranging nature it makes sense to also include the West Scotland MU in the discussion (and for cumulative impacts). We consider both seal species to be at risk from the corkscrew injuries and would therefore suggest sensitivity for both should be 'high'. Potential impacts such as corkscrew injuries and disturbance should also be considered during maintenance operations. Details of the modified collision risk model (CRM), used for considering annular turbines such as the OpenHydro turbine, can be found in the EMEC Falls of Warness collision risk assessment (Band, 2014).	Both MUs are included in Section 13.9, Baseline description and taken forward as a combined reference populations for the impact assessments. Developments in understanding of 'corkscrew injuries' have since been made and latest advice (SNCBs Feb 2015) is followed in the assessment: "it is considered very likely that the use of vessels with ducted propellers may not pose any increased risk to seals over and above normal shipping activities and therefore mitigation measures and monitoring may not be necessary in this regard, although all possible care should be taken in the vicinity of major seal breeding and haul-out sites to avoid collisions." – see Section 13.12.1.2. Potential impacts assessed during operation and maintenance include: Underwater noise; Collision with devices; Collision with vessels; Electromagnetic Fields; Disturbance at haul out sites; Indirect effects on prey species; and Accidental contamination from vessels or devices (Section 13.12.2). As outlined above, both of these approaches were used in the assessment (Section 13.12.2.2): ERM for the unshrouded devices (based on the '2015 06 22 – SNH underwater collision spreadsheet – June 2015 draft') and the modified ERM for the open centre tidal devices (OCT) (based on the '2014 09 05 – EMEC FoW – tidal turbine collision assessment – sea mammals' spreadsheet).
	SNH	PVA might be more appropriate for putting the results of CRM into context. PCoD is a quite novel approach and not yet used on tidal sites so should be used with caution, but is a useful model. SNH	As outlined above, Section 13.12.2.2 uses the latest advice from SNH on collision risk modelling: '2015 06 22 – SNH underwater collision guidance – June 2015

Topic	Stakeholder	Comment	Response/Action taken with cross-reference where applicable
		need to discuss this with MS-LOT and MSS. SNH to communicate the results of this conversation to the BTAL team. MS-LOT are looking to develop specific advice on collision risk modelling for BTAL following discussions with SNH.	draft with watermark' and '2015 06 22 – SNH underwater collision spreadsheet – June 2015 draft').
	RSPB	WDC should be consulted during the EIA/HRA before ES submission.	Noted
PAM report	Marine Scotland written response 29/04/15	It would be helpful to have the PAM results incorporated into the marine mammal survey updates and impact assessment reports previously submitted. The method states that the PAM operator was not dedicated to that role. Clarification is sought on what further work will be undertaken, and what the conclusions mean in terms of the marine mammal impact assessments.	The PAM results have been incorporated into site characterisation (Section 13.9.3). During surveys, the MMO's monitored the system regularly and the PAM data was recorded and reviewed later. Given the low detection rates, further detailed analysis is not possible and instead the impact assessment will draw information from other relevant sources.
Draft baseline and approach to impact assessment	Marine Scotland written response 09/07/15	Suggested altered wording regarding EPS legislation. SNH survey guidance should be referred to as a draft. Data sources are thorough and appropriate. Query the use of percentages to determine magnitude. MS confirmed that the thesis by Lindsey Wilson on harbour seal diet is now available. MS agrees with using SMRU at sea density estimates…..advise that when density estimates are taken forward for further analysis, the most precautionary one is used for a worst case estimate of impact. MS highlights that there are potential NC MPAs for Minke whales and Risso's dolphins.	Wording changed regarding EPS legislation and SNH guidance. Percentages are used regularly in magnitude classification e.g. for Offshore Wind EIA and are useful when undertaking quantified impact assessments such as has been done for BTAL underwater noise and collision risk. Wilson (2014) has now been incorporated. Following submission of the draft baseline to Marine Scotland in April 2015 a further review of all available density estimates and which are most relevant to the AfL. This is discussed throughout Section 13.9 with a summary provided in Section 13.9.6. NC MPAs are included in Section 13.4.

Topic	Stakeholder	Comment	Response/Action taken with cross-reference where applicable
		The feedback for Marine Scotland also includes comments on the "impact assessment" however no impact assessment was provided, rather a high level discussion of the approach. Where applicable to this ES chapter these comments have been incorporated.	

SNH advice on ERM and CRM as well as PCOD and PBR	SNH written response 30/10/15	Following the submission of two reports "Preliminary Assessment of the Potential Encounter Rate and Collision Risk for Marine Mammals and Basking Shark at the Brims Tidal Array Site" and "Preliminary PCoD and PBR Assessment for Marine Mammals at the Brims Tidal Array Site". Key comments raised include:
		• Clarification of certain parameters e.g. surface clearance, rotor width etc.
		• SNH agree with the species included in the assessment.
		• SNH clarified the species parameters in Band (2015) should be used in modelling.
		• SNH agrees with the density estimates used but advises that the modelling should also be run using the SMRU seals densities and SCANS II densities for comparison.
		• SNH suggest that the modelling results using 0, 50, 95, 98, and 99% avoidance rates should all be presented.
		• SNH is content that the density estimates are correctly used in the modelling in relation to correcting for the probability of detecting an animal on the transect line (g(0)), included adjustment for availability bias in the model (which should be clearly detailed in the report and ES).
		• The following reference population estimates should be used:
		  • Grey seal – 20,682 (SCOS 2014)
		  • Harbour seal – 1,938 (SCOS 2014)
		  • Cetaceans – used management unit population estimates in IAMMWG (2015)
			All project parameters used in the collision risk modelling are outlined in Table 13.2.
			Species parameters from Band (2015) have been used in the final modelling (see Table 13.29).
			The ERM, CRM (for unshrouded devices) and modified ERM (for the OCT device) were run using the SCANS cetacean density estimates and SMRU seal density estimates and the results are provided in Appendices 1, 3 and 4, respectively.
			Encounter rates (with 0% avoidance) and the collision risk associated with a range of avoidance rates (0, 50, 95, 98 and 99%) are presented for all models (see Section 13.12.2.2 and Appendices 1 to 4).
			The density estimates presented have all been corrected and therefore no further adjustment is made in the model, this is outlined in Section 13.12.2.2.
			The recommended reference populations have been used and are summarised in Table 13.26.
			
			Adult survival of 0.85 and fecundity of 0.96, representing a stable population as suggested by SNH has been used in the interim PCoD for harbour porpoise as discussed in Section 13.8.2.1.
			Comparison of the undisturbed populations shows the greatest difference between comparable populations is 0.141 (based on the 2% decline scenario for the harbour porpoise North Sea population). As this is on a

Topic	Stakeholder	Comment	Response/Action taken with cross-reference where applicable
		• SNH suggest the Harwood & King (2014) survival parameters for PCoD should be based on high adult survival (0.925) with low fecundity (0.48); or lower adult survival (0.85) with higher fecundity (0.96) for harbour porpoise. • There seem to be considerable differences between the predicted declines for undisturbed populations under each scenario (i.e. unshrouded/OCT and 30/200). • The outputs from the ERM suggest much higher numbers of individuals involved in collision for unshrouded than OCT devices, and for 200 than 30 devices, (both of which seem intuitively correct). However, in the PCoD outputs, the differences between unshrouded and OCT, and between 30 and 200 devices, are very small, and in some cases the probabilities of decline are actually higher for the OCT devices.	scale of 0 to 1 it therefore represents a very small difference in the probabilities presented. There are also some extremely small variations (on the 0 to 1 scale) when comparing shrouded and unshrouded. As the scenarios are run 1000 times a small amount of variation is possible. The PCoD outputs indicate that there is no significant additional risk associated with either unshrouded or shrouded devices. Interim PCoD has been used to provide context to the BTAL impact assessment and CIA, but is not a primary factor in determining the level of risk. It is understood that PCoD is still in development and Marine Scotland and SNH are in the process of determining how/if PCoD should be used.
	SNH and Marine Scotland meeting 05/11/15	Presentation of interim collision risk assessment to SNH and Marine Scotland incorporating feedback in the SNH written response 30/10/15 and agreement of the parameters for CRM/ERM and PCoD. Agreement to incorporate the MeyGen collision risk which was done by MS/SNH during determination rather than the modelling which is in the MeyGen ES.	N/A – incorporation of the written feedback outlined above.

Table 13.4: Scoping (August 2013) comments relevant to marine mammals and basking sharks

Topic	Stakeholders	Comment	Response/Action taken with cross reference where applicable
Collision risk	MSS	BTAL will need to carry out a full encounter risk assessment for marine mammals, including as a minimum harbour and grey seals, and harbour porpoise.	This has been done and the approach developed in consultation with SNH (see Table 13.3).
Underwater noise	MSS	Depending upon the selected methods for installation of the devices, it may be necessary to assess the impact of construction noise on marine mammals. We would consider this necessary for pile driving and potentially for drilling. Potential impacts related to fatal interactions between seals and ducted propellers on construction and maintenance vessels should be assessed in the application. Marine Scotland Science is in the process of commissioning a study of the noise produced by operational tidal turbines and its potential impacts on marine mammals, which BTAL may wish to refer to if it is available in a suitable time frame (anticipated Q2/Q3 2014).	Underwater noise modelling is described in Support Document (Xodus, 2015) and the predicted impacts on marine mammals described in Section 13.10. The noise modelling assesses drilling. There will be no pile driving The impact assessment for potential collision with vessels, provided in Section 13.12.1.2, uses the latest guidance from the SNCBs (as discussed in Table 13.3) Marine Scotland (2014) provides the study of noise produced by operational tidal turbines and its potential impacts on marine mammals. This has been taken into consideration in terms of the required baseline information (Section 13.9) and in defining the potential impacts (Supporting Document: Xodus, 2015) and Section 13.10)
Underwater noise	Orkney Islands Council	Address construction noise, noise from all operations, noise from onshore and offshore installations, noise from associated works, and cumulative effects.	As above, underwater noise modelling is described in Xodus (2015) and the predicted impacts on marine mammals described in Section 13.12.1.
HRA	Orkney Islands Council	The information to be submitted with the EIA should also be sufficient to enable the competent authority to make an Appropriate Assessment of the implications for the site if required by the regulations.	An 'Information to Support HRA' report is submitted with the application which draws on information from the ES and aims to support the competent authorities AA process.
Underwater noise	Whale and Dolphin Conservation (WDC)	There is considerable scientific uncertainty surrounding the impacts of pile driving during construction on all species, and in this region. As a result, our preference is that pile driving is not used at all during construction. An effective underwater noise mitigation plan needs to be developed within the Project Environmental Management Plan (PEMP)	The project will not include pile driving. WDC will be involved in production of the PEMP

Topic	Stakeholders	Comment	Response/Action taken with cross reference where applicable
		for all the potential support structures. WDC requests involvement in the Project of the PEMP.	
Ducted propellers	Whale and Dolphin Conservation (WDC)	Ducted propellers should not be permitted unless they are guarded, or potential impacts can be effectively mitigated in some other way. If ducted propellers are to be used, a proposed Seal Corkscrew Injury Monitoring Scheme (SCIMS) should be developed.	Developments in understanding of this issue have since been made and latest advice (SNCAs Feb 2015) is followed in the assessment.
HRA Screening	Whale and Dolphin Conservation (WDC)	Dornoch Firth and Morrich More SAC for harbour seals should be changed to 'Potential LSE' due to the severe declining population of this species and also to account for cumulative effects.	Considered within the 'Information to Support HRA' report.
Protected species	Whale and Dolphin Conservation (WDC)	Whilst not a requirement for the HRA, the potential impact on other cetacean species e.g. minke whale, harbour porpoise and white-beaked dolphin, which are listed as Priority Marine Features and minke whale and white-beaked dolphin are drivers in the Scottish Marine Protected Areas project, should also be given adequate consideration.	These species are assessed, where appropriate in Section 13.12.
Marine bird and marine mammal characterisation surveys	SNH	We note that surveys will continue for a second year and will hopefully address the issues raised in our previous response of the 12th March 2013, including the autumn and winter data gaps. MS-LOT advised the applicant to continue with the same survey methods, and stated that 'due consideration must be given within the Environmental Statement to the potential biases that may result from the relatively limited survey effort within the Project site and immediate surrounds'.	See March 2013 consultation responses in Table 13.3 above.
Seal haul out sites	SNH	The applicant will also need to consider the proposed designated seal haul-outs.	Assessed in Section 13.12.
Ducted propellers	SNH	We highlight that due consideration should be given to the most recent knowledge available relating to 'corkscrew' injuries to seals, consistent with seals being drawn through	Developments in understanding of this issue have since been made and latest advice (SNCAs Feb 2015) is followed in the assessment.

Topic	Stakeholders	Comment	Response/Action taken with cross reference where applicable
		a ducted propeller such as a Kort nozzle or some types of Azimuth thrusters. Vessels used for the proposed Project could use such equipment.	
Collision risk modelling	SNH	We recommend that collision risk modelling is undertaken for marine mammals.	Modeling has been undertaken for the worst case scenario for shrouded and unshrouded devices using the model and guidance provided by SNH (2015a and 2015b) for unshrouded devices and based on the modified ERM for shrouded open centre devices using EMEC (2014b).
European Protected Species	SNH	Consideration of European Protected Species must be included as part of the application process, not as an issue to be dealt with at a later stage. Any consent given without due consideration to these species is likely to breach European Directives with the possibility of consequential delays or the Project being halted by the EC.	Section 13.4 discusses EPS, with the cetacean species relevant to the BTAL Project discussed further in Section 13.9.3, and the impacts on cetaceans assessed in Section 13.12. A licence to disturb EPS will be applied for post consent, if required, once the final details of the project design are known. It is generally best to wait to apply for the EPS Licence, if needed, once all the project details have been agreed and finalised so that as much detail can be included, realistic impacts assessed and what mitigation will be put in place. The EPS licence, if required, will draw on information provided in this ES chapter.
HRA		In the scoping report, potential LSE has been concluded for bottlenose dolphins from the Moray Firth SAC. Although this species is wide ranging, there are limited observations of bottlenose dolphin in the Pentland Firth and Orkney Waters. We are considering our advice internally over this topic [connectivity with SACs] and expect to be able to provide guidance to the applicant in due course. Baseline surveys during the nonbreeding season will provide further information to inform the HRA/EIA. We currently advise, therefore, no LSE for the Isle of May SAC and Berwickshire and North Northumberland Coast SAC.	Considered within the 'Information to Support HRA' report.

13.8 ASSESSMENT METHODOLOGY

13.8.1 Assessment Criteria

The overarching EIA process and methodology will follow the approach described in Chapter 7. A matrix approach will be used as a tool to inform the impact assessment along with expert opinion and consideration of uncertainty, following best practice, best available scientific understanding and relevant EIA guidance (e.g. IEEM 2010). The approach to assessment is summarised below:

- Receptor **sensitivity** for an individual from each marine mammal species or basking sharks will be independently defined (in the impact assessment, Section 13.12) using best available scientific information following the definitions set out in Table 13.5;
- The potential **magnitude of effect** takes account of the duration, extent and reversibility of the effect, and will be described for permanent and temporary outcomes, as detailed in Table 13.6;
- The sensitivity of receptor and magnitude of impact are then combined to determine the **consequence** of the impact. The definitions for impact consequence are presented in Table 13.7; and
- **Impact significance** is then considered by reference to the relevant criteria in the EIA Regulations, with those impacts defined as major and moderate considered to be significant under the EIA Regulations.

In this assessment value has not be assigned to marine mammal ecological features within the assessment matrix. Instead the approach used here reflects the inherent value of the populations of all marine mammal species and basking shark, which may be found in the area considered in the assessment. High value is assigned to all species assessed in this chapter, based on the level of international and national protection afforded to these species/populations, as outlined in Section 13.4. This inherent high value is taken forward in the impact assessment through consideration of the definitions for magnitude of effect and receptor sensitivity, and the level at which the potential for a significant effect to occur at the population level.

Table 13.5: Definitions for sensitivity of marine mammals and basking sharks

Sensitivity	Criteria
High	Individual receptor has no capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Medium	Individual receptor has limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.
Low	Individual receptor has some tolerance to avoid, adapt to, accommodate or recover from the anticipated impact.
Negligible	Individual receptor is generally tolerant to and can accommodate or recover from the anticipated impact.

Table 13.6: Definitions for magnitude of effect for marine mammals and basking sharks

Magnitude	Criteria
High	Permanent irreversible change to exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that >1% of the reference population is anticipated to be exposed to the effect. OR Temporary effect (limited to phase of development or Project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that >10% of the reference population is anticipated to be exposed to the effect.
Medium	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that >0.01% or <=1% of the reference population anticipated to be exposed to effect. OR Temporary effect (limited to phase of development or Project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that >5% or <=10% of the reference population anticipated to be exposed to effect.
Low	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that >0.001 and <=0.01% of the reference population anticipated to be exposed to effect. OR Intermittent and temporary effect (limited to phase of development or Project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that >1% or <=5% of the reference population anticipated to be exposed to effect.
Negligible	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that <=0.001% of the reference population anticipated to be exposed to effect. OR Intermittent and temporary effect (limited to phase of development or Project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that <=1% of the reference population anticipated to be exposed to effect.
Positive	The impact is positive and to be encouraged.

Table 13.7: Assignment of impact significance for marine mammals and basking shark based on sensitivity of receptor and magnitude of effect

Sensitivity of Receptor	Magnitude of effect			
	High	Medium	Low	Negligible
High	*MAJOR*	*MAJOR*	*MODERATE*	*MINOR*
Medium	*MAJOR*	*MODERATE*	*MINOR*	*MINOR*
Low	*MODERATE*	*MINOR*	*NEGLIGIBLE*	*NEGLIGIBLE*
Negligible	*MINOR*	*NEGLIGIBLE*	*NEGLIGIBLE*	*NEGLIGIBLE*

Any impact ≥ moderate is significant under EIA regulations.

13.8.2 Collision risk assessment methodology

The latest draft guidance from SNH (Band 2015) outlines the use of two models for assessing collision risk between marine mammals and basking shark with unshrouded tidal turbines and provides template Excel spreadsheets for each model:

- "Collision Risk Model" (CRM) based on the Band model used for bird collision with wind farms; and
- "Encounter Rate Model" (ERM) based on the work by the Scottish Association for Marine Science (SAMS) (Wilson *et al.* 2007).

Both models provide both "encounter rate" (number of animals which may encounter a turbine in the absence of avoidance action) and "collision rate" (number of animals potentially at risk of collision taking into account likely avoidance).

Band (2014) noted that, for small animals e.g. birds, the ERM is likely to over-estimate encounter rate, as it does not take account of the geometry of the blade and the likelihood that a small animal may pass between blades, , however this is unlikely to be an issue for marine mammal species. For large animals like marine mammals, an encounter with more than one successive blade is quite possible. As the ERM calculates the encounter rate with individual blades, rather than with the turbine as a whole, it counts such events as multiple encounters. In contrast, the CRM counts such events as a single no-avoidance collision. This is an issue, particularly for large animals such as basking shark and minke whale. Collision risk using ERM is presented in Section 13.12.2.2 and taken forward in the assessment of the population level impacts. Results using CRM are presented in Appendices 2 and 3.

EMEC (2014b) provides a model for the OpenHydro OCT device based on a modified version of the ERM. Annular devices have a ring of blades, surrounding an open central core. The open core has potential to allow clear passage of animals and so the model takes into account the area of the open core and the body-width of the animal, and therefore the potential for the animal to pass safely either within the open core or outside the turbine (Band 2014).

13.8.2.1 PCoD methodology

The interim version of the Population Consequences of Disturbance (PCoD) has been developed as an approach for assessing and quantifying the potential consequences for marine mammal populations of any disturbance and/or injury that may result from offshore enerpcod developments (Harwood et al. 2014).

The protocol provides estimates of the potential effects of death, injury, and behavioural disturbance associated with marine renewable energy developments on the conservation status of the populations of marine mammal species. The interim PCoD protocol has been used to put the ERM results into context in Section 13.12.2.2.

The Interim PCoD was run by SMRU Consulting Ltd using R and RStudio, with the necessary libraries installed. Species files were set up for grey seal, harbour seal, harbour porpoise and minke whale for the relevant management units and key demographic rates (see Table 13.8 to Table 13.11). Scenarios were run using the collision risk outputs from the ERM outlined in Table 13.30 to Table 13.33. All scenarios were run for 1000 simulations, as recommended for an impact assessment. The simulations were set to run for 25 years in line with the planned life of the Project.

The results were used to determine the median difference between the disturbed population (with devices) and undisturbed populations (without devices) to indicate possible change in population size. The cumulative (during the life-time of the Project, i.e. not with other projects) probability of 1%, 2%, 5% and median annual declines in the population 1 year, 6 years, 12 years and 18 years after the installation of the Project were also calculated and plotted for Stage 1 for 30 unshrouded three-blade devices or 30 OCT devices and Stage 1 and 2 for 200 unshrouded three-blade devices or 200 OCT devices. Probability is on a scale of 0 to 1, where 1 is 100% probability.

The marine mammal Management Units (MU) for each species (grey seal, harbour seal, harbour porpoise and minke whale), that could potentially be affected by the Project are shown in Table 13.8 to Table 13.11. The estimates for the current size of the population in the relevant MUs were taken from SCOS (2014) for seals and the most recent Inter-Agency Marine Mammal Working Group reports (IAMMWG 2015) for cetaceans. The key demographic rates for each of these populations were taken from (Harwood and King 2014), which included:

- annual survival rate for pups or calves;
- annual survival rate for juveniles (animals that are not yet able to give birth);
- annual survival rate for adults;
- average age at which females give birth for the first time; and
- fecundity (probability of giving birth) for mature females for each population.

The value for the proportion of each of these populations that is likely to be vulnerable to the effects of the Project was taken to be one, in that the entire population could be vulnerable.

Table 13.8: Harbour porpoise management unit and key demographic rates

Species	Harbour porpoise	
Management Unit	North Sea (NS)	West Scotland (WS)
Population Size	227,298	21,462
Growth rate	1	1
Age2: age at first breeding	5	5
Age1: age at independence	1	1
Calf Survival Rate	0.6	0.6
Juvenile Survival Rate	0.85	0.85
Adult Survival Rate	0.85	0.85
Fecundity	0.96	0.96

Source: IAMMWG (2015), Harwood and King (2014), Hammond et al. (2013)

Note: Both NS and WS based on lower adult survival and higher fecundity

Table 13.9: Harbour seal management unit and key demographic rates

Species	Harbour seal
Management Unit	Orkney and North Coast
Population Size	1,938
Growth rate	0.915
Age2: age at first breeding	4
Age1: age at independence	1
Pup Survival Rate	0.6
Juvenile Survival Rate	0.56
Adult Survival Rate	0.86
Fecundity	0.88

Source: SCOS (2014), Harwood and King (2014)

Table 13.10: Grey seal management unit and key demographic rates

Species	Grey seal
Management Unit	Orkney and North Coast
Population Size	20,682
Growth rate	1.01
Age2: age at first breeding	5
Age1: age at independence	1
Pup Survival Rate	0.235
Juvenile Survival Rate	0.94
Adult Survival Rate	0.94
Fecundity	0.84

Source: SCOS (2014), Harwood and King (2014)

Table 13.11: Minke whale management unit and key demographic rates

Species	Minke whale
Management Unit	Celtic and Greater North Seas (CGNS)
Population Size	23,528
Growth rate	1
Age2: age at first breeding	9
Age1: age at independence	1
Calf Survival Rate	0.70
Juvenile Survival Rate	0.77
Adult Survival Rate	0.96
Fecundity	0.91

Source: IAMMWG (2015), Harwood and King (2014), Hammond *et al*. (2013)

Information to conduct the interim PCoD assessment is currently not available for white-beaked dolphin, killer whale *Orcinus orca* and Risso's dolphin (Harwood and King 2014).

13.9 BASELINE DESCRIPTION

13.9.1 Introduction

In UK waters, two groups of marine mammals commonly occur: cetaceans (whales, dolphins and porpoises) and pinnipeds (seals). Of these two groups, eleven species of cetacean may be seen regularly throughout the year including: minke whale, fin whale *Balaenoptera physalus*, sperm whale *Physeter macrocephalus*, killer whale, humpback whale *Megaptera novaeangliae*, harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin, Atlantic white-sided dolphin *Lagenorhynchus acutus* and white-beaked dolphin. Two seal species are common and resident in UK waters: grey seal and harbour (or common) seal.

The cetacean data used to inform the baseline incorporates the most recent assessments of UK marine mammal populations occurring within UK waters, as identified through the Habitats Directive 3rd UK reporting round (JNCC 2013), whose range encompasses the AfL area and cable corridor as well as the results of site specific surveys. The Favourable Conservation Status (FCS) assessment at the 3rd UK reporting round for the regularly occurring cetacean species are presented in Table 13.12.

The Inter Agency Marine Mammal Working Group (IAMMWG) Management Units (MUs) for marine mammals in UK waters have been used as appropriate reference populations for marine mammal species (IAMMWG 2013, 2015), and this approach has been agreed informally during consultation with SNH and Marine Scotland.

The data presented by Evans *et al.* (2011), Reid *et al.* (2003), SCANS I (Hammond *et al*. 2002), SCANS II (Hammond *et al*. 2013), SMRU Ltd (2011) and JNCC (2013) confirm that several marine mammal species occur regularly in Pentland Firth and Orkney waters. These include grey seal, harbour seal, harbour porpoise, minke whale, white-beaked dolphin, Risso's dolphin, bottlenose dolphin and killer whale.

Short-beaked common dolphin, Atlantic white-sided dolphin, long-finned pilot whale *Globicephala melas* and sperm whale can be considered as casual visitors, occurring more regularly in offshore waters (Evans *et al*. 2011). These cetacean species are not considered further in this assessment as the AfLis sited in inshore waters, and none of these species were seen during the site specific surveys (Royal HaskoningDHV 2014).

Basking shark is also a casual visitor but was recorded during the Project site specific surveys and is given further consideration in Section 13.9.5.

Table 13.12: FCS assessment for common cetacean species in Annex IV of the Habitats Directive occurring in Orkney and Pentland Firth waters (JNCC 2013)

Species	FCS assessments
Harbour porpoise	Favourable
Minke whale	Favourable
White-beaked dolphin	Favourable
Risso's dolphin	Unknown
Bottlenose dolphin	Favourable

13.9.2 Pinnipeds

13.9.2.1 Grey Seal

Population Status

The geographical range of the grey seal is restricted to the Northern hemisphere. In the north east Atlantic, distribution is centred on breeding colonies in the UK (predominantly Scotland), Iceland, Norway, Ireland, and the Baltic. Grey seal breed annually when females come ashore to give birth on land or ice during which time the females fast. In the UK, the breeding season is between September and December, conception occurs at the end of lactation, three to four weeks after giving birth. Grey seal spend a greater proportion of their time ashore during the annual moult (four months after conception) when delayed implantation of the fertilised egg occurs (Hall 2002).

The UK holds approximately 38% of the world's grey seal breeding population; estimated at 111,600 individuals (95% confidence interval (CI) 92,000-137,900) based on the most recent complete surveys from 2010 (SCOS 2014). The overall population size is estimated through a population modelling approach to extrapolate survey derived pup production estimates. In the UK, the major grey seal breeding colonies in Scotland are monitored using aerial surveys by the Sea Mammal Research Unit (SMRU) to estimate pup production. The total number of pups born at colonies in 2012 in the UK was estimated to be 56,988 (95%CI=56,317-57,683) of which 22,926 were estimated to be from Orkney colonies (SCOS 2014). Pup production in Orkney has been increasing over recent years, the 2012 estimate (SCOS, 2014) represented a 6.2% increase on the 2010 estimate, and average rate of increase between 2006 and 2012 was 3.0% per annum. Thomas (2014) estimates that the population size of grey seal in Orkney in 2013 was 43,500 (95%CI 36,600-53,300) (provided in the SCOS 2014 briefing paper). Thompson *et al.* (2014) provides a minimum population estimate of 20,682 for the Orkney management unit which is used in the impact assessment in order to be conservative.

In addition to surveys during the breeding season, grey seals are also counted during August surveys using a thermal imaging camera. The most recent survey was competed in 2013 (Duck & Morris 2014). A total of 8,079 grey seal were counted in the Orkney and North coats management area, with numbers being comparable to earlier surveys. The number of grey seal counted on Hoy in 2013 was 293, or 3.6% of the total count.

Marine Scotland and The Crown Estate funded aerial surveys of the Pentland Firth and Orkney waters in 2012 and 2013 (APEM 2013). Grey seal were frequently sighted in all seasons, with peak counts during the October/November surveys. Most of the sightings were in the near-shore areas (within 3km of the shore). Population estimates during this peak sighting period were 22,960 (95%CI=11,722-35,726) for the near-shore areas, and 8,285 (95%CI=96-24,856) for the wider area. The sightings were aggregated around the major breeding colonies in the region (APEM 2013).

Reference Population for Assessment

The reference populations to be used in the assessment for grey seal is based on IAMMWG Management Units (MUs) and the most recent population estimates of these units based on updated SCOS information. The reference population for this assessment will be the Orkney and North Coast MU shown in Figure 13.2 (IAMMWG 2013) with a population of 20,682 (SCOS 2014).

Under the Marine (Scotland) Act 2010 licences can be issued to shoot seals e.g. for fish farm protection. The management of the maximum number of licences is controlled using the concept of Potential Biological Removal (PBR). PBR is the number of individual seals that can be removed from the population without causing a decline in the population and is calculated annually by SMRU using the latest seal counts. The most recent, 2015, PBR for the Orkney and North Coast MU is 1,240 grey seals, with 220 licences granted (Scottish Government 2015).

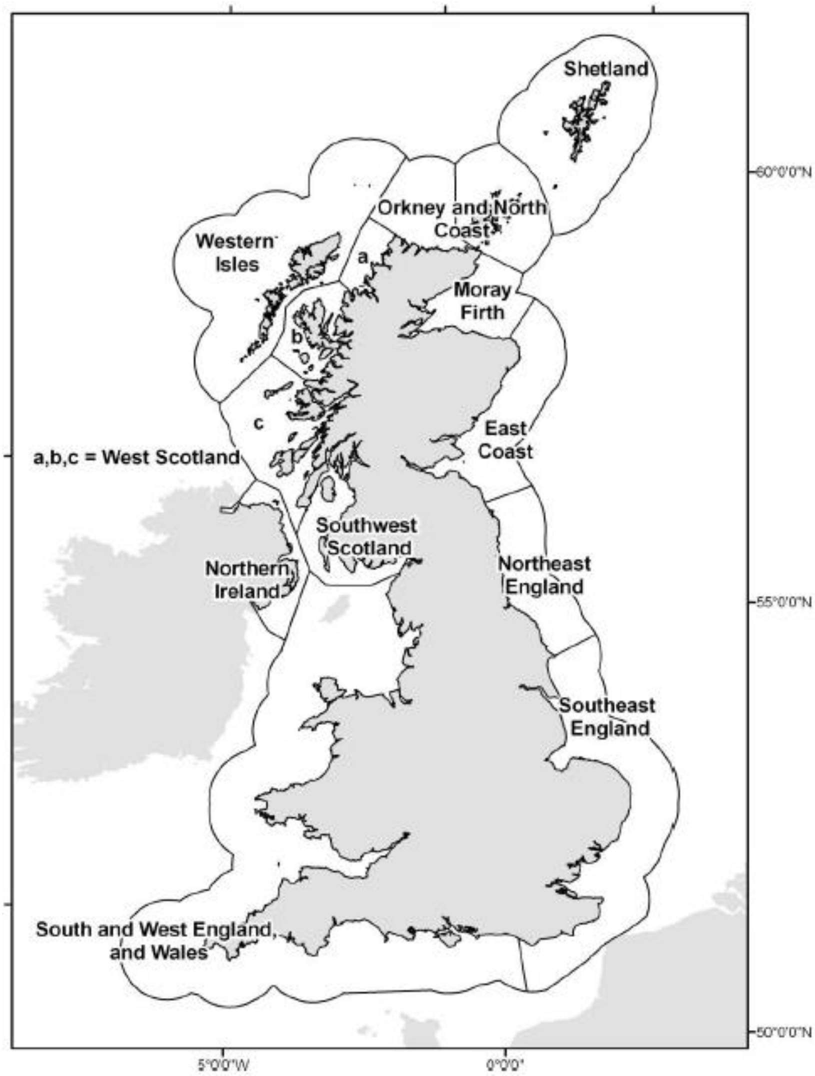


Figure 13.2: Seal Management Units (IAMMWG 2013)

Diet

The grey seal is an opportunistic predator of fish and invertebrates. Three major studies have been conducted on grey seal diet, in 1985, 2002 and between 2010-2012 (Hammond & Grellier 2006, Wilson & Hammond 2012). The results of the most recent study are not yet published. In 1985, the diet of grey seal in Orkney was strongly dominated by sandeel, in 2002, the diet was composed of more than 50% sandeel throughout the year and gadoids were the next most common prey, especially in quarter 1 (Hammond & Grellier 2006). Between 1985 and 2002 there was a change in diet; dominated by an increase in the percentage of gadoids taken (approximately 20% in 2002 versus approximately 10% in 1985) and a decrease in the percentage of sandeel taken (approximately 60% in 2002 versus approximately 80% in 1985). A strong feature of this difference was a large increase in the percentages of cod and haddock taken in the first quarter of the year.

Recent evidence has shown grey seal predating on other small marine mammals, including juvenile grey seal (Thompson et al. 2015), harbour seal (van Neer et al. 2014) and harbour porpoise (Stringell et al. 2015).

At Sea Distribution

SMRU Ltd (2011) compiled grey seal tagging data from deployments in the Pentland Firth and Orkney waters as part of an SNH commissioned report. Telemetry data from 61 tagged grey seals (including four pups) that entered the area, and 17 adult grey seal tagged at North Rona SAC, were examined. Seals tagged at Abertay, the Farne Islands, Inner Hebrides, Isle of Mat, Monach Islands, Moray Firth, Shetland, Orkney and North Rona, all entered Pentland Firth and Orkney waters.

Grey seal dived to depths of up to 100m, with a mean depth of 29.83m, mean duration of 3.82 minutes, mean time at surface on 27.09%, and mean speed of 0.54m/s (SMRU Ltd 2011). There was a major overlap between grey seals and high tidal current sites around Stroma and the Pentland Skerries where there are large numbers of grey seals hauled out (Figure 13.3).

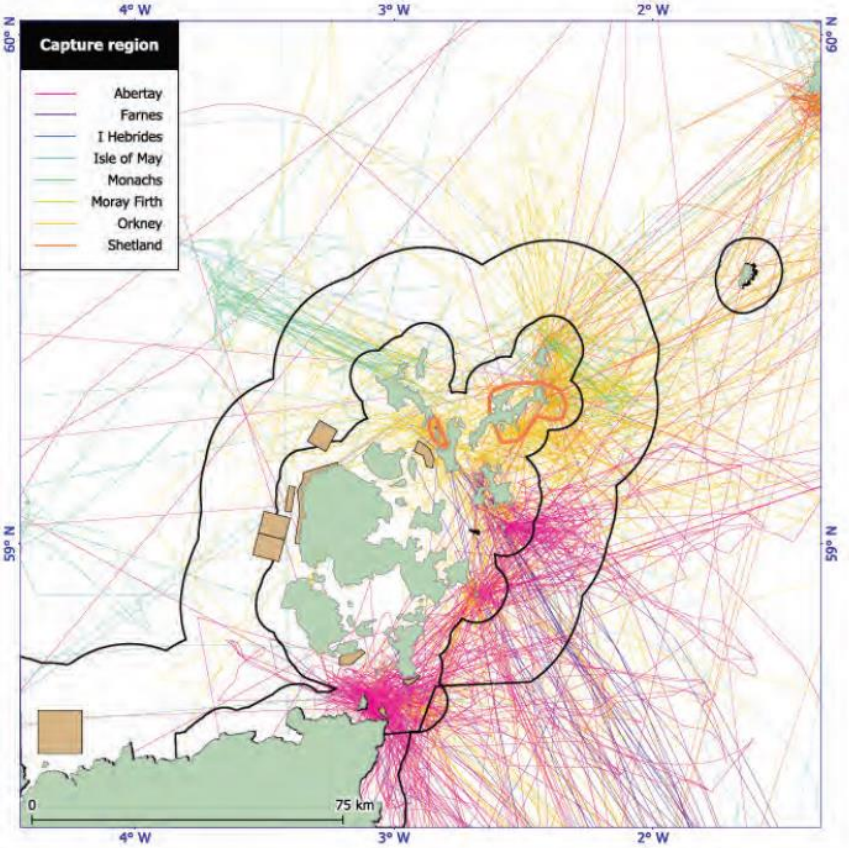


Figure 13.3: Grey seals tagged with SMRU Argos and SMRU GSM/GPS tags which at least once entered the Pentland Firth and Orkney Strategic Area (excludes the grey seals tagged at North Rona) (SMRU Limited 2011)

In 2010 SMRU Ltd undertook a tagging programme on recently weaned grey seal pups in Orkney (Thompson 2012). The study was focussed on investigating the initial foraging behaviour of weaned grey seal pups from two sites; Stroma in the Pentland Firth and Muckle Greenholm close to the EMEC site in the Falls of Warness. Highly detailed movement and dive behaviour records have been received from 15 of the tagged seals. The seals showed wide ranging and variable movement, some travelling to forage more than 400km from the tagging sites, others remaining within the Orkney area. Further analysis of these data are expected which should allow data will allow estimates of the rate at which tagged grey seal pups travelled through areas of potential tidal turbine deployments, although this work is not yet published (Thompson 2012).

As part of the MeyGen ES a number of baseline studies were completed, including boat-based transect surveys (MeyGen 2011). The MeyGen AfL is approximately 15km from the AfL area. Grey seal was the most commonly sighted species during the boat-based transect and stationary point surveys, as well as the land-based vantage point surveys. Mean density estimates from the boat based surveys were 0.266 individuals per km2 (95% CI=0.073-0.699) with peak densities of 0.555 individuals per km2 (95%CI=0.0122-25.286, MeyGen 2011). The Inner Sound survey area at MeyGen may provide a comparable environment to the AfL area, however, it should be noted that the MeyGen survey area included waters directly adjacent to a major grey sea breeding and haul out site on the south west tip island of Stroma, where more than 100 grey seal commonly haul our during the summer months, and breed during the autumn. There are no comparable haul-outs adjacent to the AfL area, therefore average densities of grey seal in the Inner Sound are likely to be higher than at the AfL area.

Regular surveys at the EMEC Falls of Warness tidal test site, from July 2005 to March 2014 were undertaken from a single observation point on the island of Eday over-looking the test site, covering an area of approximately 8.75km^2. Mean areal density estimates for grey seals, were calculated at 0.028 individuals per km^2 based on surface observations of 0.01 individuals per km^2 (EMEC 2014a).

No estimates of density were generated from the APEM (2013) aerial surveys.

Marine Scotland commissioned SMRU to map seal density estimates based on telemetry data around the UK collected between 1991 and 2011 (Jones *et al.* 2013). These density estimates provide an estimate of seal usage in an area as they focus on the 'at-sea' seal numbers based on extensive telemetry deployments and population surveys. Estimates of density are provided per 25km^2 grid cells (Figure 13.4); the AfL area covers two grid cells with estimates with mean, upper 95%CI and lower 95%CI at seas usage estimates as shown in Table 13.13. The mean estimate over the whole area (over the two grid cells) is 2.07 individuals per km^2 (upper and lower 95%CIs from the two grid cells of 6.42 and 0 individuals per km^2).

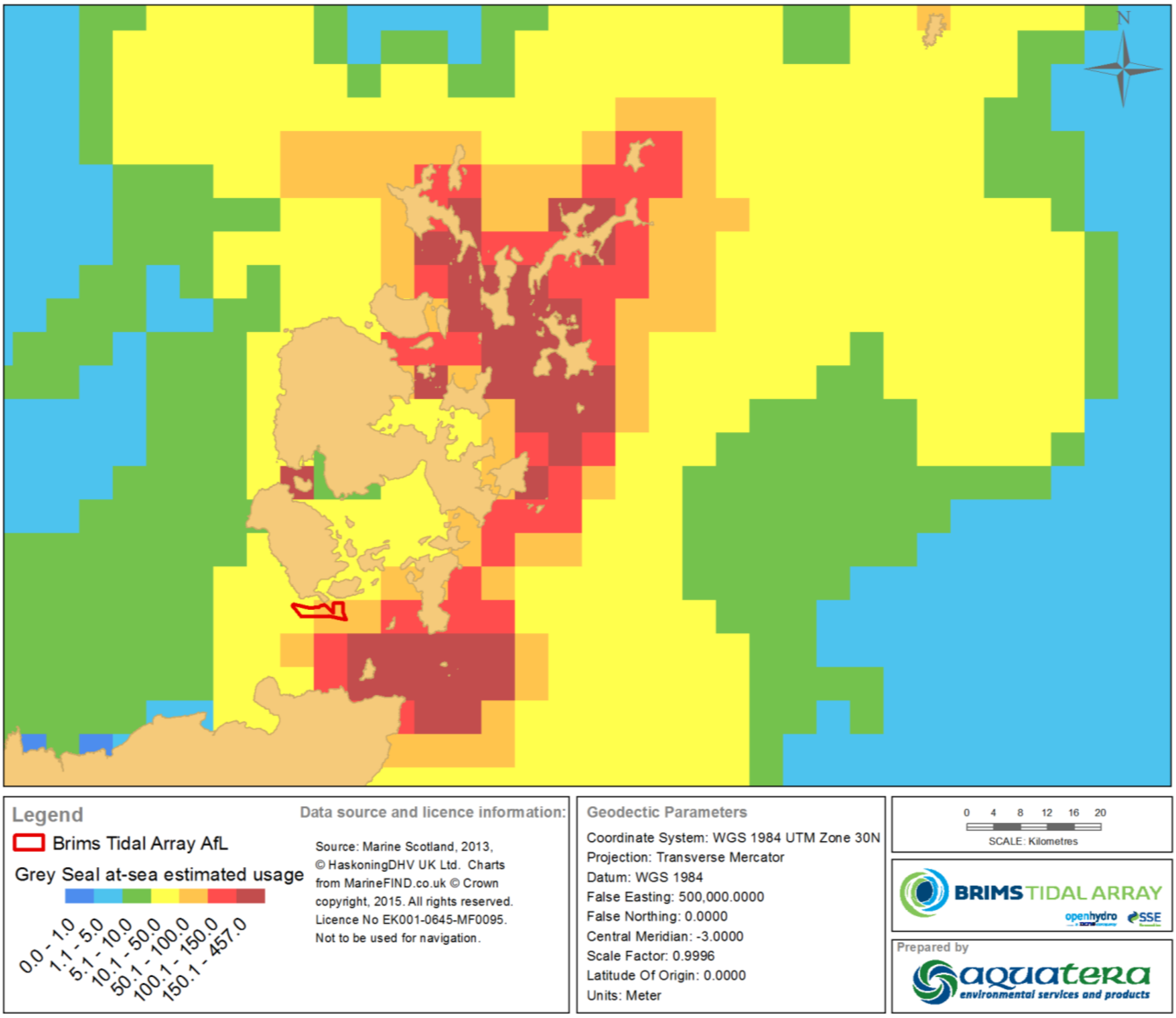


Figure 13.4: Grey seal mean at sea density (Jones *et al.* 2013)

Table 13.13: Grey seal at sea usage (density) estimates (number of individuals per 25km^2) for the two grid cells covering the AfL area (Jones *et al.* 2013)

Mean densities	Upper 95% CI	Lower 95% CI
36.875	75.0	0
66.748	160.7	0

Site Specific Surveys

During the site specific surveys (Supporting Document: RHDHV, 2014c) grey seal were seen throughout the year, with some indication of higher sightings rates during the summer and autumn months. The average sighting rate made by the dedicated MMOs was 0.99 grey seal individuals per hour (not corrected for availability). The ESAS surveyors recorded fewer grey seal sightings than the dedicated MMOs.

It was possible to combine the Project survey area sightings with those made at Westray South Tidal Array to generate a global detection function. The surveys were undertaken using the same survey method and completed over same survey period (see Supporting Document: RHDHV, 2014c for details) and therefore visibility and availability of marine mammals and basking shark is expected to be comparable for both sites. The data were post stratified to provide an estimate of abundance and density for the Project survey area (including survey buffer area) and Westray South Tidal Array separately. Density of grey seals during the Project survey was estimated to be 0.09 individuals per km^2 (coefficient of variation[9] (CV)=19.24).

Density Estimates for Assessment

The density estimates for grey seals calculated from the AfL area specific survey of 0.09 individuals per km^2 (CV=19.24) will be used to quantify impacts associated with the Project.

Designated Sites

The Faray & Holm of Faray SAC is located approximately 75km to the north of the AfL area. This SAC is primarily designated for its grey seal population and the conservation objectives for this SAC (as specified in the SNH Advice under Regulation 33(2)) are to maintain the population size structure, function and distribution of grey seals and their supporting habitats and to ensure that no significant disturbance is suffered. This SAC is the second largest grey seal breeding site in the UK and accounts for approximately 9% annual UK pup production. Telemetry studies in grey seals have highlighted a level of connectivity between usage areas in the Pentland Firth and Orkney Area and North Rona SAC (155km from the AfL area), and the Monachs SAC (approximately 240km from the AfL area, SMRU Ltd 2011). Further afield, there is also some evidence of connectivity between the Orkney and North Coast management unit and the Isle of May SAC (320km from the AfL area) and the Berwickshire and North Northumberland SAC (340km from the AfL area, SMRU Ltd 2011; Russell & McConnell 2014). Telemetry from seals tagged at the Waddenzee SCI in Dutch waters show movement across the North Sea to the Orkney and North coast MU (Brassuer *et al.* 2010).

There are designated haul-out sites of importance to provide additional protection for seals from intentional or reckless harassment. A total of 194 seal haul-out sites have been designated through The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014 laid in the Scottish Parliament on 26th June 2014.

Figure 13.5 shows the designated haul out sites around Orkney. The grey seal breeding colonies included in this designation that are approximately 15km or less from the AfL include:

- BC-032 South Ronaldsay East 13.7km from the AfL

9 the percentage variation of mean value

- BC-041 Duncansby Head 14.5km from the AfL
- BC-019 Swona 6.0km from the AfL;
- BC-023 N-Flotta 9.5km from the AfL;
- BC-027 South Ronaldsay West 10.6km from the AfL;
- BC-029 Calf of Flotta 10.6km from the AfL;
- NOO-033 Pentland Skerries 15.3km from the AfL; and
- NON-001 Gills Bay 10.3km from the AfL.

In addition to SACs and designated haul out sites, there are two Sites of Special Scientific Interest (SSSIs), for which grey seal are notified features:

- Faray and Holm of Faray (also an SAC) 52km from the AfL; and
- Muckle and Little Greenholm 44km from the AfL.

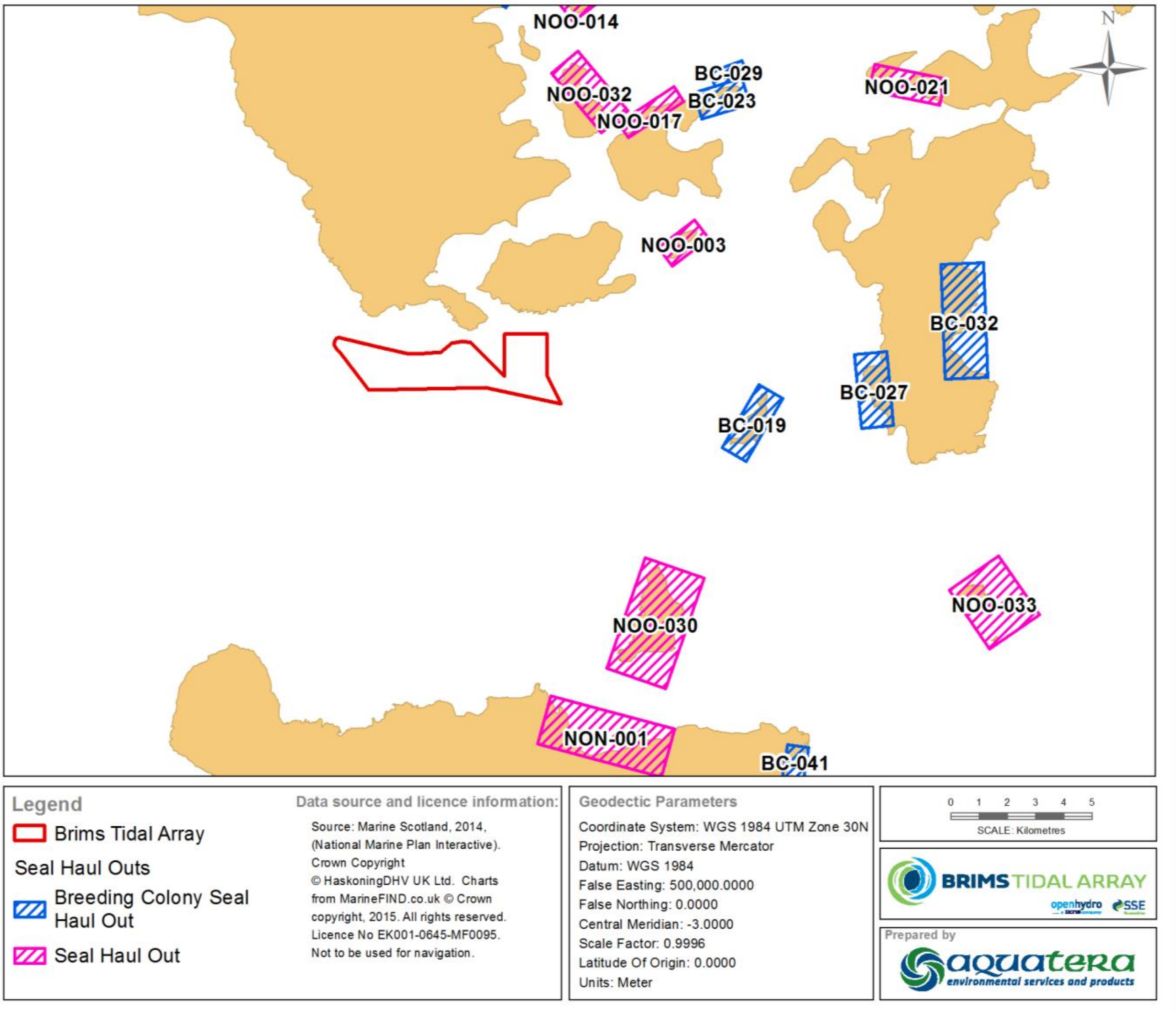


Figure 13.5: AfL and the Orkney designated seal haul out sites

13.9.2.2 Harbour Seal

Population Status

Harbour seal have a circumpolar distribution and are widespread throughout the Northern Hemisphere. The harbour seal is the smaller of the two UK seal species occurring along all coasts of the UK. Approximately 30% of European harbour seals are found in the UK; this proportion has declined from approximately 40% in 2002 (SCOS 2014).

In the UK, pupping occurs in the summer (June and July) and peak moulting occurs in August. In the UK harbour seal are surveyed during their annual moult on a three to five year cycle by SMRU using thermal imaging cameras. Using the most recent survey data (2007-2012) the UK minimum population size is estimated at 26,290 individuals and 1,938 of these individuals were surveyed at Orkney haul outs (based on the 2013 complete survey, SCOS 2014). The count of harbour seals in Orkney has declined over recent years; in 1997 the minimum population size was estimated at 8,523 harbour seal were counted, and in 2001 it was 7,752. In August 2013 Duck & Morris (2014) counted 1,865 harbour seal which is comparable with the SCOS (2014) estimates, suggesting a decline of approximately 30% over three years; the average annual rate of decline since 2006 is 11.5%. In August 2013 a total of 112 harbour seal were counted around the coats of Hoy, this represents the lowest recorded count and a reduction of 79% since the peak count in 1997 of 530 individuals (Duck & Morris 2014). Figure 13.6 shows the 2013 harbour seal counts compared with the 1997 counts.

During the APEM 2012 and 2013 aerial surveys of the Pentland Firth and Orkney waters, harbour seal were only sighted during August and September surveys (APEM 2013). The sightings were in the near-shore areas at haul-out sites near the Holm of Papa. Only 17 harbour seal were sighted, providing a population estimate of 523 (95%CI=17-1,568). The low number of sightings reflects the fact that this type of survey method is not appropriate for this species due their cryptic nature.

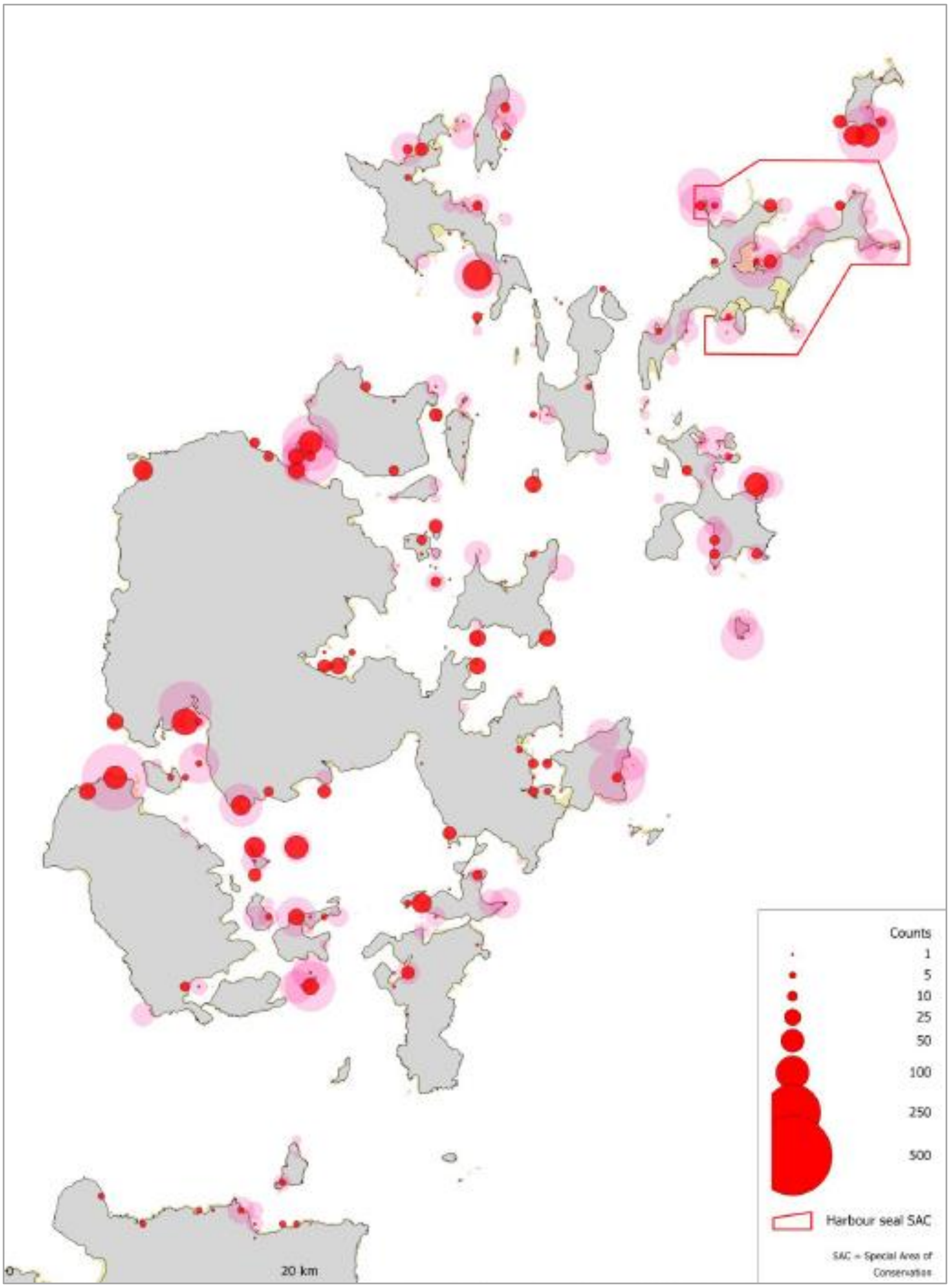


Figure 13.6: Harbour seal counts in Orkney in 2013 (red) compared with the highest previous count in 1997 (pink) (SCOS 2014)

Reference Population for Assessment

The reference populations to be used in the assessment for harbour seal is based on IAMMWG Management Units (MUs) and the most recent population estimates of these units based on updated SCOS information (it should be noted that these are limited to 12nm). The reference population for this assessment will be the Orkney and North Coast MU shown in Figure 13.2 (IAMMWG 2013) with a count of 1,938 harbour seal (SCOS 2014).

As described previously for grey seal, the management of harbour seal populations and the maximum number of shooting licences is controlled using PBR. The most recent, 2015, PBR for the Orkney and North Coast MU is 11 harbour seals, with no licences granted (Scottish Government 2015).

Diet

Harbour seal eat a wide range of prey, including sandeel, gadoids, flatfish, scorpion fish, sandy benthic fish, pelagic fish and cephalopods (SCOS 2014).

Research into the causes of the decline in harbour seals in some areas of Scotland is ongoing. One hypothesis is that competition with grey seals for prey is a driver, as grey seals are increasing in areas where harbour seals are declining. Diet studies in 2010/11 show no overall consistent pattern between the prey of the two seal species which would link the differences with observed regional changes in seal abundance (SCOS 2014). More detailed analysis is continuing but there is currently no obvious overlap that could readily explain the decline of harbour seals (Wilson 2014; SCOS 2014).

At Sea Distribution

SMRU Limited (2011) also compiled harbour seal tagging data from deployments in the Pentland Firth and Orkney waters as part of an SNH commissioned report. A total of 47 tagged harbour seal (including 15 pups) entered the Pentland Firth and Orkney waters. The seals had been tagged in Orkney, the Moray Firth and Yell Sound, Shetland. Foraging was generally within 20km of the departure haul-out sites showing site fidelity to foraging areas, and there was little movement between haul-out regions within the Orkney Isles (Figure 13.7). Harbour seal pups showed more extensive movements than adults, eight of the 15 tagged in Orkney relocated to Shetland (SMRU Limited 2011).

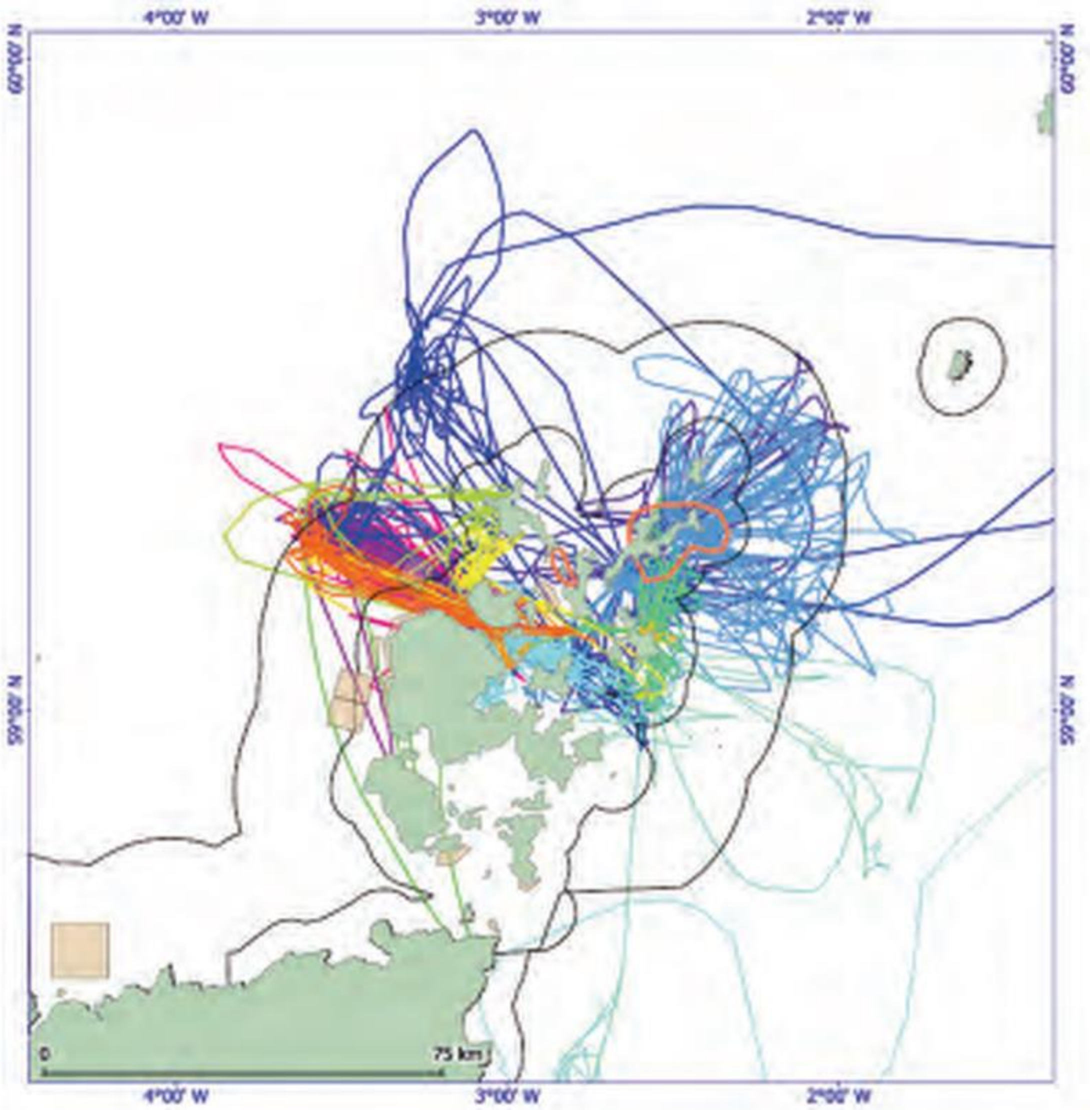


Figure 13.7: Harbour seal telemetry[10] (SMRU Limited 2011)

Harbour seal dive to depths of up to 100m, with a mean depth of 30.91m, mean duration of 4.14 minutes, mean time at surface on 18.32%, and mean speed of 0.11m/s. There are insufficient telemetry data from harbour seal haul-out sites in high tidal energy areas to examine any overlap in distribution (SMRU Ltd 2011).

A small number of harbour seal (18) were sighted during the boat-based transect and stationary point surveys, as well as seven sightings during the land-based vantage point surveys untaken in the Inner Sound for the MeyGen development (MeyGen 2011). MeyGen (2011) states that as these numbers were insufficient to determine at-sea density estimates and

10 17 harbour seals tagged with SMRU Argos tags, which at least once entered the PFOSA. The tracks are colour coded by individual seal. All but two of the seals were tagged in the northern Isles (Sanday, Eynhallow, Rousay and Stronsay of Orkney). The remaining two (show by triangles) were tagged in the Moray Firth.

there are no published density estimates (in terms of animals per km^2) an alternate method of using shore-based counts was used to provide a crude estimate density of 0.202 seals per km^2 (MeyGen 2011). It should be noted that this density estimate is based on counting harbour seal and haul-out sites on the northern Caithness and southern Orkney coasts which are directly adjacent to the Inner Sound, and MeyGen development area. There are no harbour seal haul-out sites directly adjacent to the Project site (Duck & Morris 2014).

Regular surveys at the EMEC Falls of Warness tidal test site, from July 2005 to March 2014 provided mean areal density estimates for harbour seals of 0.016 individuals per km^2 based on surface observations of 0.004 individuals per km^2 (EMEC 2014a).

Jones *et al.* (2013) mean density estimates of harbour seal at sea usage in the Project site along with upper and lower 95%CI are shown in Table 13.14 with the mean estimates shown in Figure 13.8. The mean estimate (over the two grid cells) is 1.49 individuals per km^2 (upper and lower 95%CIs from the two grid cells of 2.67 and 0.31 individuals per km^2).

Table 13.14: Harbour seal at sea usage (density) estimates (number of individuals per 25km^2) for the two grid cells covering the AfL area (Jones *et al.* 2013)

	Mean densities	Upper 95% CI	Lower 95% CI
Grid cell one in AfL	36.72	68.88	4.56
Grid cell two in AfL	37.99	64.81	11.16
Average of grid cells which overlap with the AfL	37.36	66.85	7.86
Average per 1km2	1.49	2.67	0.31

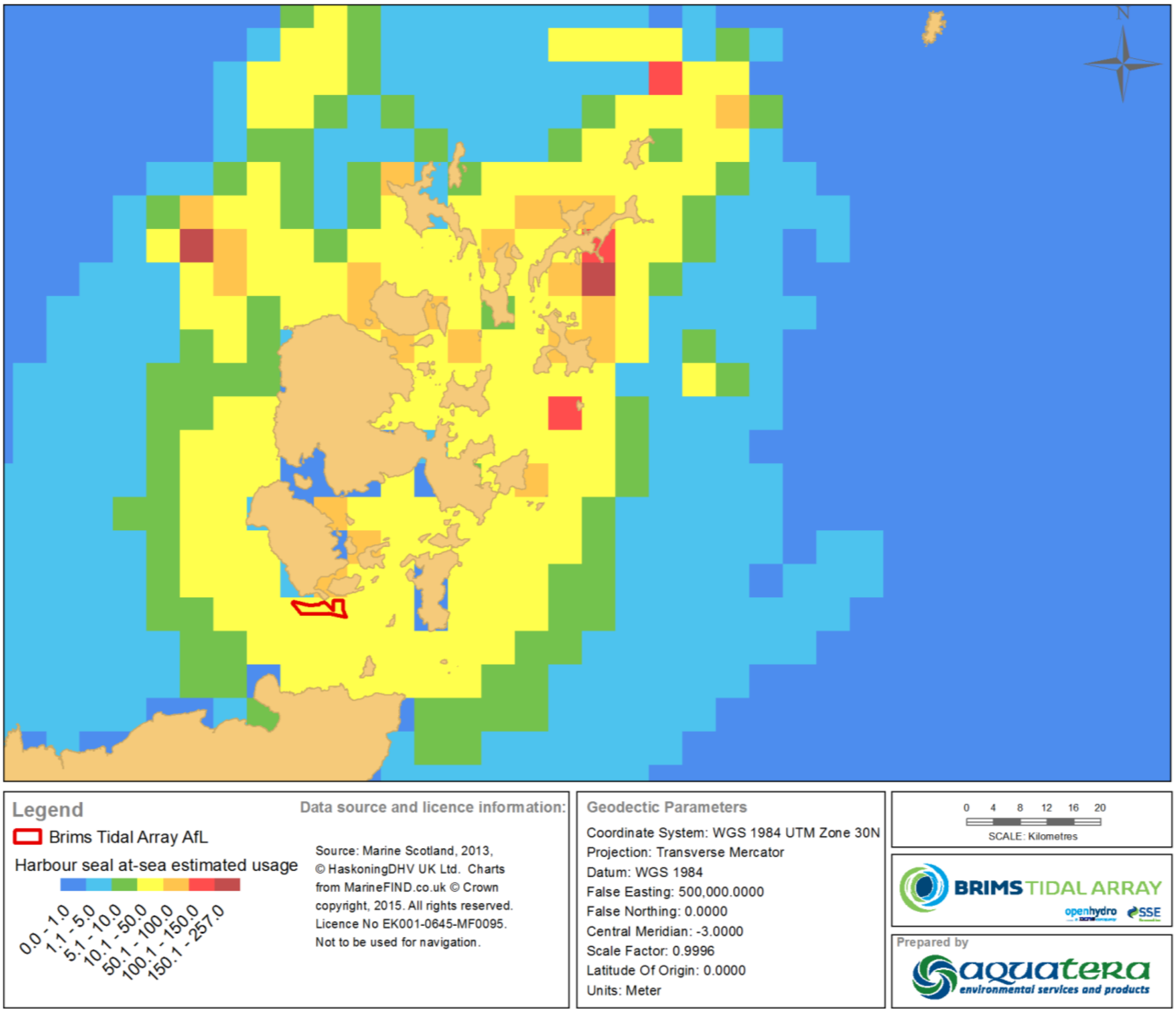


Figure 13.8: Harbour seal mean at sea density (Jones *et al.* 2013)

Site Specific Surveys

Only 13 harbour seal were seen by the dedicated MMOs while on survey effort during site specific surveys giving an average sighting rates on 0.22 individuals per hour (not corrected for availability, Royal HaskoningDHV 2014). There were more sightings between June and September in 2013, than in other months. The ESAS surveyors recorded a lower number of harbour seal sightings than the dedicated MMOs. Due to the low sightings rate it was not possible to estimate density of harbour seal from these surveys.

Density Estimates for Assessment

In the absence of density estimates from the Project surveys, due to the low number of sightings, this section provides consideration of other available density estimates to use in the assessment.

The Marine Scotland mean at sea density estimate of 1.49 (95%CI=0.18-2.76) individuals per km^2 is over 9000% greater than the EMEC Falls of Warness density estimate (0.016) and 600% greater than the MeyGen density estimate (0.202).

Likewise the Marine Scotland at sea density estimate for grey seal of 2.07 (95%CI=0-6.42) individuals per km^2 is over 7000% greater than the EMEC Falls of Warness grey seal density estimate (0.028) and 600% greater than the MeyGen grey seal density estimate (0.266).

The Marine Scotland estimates are provided at a resolution of $25km^2$ and, given these comparisons, are deemed to be too crude for the localised variations across Orkney and are therefore not used in the impact assessment.

The Inner Sound survey area at MeyGen may provide a comparable environment to the AfL area, however it should be noted that the MeyGen survey area included waters directly adjacent to harbour seal haul-out sites on the northern Caithness and southern Orkney coasts which are directly adjacent to the Inner Sound, and MeyGen development area. There are no harbour seal haul-out sites directly adjacent to the Project site.

The density estimates used in the EMEC Environmental Appraisal are likely to be the most comparable to the AfL, however the Marine Scotland mean at sea density maps (Figure 13.8, Jones *et al*. 2013) indicates that harbour seal at sea density may be lower at the Falls of Warness site than the AfL area and so these may be an underestimate for the Project AfL area.

Although it was not possible to generate an estimation of harbour seal density for the AfL area from the site specific surveys, a conservative approach, which lies between the MeyGen and EMEC density estimates and is based on estimating a density which is proportional to the grey seal sightings rate11, assuming the ability to detect harbour seals is broadly similar for the grey seals, giving 0.02 harbour seal per km^2.

Designated Sites

Sanday SAC is designated for harbour seal and is located approximately 63km north east of the AfL area. In 2013 this site supported approximately 6.1% of the Orkney population; at its peak in 1997 it supported approximately 19.6% of the Orkney total count (Duck & Morris 2014). Telemetry data suggest that tagged animals using the Orkney and North Coast management unit, also show connectivity with the Shetland and Moray Firth management units and hauled-out at the Yell Sound Coast SAC (approximate 230km from the AfL area) and the Dornoch Firth and Morrich More SAC (125km from the AfL area, SMRU Limited 2011). Further consideration of the SACs is given in the Information to Support HRA report.

The harbour seal haul-out sites designated through The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014 that are within approximately 15km of the AfL include:

- NOO-003 Switha 5.1km from the AfL;
- NOO-017 Flotta Oil Terminal 7.6km from the AfL;
- NOO-030 Stroma 6.2km from the AfL;
- NOO-032 North & East Fara 7.4km from the AfL;

[11] Grey seal Project hourly sighting rate (0.99) divided by harbour seal hourly sighting rate (0.22) = 4.5; grey seal density estimate ($0.09/km^2$) divided by 4.5 = 0.02 harbour seal per km^2, to give rough indication of harbour seal density at AfL area.

- NON-001 Gills Bay 10.3km from the AfL;
- NOO-014 Cava 11.1km from the AfL; and
- NOO-021 North West Water Sound 14.4km from the AfL.

In addition to SACs and designated haul out sites, there are two Sites of Special Scientific Interest (SSSIs), for which harbour seal are notified features:

- East Sanday Coast (also an SAC) 60.6km from the AfL; and
- Eynhallow 41.0km from the AfL.

13.9.3 Cetaceans

13.9.3.1 Harbour Porpoise

Population Status

Harbour porpoise is the most commonly sighted cetacean in the North Sea (ASCOBANS 2012) and is the cetacean most likely to be found in greatest numbers in Orkney and Pentland Firth waters. The IAMMWG has identified three appropriate management units within the UK Exclusive Economic Zone (EEZ); these are the North Sea; West Scotland; and Celtic and Irish Seas (IAMMWG 2015). The abundance of harbour porpoise in these MUs is based upon the SCANS II and CODA surveys (Hammond *et al*. 2013, Macleod *et al*. 2009). The AfL area is located in the North Sea NS MU (IAMMWG 2015) with an estimated abundance of 227,298 (CV=0.13; 95%CI=176,360–292,948). The estimate of abundance in SCANS-II survey block J which includes the waters around Orkney and Shetland (see Figure 13.10), and encompasses the AfL area is 10,254 individuals (CV=0.36; Hammond *et al*. 2013).

The SCANS and SCANS II surveys were a major international collaborative survey program carried out to provide baseline data on cetacean abundance in the North Sea, Baltic and Celtic Seas. Surveys were undertaken in the summer of 1994 and 2005 and the extent of the 2005 survey was greater than in 1994. Estimated abundance in 2005 in the equivalent area surveyed in 1994 was 323,968 (CV=0.22; 95%CI=256,300–549,700; Hammond *et al*. 2013), compared to 341,366 (CV=0.14; 95%CI=260,000–449,000) in 1994 (SCANS II 2008). Therefore, there was no reported change in the overall estimated abundance in the North Sea. Despite no overall change in population size between the two surveys, large scale changes in the distribution of porpoise were observed between 1994 and 2005, with the main concentration shifting from north eastern UK and Denmark to the southern North Sea. Such large scale changes in the distribution of harbour porpoise are likely the result of changes to the availability of principal prey within the North Sea (SCANS II 2008).

Surveys undertaken by APEM in 2012 and 2013 in Pentland Firth and Orkney waters recorded only two positive sightings of harbour porpoise (in June/August 2012) in the wider area (beyond 3km from shore). These generated an abundance estimate of 175 (95%CI=2-525). There were some sightings during the surveys which could not be identified to species, which could be harbour porpoise, and the sightings have not been corrected for surface availability. As such this estimate is likely to represent an underestimate of the number of harbour porpoise in the region.

Reference Population for Assessment

The AfL area is located in the North Sea MU (see Figure 13.9) which will be used as the reference population for the assessment, with an estimated abundance of 227,298 (CV=0.13; 95%CI=176,360–292,948; IAMMWG 2015). However, the West Scotland MU (with an estimated abundance of 21,462 (CV=0.42, 95%CI=9,740-47,289; IAMMWG 2015) is located only approximately 60km to the west of the site.

The IAMMWG management units have a transboundary nature; with the North Sea MU comprising the international Council for the exploration of the Seas (ICES) area IV (North Sea), VIId (Eastern Channel) and Division IIIa (Skagerrak and north Kattegat) (Figure 13.9).

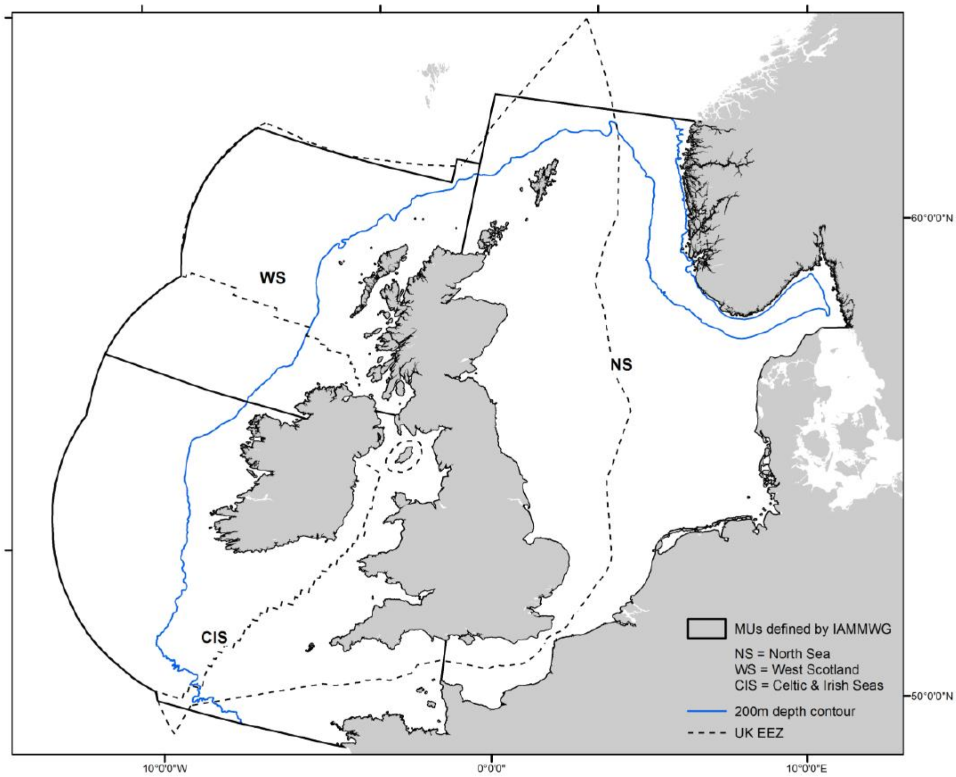


Figure 13.9: Harbour porpoise Management Units (IAMMWG 2015)

Diet

The diet of harbour porpoises in Scottish waters has been determined through stomach content analysis and, although fish from 15 taxa, cephalopods from five taxa and crustaceans from four taxa were recovered from the stomachs of harbour porpoises between 1992 and 2003, the diet is dominated by four main prey categories: (i) whiting; (ii) sandeels (*Ammodytida*e spp.); (iii) haddock/saithe/pollack and (iv) *Trisopterus* spp. (Norway pout and poor cod) (Santos *et al.,* 2004). Regional, seasonal and inter-annual differences in diet composition were identified with other small gadoids and cephalopods along with clupeids such as herring in some years.

At Sea Distribution

The mean density for the SCANS II survey block J, (Orkney and Shetland, see Figure 13.10) is 0.274 (CV=0.36) individuals per km2 (Hammond *et al*. 2013), although it should be noted that this survey block includes Shetland and the Moray Firth, as well as Orkney, and may include areas of higher porpoise density than the AfL area.

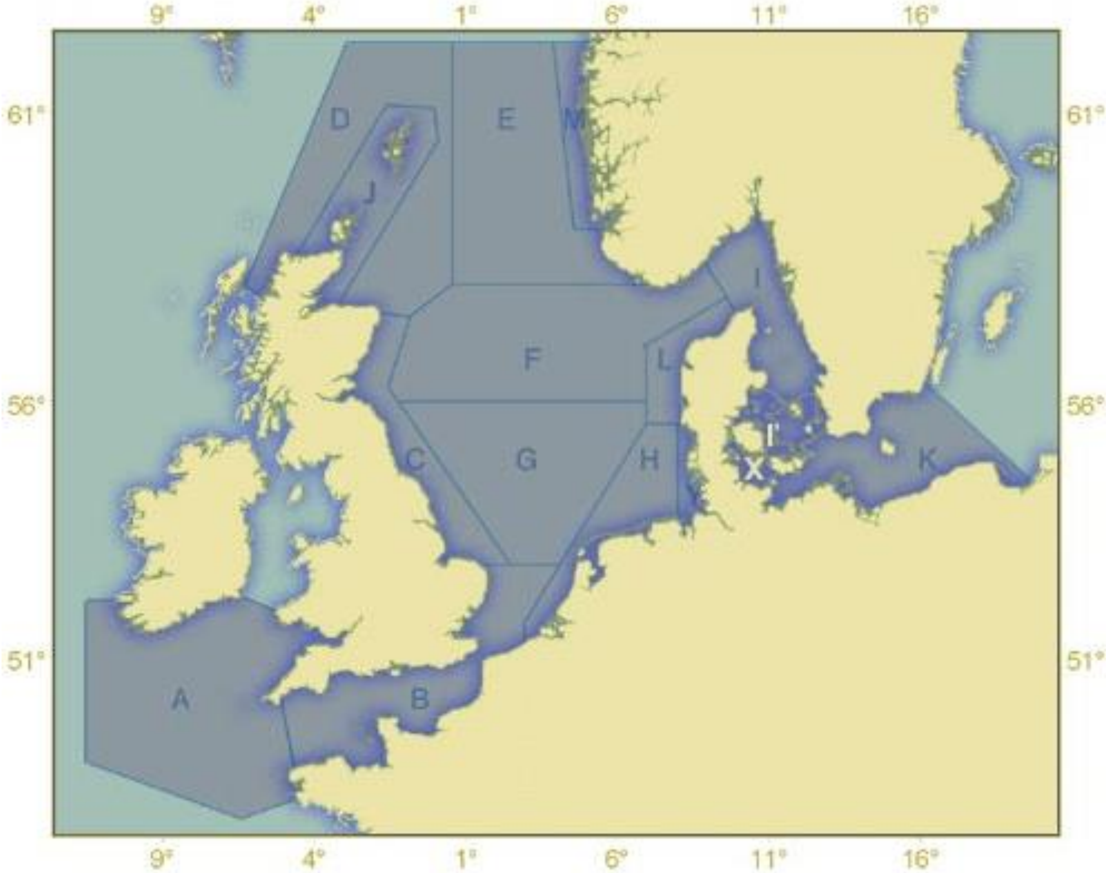


Figure 13.10: SCANS II survey blocks (SCANS II 2008)

The JNCC Cetacean Atlas (Reid *et al.* 2003) and Evans *et al.* (2011) report sightings of harbour porpoise distributed throughout the Pentland Firth and Orkney waters. Figure 13.11 shows the sightings data from 1980-2010, presented in Evans *et al.* (2011).

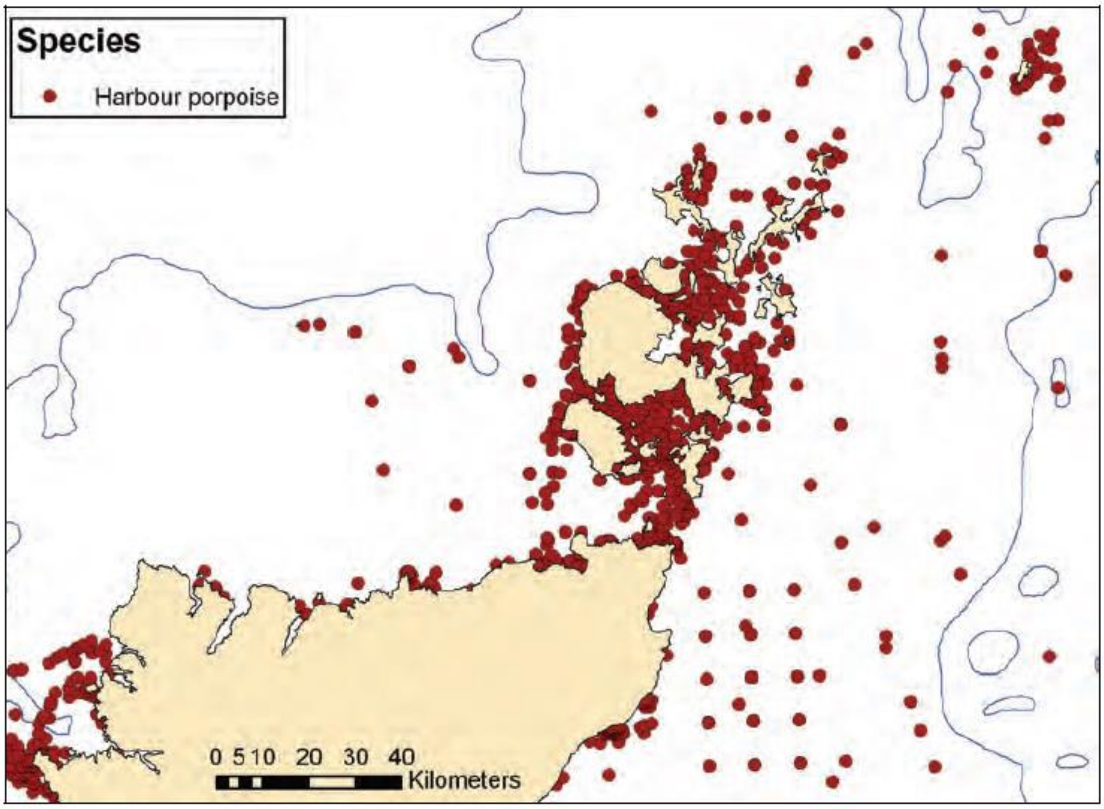


Figure 13.11: Distribution of sightings of harbour porpoise, 1980-2010 (Evans *et al.* 2011b)

Harbour porpoise was the most frequently sighted cetacean species during the MeyGen boat-based transect and stationary point surveys, as well as the land-based vantage point surveys (MeyGen 2011). Towed hydrophone surveys suggested that acoustic detection rates were higher than visual sightings rates, as averaging at 7.03 per hour. Mean density estimates for the Inner Sound from the boat bases surveys were 0.105 individuals per km^2 (95%CI=0.055-0.202), and peak densities were 0.6 individuals per km^2 (95%CI=0.226-1.594; MeyGen 2011). SRSL (2012) undertook analysis to estimate the time this species may be present at different water depths, the analysis indicated that harbour porpoises make many dives that are not to the seabed which maybe when feeding on pelagic species and travelling.

The APEM (2013) aerial surveys did not provide estimates of density for harbour porpoise.

Surveys at the EMEC Falls of Warness tidal test site, from July 2005 to March 2014 provided mean areal density estimates for harbour porpoise of 0.007 individuals per km^2 based on surface observations of 0.003 individuals per km^2 (EMEC 2014).

Studies conducted in Welsh waters have suggested that harbour porpoise may use high tidal energy areas for foraging, with small scale areas of high density in areas of more turbulent waters downstream from the area of strongest flow, with the location of these higher density areas moving to the other side of the highest current areas when the tidal stream reversed (Gordon *et al*. 2011). This study also developed and tested a system for examining the use of the water column by harbour porpoise. This is subject to ongoing work, but preliminary results suggest that harbour porpoise may use of the entire water column in these areas, and dive to the seabed (Gordon *et al*. 2011).

Site Specific Surveys

Harbour porpoise were the most frequently sighted species by both the dedicated MMOs and the ESAS surveyors during the site specific surveys; average sightings rates while on effort were 1.99 individuals per hour, and 1.5 individual per hour respectively (not corrected for availability). Harbour porpoise were seen in groups of up to six individuals, but were most commonly seen alone. Based on the number of sightings of harbour porpoise it was possible to estimate abundance and density at the AfL area. The most robust of density for harbour porpoise is 0.137 (CV=19.50) individuals per km^2, this estimate is based on the entire survey area, although detection probability is not known for this survey so an estimate of g(0), the probability of detecting the animal on the track line, has been used from a different survey (Royal HaskoningDHV 2014).

The use of a towed PAM has supplemented the visual surveys for harbour porpoise (MER 2014). The majority of the acoustic detections were in the more offshore parts of the survey area (MER 2014). The average detection rate using PAM (1.58 unique acoustic encounters per hour) was higher than the visual sighting rate (0.68 sightings per hour) over comparable survey periods. However, visual and acoustic detection rates did vary over the survey period, with visual detection rates being higher in some months and vice versa.

Density Estimates for Assessment

The density estimate of 0.137 (CV=19.50) individuals per km^2 calculated from the AfL area specific survey is used in the impact assessment.

Designated Sites

The West Scotland MU also includes the Northern Ireland coast and the UKs only SAC where harbour porpoise are a qualifying feature. The North Sea MU includes a number of Sites of Community Importance (SCIs) which are designated for harbour porpoise in European waters. Eight draft offshore SACs (dSAC) for harbour porpoise have been proposed in UK waters. The closest proposed dSACs to the Project site are in the Outer Moray Firth and North Minch, further consideration is given to these sites in the Information to Inform HRA report (Supporting Document: BTAL, 2015c).

13.9.3.2 White-beaked Dolphin

Population Status

White-beaked dolphin are widespread across the northern European continental shelf. The species is the most abundant cetacean after the harbour porpoise in the North Sea (Jansen *et al*. 2010) and the waters off the coast of Scotland and north east England are one of the four global centres of peak abundance.

Scientific evidence supports the assumption that white-beaked dolphin from around the British Isles and North Sea represent one population, with movement between Scottish waters and the Danish North Sea and Skagerrak (Banhuera-Hinestroza *et al*. 2009). Sightings are common throughout the year, with peaks between June and October (Reid *et al*. 2003). Off northern Scotland there have been sightings in every month expect January (Evans *et al*. 2011). White-beaked dolphin breed mainly between May and August, although some breeding occurs in September and October (Anderwald & Evans 2010). The gestation period is approximately 11 months (Culik 2010).

A single management unit has been proposed by the IAMMWG (2015) for this species comprising all UK waters is shown in Figure 13.12. The estimate of the size of the population in the Celtic and Greater North Seas MU is 15,895 individuals

(CV=0.29), and is derived from the SCANS II surveys data (Hammond *et al*. 2013). The abundance of animals in the UK EEZ is 11,694 (CV=0.30; 95% CI=6,578-20,790; IAMMWG 2015).

The estimate of abundance in the SCANS-II survey block J (Orkney and Shetland, see Figure 13.10) is 1,078 individuals (CV=0.85; Hammond *et al*. 2013).

During the APEM (2013) surveys of the Pentland Firth and Orkney waters a total of five white-beaked dolphin were seen in a single sighting in the wider area, to the west of mainland Orkney. This sighting during the October/November survey provided an abundance estimate of 432 (95%CI=5-1,272).

Reference Population for Assessment

The reference population for the impact assessment is the Celtic and Greater North Seas MU (Figure 13.12) is 15,895 individuals (CV=0.29; IAMMWG 2015).

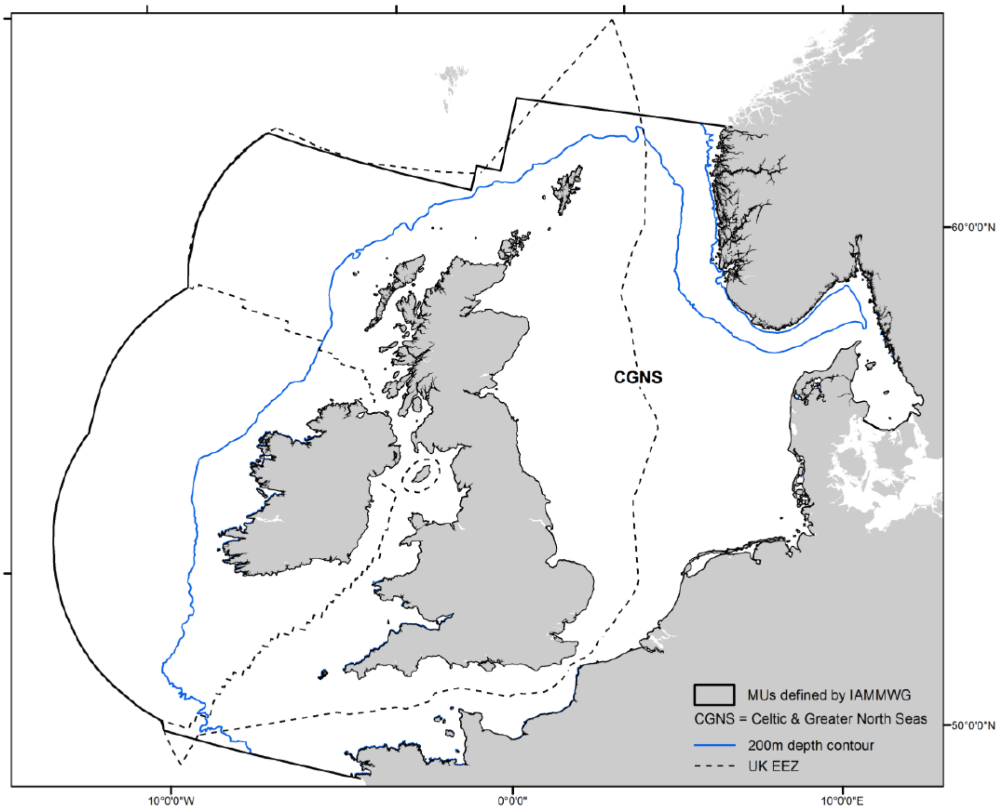


Figure 13.12: White-beaked dolphin Management Units (IAMMWG 2015)

Diet

The diet of white-beaked dolphin within the North Sea is dominated by gadoids, notably whiting and cod (Jansen *et al.* 2010); however, in Scottish waters they also consume cephalopods (Santos *et al.* 1994). Stomach contents' analysis, from dolphins stranded mainly on the Scottish east coast, identified haddock and whiting as the predominant fish species being taken (Canning *et al.* 2008).

At Sea Distribution

The species occurs mainly in waters of 50-100m in depth (Reid *et al.* 2003). The majority of the sightings in Pentland Firth and Orkney water are in more offshore areas (Evans *et al.* 2011b). Figure 13.13 shows the sightings data from 1980-2010, presented in Evans *et al.* (2011b).

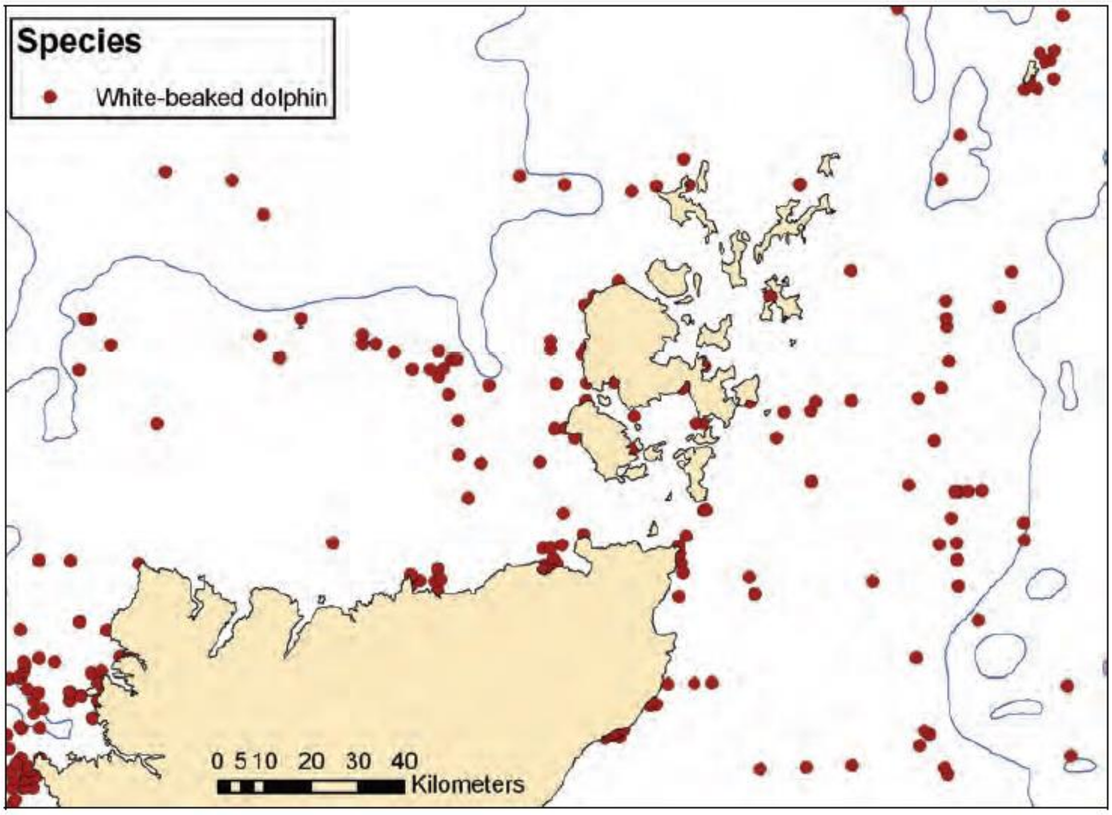


Figure 13.13: Distribution of sightings of white-beaked dolphin, 1980-2010 (Evans *et al.* 2011b)

The estimate of density for the SCANS-II survey block J (Orkney and Shetland, see Figure 13.10) is 0.029 individuals per km^2 (CV 0.85, Hammond *et al.* 2013). It should be noted that this estimate is based on a summer survey, when white-beaked dolphin occurrence may be greatest.

No sightings of white-beaked dolphin were made during the MeyGen surveys (MeyGen 2011) of the Inner Sound or the EMEC Falls of Warness tidal test site (EMEC 2014).

Site Specific Surveys

In July 2013, 13 white-beaked dolphin were recorded by the MMO while on effort, with three more sighted off effort. This approximates to a sighting rate of 0.22 individuals per hour, but it should be noted that the animals were sighted in one group, and an average rate of occurrence may be misleading. No estimate of density could be generated from this sighting. White-beaked dolphin was also detected during the PAM surveys (Wittich & Gordon 2012).

Density Estimates for Assessment

Due to the low number sightings of white-beaked dolphin during the Project, MeyGen, and EMEC site specific surveys to allow density estimates to be created, a qualitative impact assessment will be undertaken.

Designated Sites

There are no designated sites for white-beaked dolphin in UK waters.

13.9.3.3 Minke Whale

Population Status

Genetic evidence suggests a limited spatial separation of populations of minke whale within the North Atlantic (Anderwald & Evans 2010). The International Whaling Commission (IWC) treats this as a single stock (Central and North eastern North Atlantic), with a population estimate (between 1996 and 2001) of 174,000 (Northridge 2012).

The species is most commonly seen singly or, less commonly, in loose groups of up to three. In late summer, off the coast of northern and north west Britain, loose feeding aggregations of up to 15 animals may form (Anderwald & Evans 2010). In the northern hemisphere, mating is from October to March. Gestation is about 10 months, with calving occurring primarily between December and January.

The IAMMWG has identified a single MU appropriate for minke whale in European waters (IAMMWG 2015). The abundance of minke whales in the Celtic and Greater North Seas MU (Figure 13.14) is 23,528 animals (CV=0.27; 95%CI=13,989-39,572). The estimate was derived from SCANS-II (Hammond *et al*. 2013) and CODA (Macleod *et al*. 2009) surveys and is likely to be underestimated because the SCANS-II estimate was not corrected for perception bias in the aerial surveys and the CODA estimate was not corrected for perception or availability biases. The IAMMWG MUs for minke whale is transboundary as it incorporates a number of European Exclusive Economic Zones (EEZs). The abundance o in the UK EEZ is estimated to be 12,295 (CV=0.28; 95% CI=7,176-21,066). The estimate of abundance in the SCANS-II survey block J (Orkney and Shetland, see Figure 13.10) for minke whale was 833 (CV=1.04; Hammond *et al*. 2013).

The only published information on trends in population size for minke whale in UK waters is from the North Sea, English Channel and Celtic Sea undertaken for SCANS and SCANS –II surveys. The SCANS survey conducted in July 1994 estimated 8,445 individuals (95%CI=5,000-13,500; Hammond *et al*. 2002). The SCANS II survey in July 2005 gave an estimate of 13,734 (CV=0.41; 95%CI=9,800–36,700) within an area comparable to the 1994 survey (Hammond *et al*. 2013). Although these estimates were not significantly different, there were noticeable changes in distribution between the two surveys.

Only one minke whale was sighted during the August/September 2012 survey of the Pentland Firth and Orkney waters (APEM 2013). This near-shore sighting, off South Ronaldsay, provided a population estimate for the region of 31 individuals (95%CI=1-92).

Reference Population for Assessment

The reference population for the impact assessment is the Celtic and Greater North Seas MU is 23,528 animals (CV=0.27; 95%CI=13,989-39,572; IAMMWG 2015).

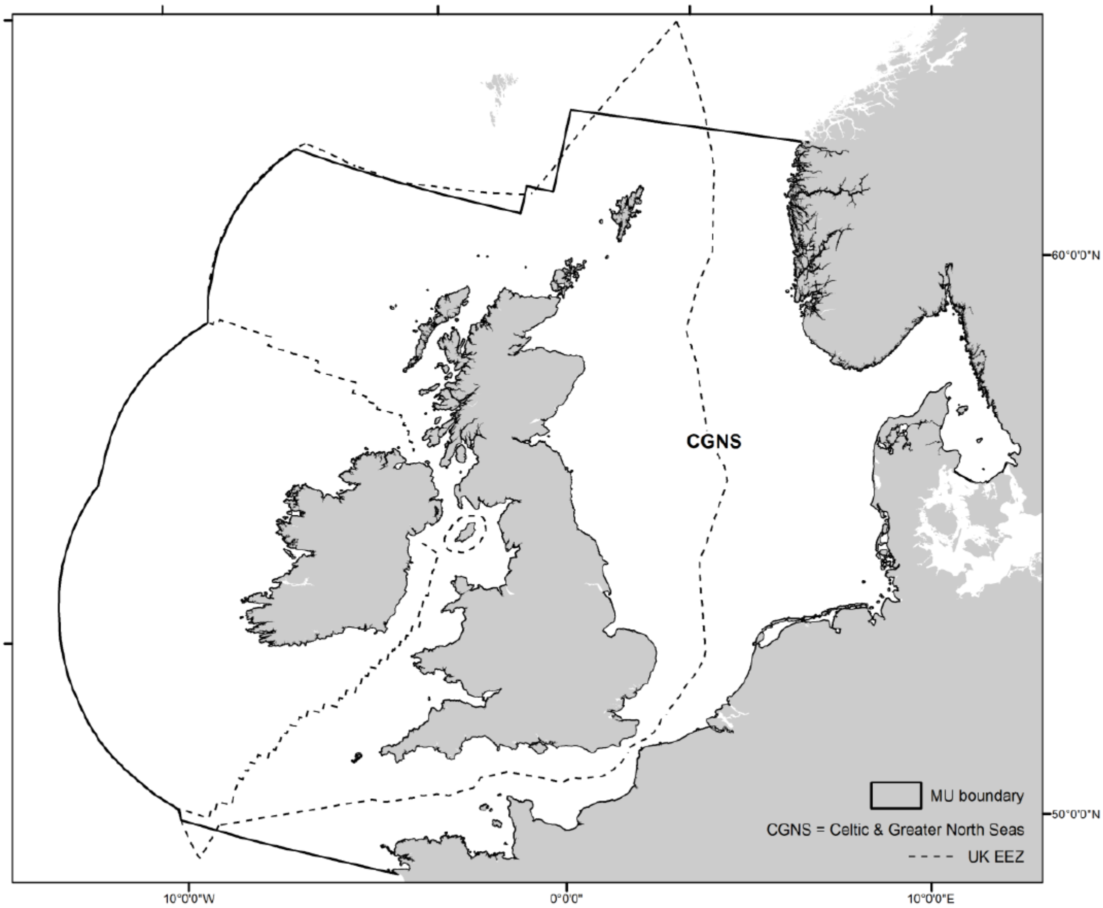


Figure 13.14: Minke whale Management Units (IAMMWG 2015)

Diet

Minke whale feed upon a variety of fish species, including herring, sandeel, cod, haddock and saithe, as well as on invertebrates (Anderwald & Evans 2010). Feeding during the summer months is often observed in areas of upwelling or strong currents around headlands and small islands.

At Sea Distribution

Minke whale is widely distributed along the Atlantic seaboard of Britain and Ireland and throughout the North Sea. Reid *et al.* (2003) indicates that minke whale occur regularly in the North Sea to the north of Humberside and around the west coast of Scotland. Animals are present throughout the year, but most sightings are between May and September.

Evans *et al.* (2011a) confirm that minke whale are also relatively common in the Pentland Firth and Orkney waters, with sightings recorded between January and October and peaking in inshore areas in June/July/August. Figure 13.13 shows the sightings data from 1980-2010, presented in Evans *et al.* (2011a).

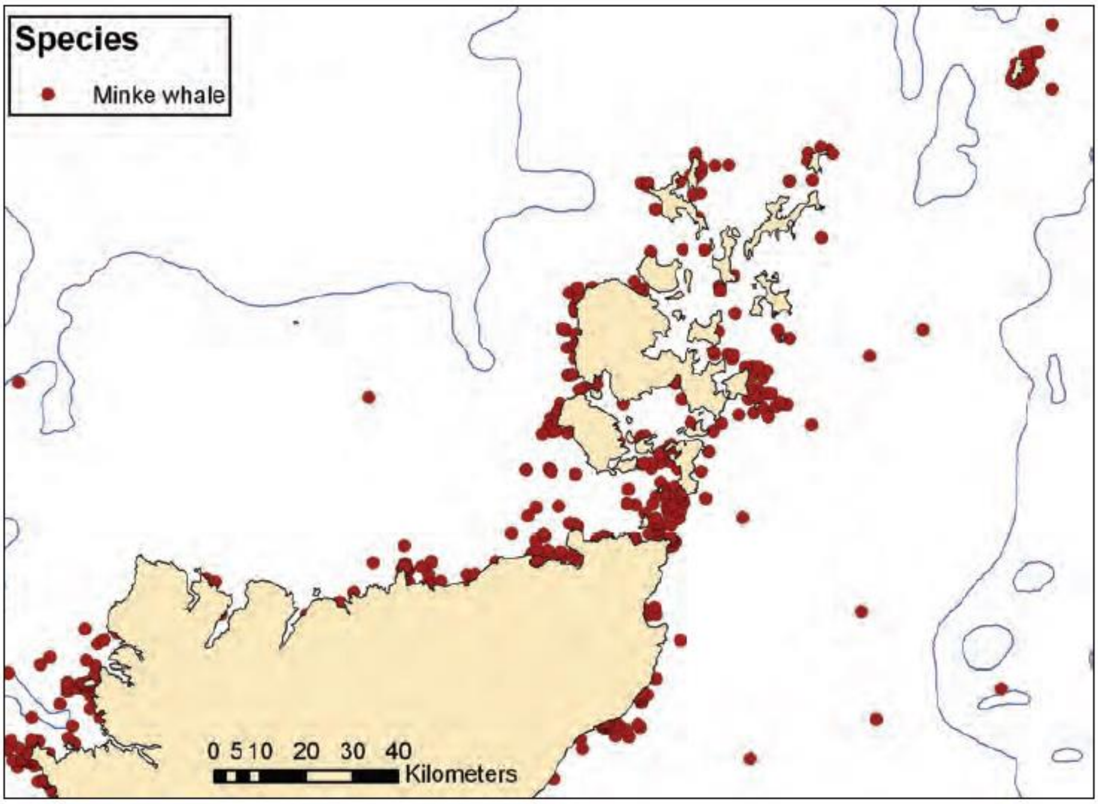


Figure 13.15: Distribution of sightings of minke whale, 1980-2010 (Evans *et al.* 2011a).

The estimate of density of minke whale in the SCANS-II survey block J (Orkney and Shetland, see Figure 13.10) was 0.022 individuals per km^2 (CV=1.04; Hammond *et al.* 2013).

Three sightings of minke whale were made during the surveys of the Inner Sound undertaken in relation to the MeyGen development (MeyGen 2011). No estimates of density could be produced from these sightings.

Surveys at the EMEC Falls of Warness tidal test site, from July 2005 to March 2014 provided mean areal density estimates for minke whale of 0.001 individuals per km^2 based on surface observations of 0.0002 individuals per km^2 (EMEC 2014).

Site Specific Surveys

In July 2012, a single minke whale was sighted on effort during the site specific surveys, by both the MMO and ESAS surveyor. No estimate of density could be generated from this sighting.

Density Estimates for Assessment

The density estimate of 0.001 individuals per km^2 calculated from the EMEC Falls of Warness survey (EMEC 2014) is used in the impact assessment.

Designated Sites

There are currently no designated sites for minke whale in UK waters. However, as part of the proposed Scottish MPA network, minke whale has been included in the Sea of Hebrides MPA proposal and the Southern Trench MPA proposal (Cunningham *et al.* 2015).

13.9.4 Other Species of Cetacean

13.9.4.1 Risso's Dolphin

Risso's dolphin is generally associated with the deeper and warmer waters of the continental slope. As such, the majority of UK sightings of Risso's dolphin are made off the north west of Scotland, surrounding the Outer Hebrides (Reid *et al.* 2003). However, there have been a number of sightings in the Pentland Firth and Orkney waters (Evans *et al.* 2011a). The status of Risso's dolphins in the UK is currently unknown, and there are no population estimates available (Hammond *et al.* 2013; IAMMWG 2015).

There were no sightings of Risso's dolphin during the APEM (2013) surveys of the region. A single sighting of a Risso's dolphin was made from land-based observations of the Inner Sound in June 2010, when three animals (two adults and one juvenile) were recorded (MeyGen 2011).

There were no confirmed sightings of Risso's dolphin during the site specific surveys. Due to the absence of any sightings, Risso's dolphin is not taken forward in this impact assessment.

There are currently no designated sites for Risso's dolphin in UK waters. However, as part of the proposed Scottish MPA network, Risso's dolphin has been included in the North-east Lewis MPA proposal (Cunnigham *et al.* 2015).

13.9.4.2 Bottlenose Dolphin

Bottlenose dolphin has been occasionally sighted in the Pentland Firth and Orkney waters (Evans *et al.* 2011a). Any bottlenose dolphin occurring in the Project site are most likely to be from the Coastal East Scotland (CES) MU which has an abundance estimate of 195 (95% CI, 162-253) (IAMMWG 2015). The abundance of bottlenose dolphin from the UK portion of the CES MU is estimates to be 195 (95% CI, 162-253) (IAMMWG 2015).

The SCANS II survey estimated abundance in survey block J (Orkney and Shetland, see Figure 13.10) to be 412 (CV=0.87), with a density estimate of 0.011 individuals per km^2 (CV=0.87; Hammond *et al.* 2013). There is a large amount of uncertainty surrounding this estimate, and it should be note that survey block J also includes the Moray Firth SAC, an area of known high bottlenose dolphin occurrence. As such is it not considered to be appropriate to apply that estimate of density to the AfL area.

No bottlenose dolphin was sighted during the two years of site specific surveys by the dedicated MMOs or the ESAS surveyors. Based on the lack of bottlenose dolphin sightings in the AfL area during the site specific surveys, this species will not be included in the impact assessment or the Information to Inform HRA.

SNH advised in their scoping opinion (August 2013) that although bottlenose dolphin are wide ranging there is limited evidence of bottlenose dolphin in the Pentland Firth. This is supported by the absence of sightings during site specific surveys and so it is unlikely that there is significant connectivity between the AfL area and bottlenose dolphin from the Moray Firth SAC.

13.9.4.3 Killer Whale

In the UK, killer whale is often sighted off northern and western Scotland (Reid *et al.* 2003). Sightings are common around the Pentland Firth, and near-shore Orkney waters, especially between May and July (Evans *et al.* 2011a). Photo-identification studies suggest these animals; around 30 in number are linked to the killer whale that follow the Icelandic summer –spawning herring (Foote *et al.* 2009, 2010). However, during the summer they have been observed taking harbour seal, harbour porpoise and common eider in the coastal waters of the Northern Isles (Evans *et al.* 2011a).

No killer whale was sighted during the APEM (2013) surveys. Two sightings of killer whales were made during land-based observations on the Inner Sound on consecutive days in May 2010, as part of the MeyGen survey. Both recording groups of six to seven individuals with only one male in each (the remainder of the groups comprised females and juveniles (MeyGen 2011).

No killer whale was sighted during the two years of site specific surveys by the dedicated MMOs or the ESAS surveyors. Based on the lack of sightings in the AfL area during the site specific surveys, this species will not be included in the impact assessment.

13.9.5 Basking Shark

13.9.5.1 Population Status

The basking shark is a widely distributed pelagic species, and the largest fish in British waters (second largest in the world), growing up to approximately 10m in length. Basking shark are predominantly recorded off the west coast of Scotland. They generally occur in open waters but migrate towards the shore in summer, when they can be seen 'basking', or swimming slowly, at the surface with the mouth wide open. They are known to migrate over large distances in both offshore and coastal waters at depths from the surface to over 750m. They are particularly associated with tidal fronts on the continental shelf and shelf edge where they feed on plankton (Speedie *et al.* 2009). Tagging work has shown that they make extensive horizontal and vertical migrations to locate feeding hotspots, often associated with frontal systems (Priede & Miller 2009).

Individual basking sharks take 11-20 years to reach maturity; females have long gestation periods (1-3 years) and give birth to few large young.

OSPAR (2008) have reported 50-90% population wide declines in recent years although there are limited data to validate these trends. As a result of declining numbers recorded the basking shark is listed as threatened and/or declining under the OSPAR convention (OSPAR, 2008).

There are currently no designated sites for basking shark in UK waters. However, as part of the proposed Scottish MPA network, basking shark has been included in the Sea of Hebrides MPA proposal (Cunnigham *et al.* 2015).

13.9.5.2 Reference Population for Assessment

There is currently no population estimate for basking sharks within Scottish or UK waters due to the difficulties in counting basking sharks (Drewery 2012).

13.9.5.3 Diet

Basking sharks are filter-feeders and, in order to meet their energy requirements, they must select and remain in areas of high plankton concentrations. Basking sharks are selective foragers of zooplankton, feeding predominately on energy rich calanoid copepods, such as *Calanus finmarchicus* and *C. helgolandicus* (Sims *et al.* 1997).

13.9.5.4 At Sea Distribution

Evans *et al.* (2011a) reported a total of 345 basking shark records (comprising 385 individuals) from North Scotland and Orkney **(**Figure 13.16) which occurred in most months of the year, although rarely between November and April. Peak records occurred between July and September (particularly August), but there was no clear spatial pattern in the occurrence of sightings.

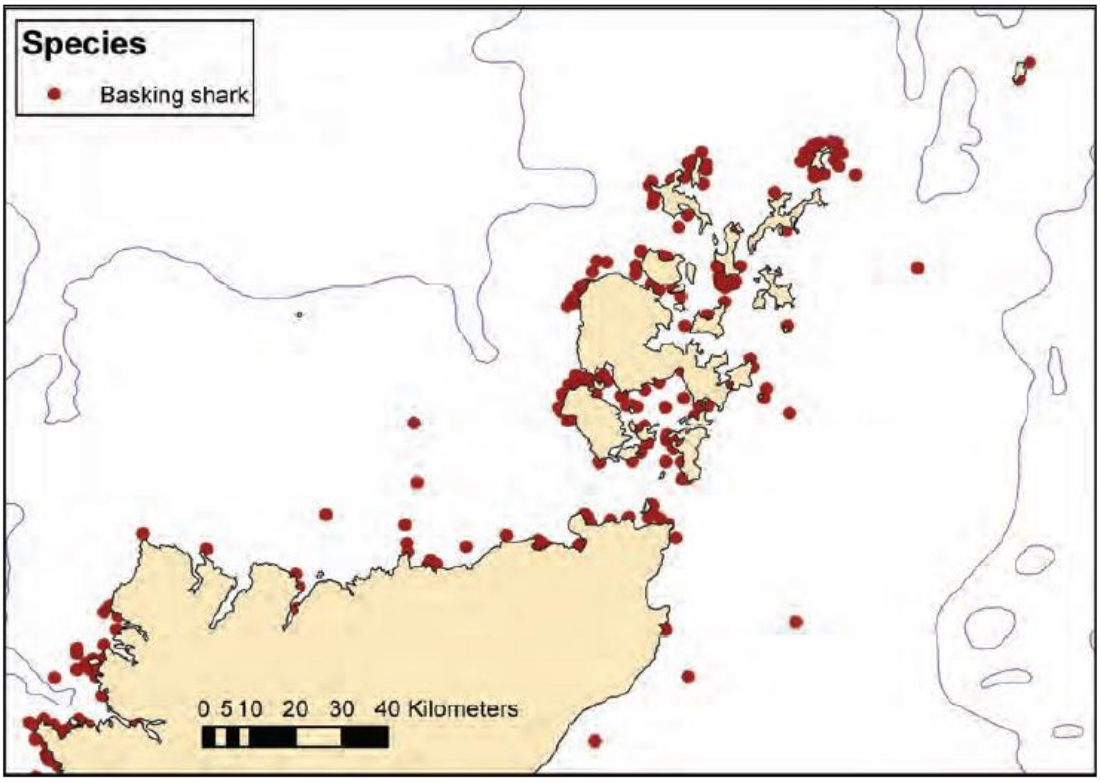


Figure 13.16: Distribution of sightings of basking shark, 1980-2010 (Evans *et al.* 2011a)

No basking sharks were reported during the APEM aerial surveys of the Pentland Firth and Orkney waters in 2012/2013 (APEM 2013).

The EMEC Falls of Warness tidal test site, from July 2005 to March 2014 provided mean areal density estimates for basking shark of 0.001 individuals per km^2 based on surface observations of 0.001 individuals per km^2 (EMEC 2014).

13.9.5.5 Site Specific Surveys

During the site specific surveys one basking shark was recorded by the dedicated MMOs while off survey effort on the 20th August 2012 (Supporting Document: RHDHV, 2014c). It is not possible to estimate density of basking shark from these surveys.

13.9.5.6 Density Estimates for Assessment

The density estimates from the EMEC Falls of Warness survey of 0.001 individuals per km^2 (EMEC 2014) will be used in the assessment.

13.9.6 Summary

Table 13.15 provides a summary of density estimates and reference populations.

Table 13.15: Summary of density estimates and reference populations taken forward in the assessment

Species	Density estimate (per km^2)	Reference population
Grey seal	0.090	20,682
Harbour seal	0.020	1,938
Harbour porpoise	0.137	227,298
White beaked dolphin	Sightings too low	15,895
Minke whale	0.001	23,528
Basking shark	0.001	unknown

In addition, collision risk results using the SMRU seal density estimates and SCANS cetacean density estimates are presented in Appendix 1 (using the ERM) and Appendix 3 (using the CRM).

13.10 POTENTIAL IMPACTS

The potential impacts on marine mammals and basking sharks identified for each phase of the Project are:

13.10.1 Construction and Installation

- Underwater noise;
- Collision with vessels[12];
- Accidental contamination from vessels or devices;
- Disturbance at haul out sites; and

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12 Following recent (February 2015) SNCB advice on the issue of corkscrew injuries in seals it is considered very likely that vessels with ducted propellers do not pose any increased risk to seals over and above normal shipping activities. Therefore the issue of seal collision with ducted propellers is not assessed as a standalone impact.

- Indirect effects on prey species.

13.10.2 Operation and Maintenance

- Underwater noise;
- Collision with devices;
- Collision with vessels;
- Electromagnetic Fields;
- Disturbance at haul out sites;
- Indirect effects on prey species; and
- Accidental contamination from vessels or devices.

13.10.3 Decommissioning

- Underwater noise;
- Collision with vessels; and
- Accidental contamination from vessels or devices.

13.10.4 Accidental and Unplanned Events

- Accidental contamination from vessels or devices during;
  - Construction/ installation
  - Operation and maintenance; and
  - Decommissioning

13.11 MITIGATION MEASURES

13.11.1 Project Design and General Mitigation Measures

All Project Design Mitigation and General Mitigation measures are set out in Chapter 5 Project Description, Table 5.15 and Table 5.16 respectively. These are standard practice measures based on specific legislation, regulations, standards, guidance and recognised industry good practice that are put in place to ensure significant impacts do not occur.

13.11.2 Specific Mitigation

The following mitigation measures will be implemented specifically to minimise the impacts on marine mammals and basking sharks (Table 13.16).

Table 13.16: Mitigation Measures Specific to Marine Mammals and Basking Sharks

Ref	Mitigation Measure Description
MM01	A vessel management plan (General Mitigation measure GM07 (Table 5.16) will be developed in consultation with SNH and Marine Scotland which will aim to develop a standard transit route and range of vessel speeds for traffic to and from the AfL area with the aim of minimising collision risk.

13.12 RESIDUAL EFFECTS

13.12.1 Impacts during Construction and Installation

13.12.1.1 Underwater Noise

Sensitivity

Southall *et al.* (2007) discuss a range of likely behavioural reactions that may occur as a result of exposure to noise. These include orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement/diving behaviour, temporary or permanent habitat abandonment, and in severe cases panic, flight stampede or stranding, sometimes resulting in injury or death. Behavioural disturbance responses may be considered likely to affect vital rates based on the potential for a severe or sustained avoidance of an area (e.g. Harwood *et al.* 2014). The duration and range of any response can vary, and the time between individuals being displaced and returning to an area is considered as part of the determination of the predicted magnitude.

Harbour porpoise have relatively high daily energy demands and need to consume between 4% and 9.5% of their body weight in food per day (Kastelein *et al.* 1997). If a harbour porpoise does not capture enough prey to meet its daily energy requirements it can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.* 1997). Thermoregulation has high energy costs in marine mammals. Kastelein *et al.* (1997) estimate that a harbour porpoise may have a life expectancy of as little as three days in waters of 20°C under starvation conditions and in the colder waters around Orkney this could be expected to be less. Should harbour porpoise be excluded from an area of key prey resource, and be unable to find alternative food sources, there could be serious impacts from behavioural disturbance. Harbour porpoise are therefore assessed as having a **medium sensitivity** to behavioural effects as a result of underwater noise.

Less is known about the sensitivity of minke whale and white beaked dolphin to disturbance as a result of underwater noise than for harbour porpoise, but it is likely that they have a comparable sensitivity to harbour porpoise (**medium sensitivity**) to this type of impact.

Harbour seal and grey seal exhibit alternate periods of foraging and resting at haul out sites (during which limited or no feeding occurs). Prolonged fasting also occurs in these species during annual breeding and moult, when there are marked seasonal changes in body condition (Rosen & Renouf 1997; Bäcklin *et al.* 2011). Although adult seals may be relatively robust to short-term (weeks rather than days compared to harbour porpoise) changes in prey availability, young and small individuals have a more sensitive energy balance (Harding *et al.* 2005). Although a fleeing response in harbour or grey seal may lead to a severe or sustained avoidance of an area, these species can be considered to have **low sensitivity** to noise disturbance.

There is no literature available specifically concerning the sensitivity of basking sharks, or other plankton feeding sharks to underwater noise. Elasmobranchs have no air-filled cavity, and are incapable of detecting sound pressure; detection is through the inner ear and organs. Basking shark appear relatively unaware of the presence of vessels, for example most basking sharks killed in the harpoon fishery were shot at very close range, showing little or no indication of any evasive action (Maxwell 1952) and scientists conducting satellite tagging exercises with Pop-up Archival Tags (PAT) typically use spear guns to attach the tags, making an approach to the shark from behind and 1m to one side and inserting the tag as the bow of the vessel draws level with the first dorsal fin (Sims *et al.* 2005). During a study on disturbance in basking shark caused by shipping in south west England (Wilson 2000), it was concluded that engine noise and the angle of approach had some limited effect on shark behaviour, but the effects were inconclusive. The study indicated that large sharks feeding at the surface seem particularly immune to the approach of vessels, whilst younger sharks (more commonly seen on their own) react more readily. Groups of large sharks at the surface appear to be in a "trance-like" state, especially when courtship-like behaviour is taking place. As such the sensitivity to disturbance noise can be considered as low, after accounting for the uncertainty and knowledge gap in this area.

Magnitude

Construction works include installation vessels, use of construction equipment, laying cables and cable protection, and installation of turbine foundations (gravity base, drilled monopile, and/or drilled pin piles). Source noise data for these installation components are presented in Table 9.1 of Supporting Document: Xodus (2015). It should be noted that the key source of noise is the construction vessels with a peak source level of191dB re 1μPa @ 1m, compared with the predicted peak source level noise of drilling of 166 dB re 1μPa @ 1m.

Noise modelling (Supporting Document: Xodus, 2015) has been undertaken for installation of the Project using the injury and behavioural threshold criteria proposed by the following sources:

- Southall *et al.* (2007) non pulsed sound thresholds of 230dB re 1μPa for all cetaceans – PTS criteria;
- Southall *et al.* (2007) non pulsed sound thresholds of 218dB re 1μPa for pinnipeds in water – PTS criteria; and
- NMFS (2005) Level B harassment threshold[13] for all marine mammals of 120 dB re 1μPa – disturbance criteria.

The noise levels associated with the proposed Project installation works are not predicted to result in any physical injury; Table 13.17 provides the estimated ranges of disturbance provided in Supporting Document: Xodus (2015) for various vessel types that will be used in the construction of the Project.

Table 13.17: Estimated disturbance ranges for marine mammals during construction

Noise source/ vessel	Estimated range for onset of marine mammal disturbance (km)	Estimated area for onset of marine mammal disturbance (km^2)
Anchor handling vessel	1.4	6
Installation/construction vessel (using DP)	14	616
Support vessel	4	50
Rock placement vessel	14	616

13 Level B Harassment is defined as having the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.

Noise source/ vessel	Estimated range for onset of marine mammal disturbance (km)	Estimated area for onset of marine mammal disturbance (km^2)
Cable lay vessel	14	616
Misc. small vessels (e.g. tugs, vessels carrying ROVs, crew transfer vessels, dive boats and RIBs)	1.4	6
Pile drilling	0.375	0.4
Cable trenching/cutting	3.5	38
Jack up barge	0.43	0.6

Table 13.18 presents the worst case modelled disturbance range for marine mammals with an estimation of the number of animals disturbed based on the density estimates discussed in Section 13.9. However it should be noted that these are not exclusion zones and there is potential for marine mammals to become habituated to the noise if motivation is sufficiently strong, e.g. prey resource. Consequently, the predicted ranges for onset of disturbance are considered to be highly precautionary and exceeding the criteria for potential onset of disturbance effects does not in itself mean that disturbance will necessarily occur. In the context of foraging ranges for seals from their haul out sites, harbour seals tagged in and around Orkney were found to have a typical foraging range of 20km (SMRU Limited (2011), see Section 13.9.2), although juveniles were found to have much less site fidelity and at other sites around the UK, harbour seal have been known to travel up to 60km routinely (e.g. Thompson *et al.* 1996). Grey seal are known to forage up to 145km from their haul out sites (Thompson *et al.* 1996), over wide estimated home ranges of 1,088 to 6,400km² (Dietz *et al.* 2003). While the population consequences of disturbance are uncertain, it is unlikely at these ranges that there would be significant population level effects. As the noise disturbance of up to 14km for cable laying, rock placement and construction vessels will be intermittent and it is unlikely that the noise ranges presented will result in complete exclusion from this area; it is highly unlikely there will be any significant barrier effects.

In addition, the modelled noise ranges do not take into account existing noise in the environment, including anthropogenic noise from vessels (e.g. ferries) as well as the high natural noise sources present in areas of high tidal currents. Supporting Document: Xodus (2015) outlines that these could be expected to be approximately 106 to 139dB re 1μPa depending on the state of tide.

During Stage 1, the potential disturbance from underwater noise would be intermittent over the 24 month construction period. The total construction period for Stage 1 and 2 will be 60 months (5 years). While there could be up to four vessels on site, occasionally, it is likely that these will be smaller vessels and therefore the noise range will be captured by the worst case scenario of 14km.

As described in Section 13.9, there is no known reference population for basking shark and the sightings data are too low to determine a density estimate for white-beaked dolphin. In addition, Supporting Document: Xodus (2015) outlines the low level of available data for disturbance effects for fish, including elasmobranchs and so no quantitative noise modelling is available. These species are therefore considered qualitatively, with input from the noise modelling where possible.

Table 13.18: Underwater noise impact areas and estimated number of animals disturbed based on greatest area of potential disturbance during construction

Species	Mean density estimate (per km^2)	Avoidance area (km^2)	Estimated mean number of animals potentially disturbed
Grey seal	0.090	616	55.44
Harbour seal	0.020	616	12.32
Harbour porpoise	0.137	616	84.39
White-beaked dolphin	No. sightings too low	616	Unknown
Minke whale	0.001	616	0.62
Basking shark	0.001	Unknown	Unknown

Table 13.19 outlines the percentage of the reference population potentially disturbed and the resultant magnitude of the effect taking into account the temporary nature of construction noise, along with a summary of the sensitivity of each species. As basking shark are described as occasional visitors to the area, any disturbance effects are likely to be of negligible magnitude. Likewise, as the numbers of white-beaked dolphin in the study area are too low to determine density estimates the magnitude of potential disturbance is deemed to be negligible.

Table 13.19: Potential percentage of the reference population disturbed by underwater noise during construction of the proposed Project

Species	Sensitivity	Reference population	Estimated mean number of animals disturbed	Percentage of reference population	Magnitude
Grey seal	Low	20,682	55.44	0.268	Negligible
Harbour seal	Low	1,938	12.32	0.636	Negligible
Harbour porpoise	Medium	227,298	84.39	0.037	Negligible
White-beaked dolphin	Medium	15.895	Unknown	Unknown	Negligible
Minke whale	Medium	23,528	0.62	0.003	Negligible
Basking shark	Low	Unknown	Unknown	Unknown	Negligible

Summary of Residual Effects

Table 13.20 summarises the residual effects.

Table 13.20: Underwater noise impact significance during construction

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Installation of unshrouded devices – increased vessels	Grey seal	Low	None suggested	Negligible	Negligible
	Harbour seal	Low		Negligible	Negligible
	Harbour porpoise	Medium		Negligible	Negligible
	White-beaked dolphin	Medium		Negligible	Negligible
	Minke whale	Medium		Negligible	Negligible
	Basking shark	Low		Negligible	Negligible

The worst case scenario is based on the installation of unshrouded device types, which would require the greater number of vessels during construction and therefore greatest potential disturbance from underwater noise. The installation of shrouded devices, such as the Open Hydro device, would require fewer vessels and therefore the potential for disturbance from underwater noise during construction would be lower.

There is a medium level of confidence in this assessment, based on the levels of predicted increased underwater noise during construction of the proposed Project in relation to existing underwater noise in the area.

13.12.1.2 Collision with Vessels

Sensitivity

Collison with vessels can potentially result in death of the animals, or secondary infections or fitness effects which could lead to the death of the animal. Laist *et al.* (2001) concluded that vessels over 80m in length cause the most severe or lethal injuries but that serious injury rarely occurs if animals are struck by vessels travelling at speeds below 10 knots.

Due to vessel noise, it is likely that cetaceans will be able to detect the presence of vessels and may be able to avoid collisions by taking evasive action. Despite the potential for avoidance of vessels, as discussed in Section 13.12.1.2 ship strikes are known to occur in cetaceans and cause injury and death. Possible reasons why collisions occur include distraction whilst undertaking other activities, such as foraging, and social interactions are (Wilson *et al.* 2007). Marine mammals can also be inquisitive, which may increase the risk of collision. It is not possible to fully quantify strike rates, as it is believed that a number go unnoticed. It is possible that collisions which are non-fatal can leave the animal vulnerable to secondary infection, other complications or predation (Wilson *et al.* 2007). However, marine mammals are relatively robust to potential collision, as they have a thick sub-dermal layer of blubber, which defends their vital organs from the worst of the impact (Wilson *et al*. 2007).

Marine mammals in the study area may be habituated to the presence of vessels and therefore be expected to be able to detect and avoid installation vessels. However, it is also possible the masking from other existing noise may limit the ability of marine mammals to detect approaching vessels.

Harbour porpoise, white-beaked dolphin, other small cetaceans, as well as grey and harbour seal are highly mobile, and are expected to largely avoid vessel collision. However, these species have been observed with signs of physical trauma (blunt trauma or propeller cuts) possibly indicating vessel strike (Evans *et al*. 2011, Onoufriou & Thompson 2014). Given this evidence harbour porpoise, white-beaked dolphin, harbour and grey seal are considered to have medium sensitivity to this impact as defined in Table 13.5. Ship strike is a known cause of mortality in minke whale, and this species is also noted for their curiosity and often approach boats, and other novel items in their environment (Wilson *et al.* 2007). Their size means they are less agile than the smaller species, as such they can be considered to have a high sensitivity to collision risk with vessels.

As stated in Section 13.12.1.1, in relation to underwater noise, basking sharks appear to show no response to surface vessels. As such there is a risk of collision, especially when vessels may be travelling at speed, which can lead to fatal consequences. As such the sensitivity of this species to collision with vessels is considered to be high.

Magnitude

Chapter 15 Shipping and Navigation outlines the levels of existing shipping activity within a 5nm buffer around the AfL area. There was an average of 25 unique vessels per day in winter 2013, and 21 per day in summer 2014. The largest proportion of these was cargo vessels and tankers using the Outer Sound of the Pentland Firth and passing south of the AfL area.

During the Project installation there could occasionally be up to four vessels on site at one time, based on concurrent device installation (including an installation vessel with support vessel) and cable laying (including a cable laying vessel with support vessel). While working on installation activities, vessels will be stationary or very slow moving and so pose minimal collision risk to marine mammals and basking shark. Section 13.3 outlines the worst case scenario number of movements for the various vessel types over the installation durations for the Project Stage 1 and Stage 2. There will be a maximum of one return trip per device for each vessel type with a maximum of four vessel trips in a day (one return journey for each of the four vessels that could be on site at one time). The average number of movements per day will be 0.3 during Stage 1 and 0.9 in Stage 2 installation. In the context of the existing vessel traffic, this level of increase for a temporary period (24 month for Stage 1 and 60 months (5 years) in total for Stage 1 and 2) would represent a negligible magnitude for Stage 1 and Stage 1 and 2 combined, for all marine mammals and basking shark.

Corkscrew Injuries

A number of damaged seal carcasses have been washed up on beaches around Scotland and the North Norfolk English coast (Thompson *et al.* 2010). The majority of seal carcasses were identified as harbour seal, but also included some juvenile grey seal were also identified. All the seals had a characteristic wound consisting of a single smooth edged cut starting at the head and spiralling around the body. Based on the post mortems, it was concluded that mortality was caused by a single traumatic event involving a strong rotational shearing force (Bexton *et al.* 2012). The majority of seal carcasses were identified as harbour seal, but juvenile grey seal were also identified. Initial tests indicated the wounds were consistent with interactions between seals and ducted propellers (Onoufriou & Thompson 2014).

Recent observations, however, have indicated that such injuries can be caused by grey seal predation on weaned grey seal pups and young harbour seals (Thompson *et al.* 2015). The corkscrew injuries documented were consistent with those seen in spiral death cases and the animals targeted for predation fitted the observed age structure of known spiral death carcasses found. Although there is currently no direct evidence of grey seals predating adult harbour seals, it is reasonable to consider that this is possible.

Based on the latest information, the SNCBs (i.e. Scottish Natural Heritage, Natural England, Natural Resources Wales, Joint Nature Conservation Committee) advice in February 2015, is that "it is considered very likely that the use of vessels with ducted propellers may not pose any increased risk to seals over and above normal shipping activities and therefore mitigation measures and monitoring may not be necessary in this regard, although all possible care should be taken in the vicinity of major seal breeding and haul-out sites to avoid collisions."

Summary of Residual Effects

Table 13.21 summarises the residual effects.

Table 13.21: Collision with vessels impact significance during construction

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Installation of unshrouded devices – increased vessels	Small cetaceans	Medium	Vessel Management Plan to standardise BTAL traffic routes and speeds to and from the AfL area GM07, MM01	Negligible	Negligible
	Grey seal	Medium		Negligible	Negligible
	Harbour seal	Medium		Negligible	Negligible
	Minke whale	High		Negligible	Minor
	Basking shark	High		Negligible	Minor

The worst case scenario for the number of vessels movements during construction is based on the installation of unshrouded device types. The installation process for these device types is anticipated to be in two parts, foundations and then turbine installation. This requires more vessel movements than installing a device as one unit which is the expected process for installation of shrouded devices, such as the Open Hydro device. The potential impact associated with this will therefore be less in magnitude, with the impact significance remaining negligible or minor.

There is a medium level of confidence in this assessment, based on the evidence used to assess the sensitivity of marine mammals and basking shark to this type of impact and the levels of predicted Project vessel traffic in relation to existing vessel data.

13.12.1.3 Disturbance of Seals at Haul Out Sites

Sensitivity

Noise disturbance and visual presence of vessels, equipment and personnel during the installation works could potentially displace seals from any nearby haul out sites.

Evidence from aerial surveys pre- and post-installation of the SeaGen tidal device in Strangford Lough showed no evidence of significant between year changes in the seal use of haul out sites in the vicinity of that single device. It is therefore expected that seals have some tolerance to adapt and recover from this potential impact (Royal Haskoning, 2012).

Given the distance of over 5km from any designated haul out sites the visual presence of activity at the AfL area and airborne noise from construction works are not anticipated to have an effect. Use of land closer to the AfL area to haul out may occur but is most likely to be on an *ad hoc* basis and if animals are disturbed by construction activities alternative *ad hoc* haul out sites may be used. The sensitivity of seals in the study area is therefore deemed to be low.

Magnitude

As described in Section 13.12.1.2, the number of installation vessels is relatively low compared with the level of existing vessel activity in the study area. Offshore construction works will occur for up to 2 years for Stage 1 and up to 3 years for Stage 2.

Landfall works will be by either open cut trenching or Horizontal Directional Drilling (HDD). Open cut trenching represents the worst case scenario for potential disturbance. Landfall works will occur for up to 4 weeks for Stage 1 and up to 8 weeks for Stage 2.

The magnitude of this impact is deemed to be low for Stage 1 and for Stage 1 and 2 combined due to the relatively small scale of the works and temporary duration.

Summary of Residual Effects

Table 13.22 summarises the residual effects.

Table 13.22: Disturbance to haul out sites impact significance during construction

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
Installation of unshrouded devices – increased vessels	Harbour and grey seal	Low	Routing of construction vessels to avoid designated haul out sites GM07	Low		Negligible

As outlined in Section 13.12.1.2, the worst case scenario for the level of construction activity is based on the installation of unshrouded device types. The installation process for these device types is anticipated to be in two parts, foundations and then turbine installation. This requires more time and vessel movements than installing a device as one unit for shrouded devices.

Landfall works by HDD will reduce the potential impacts on any seals hauling out at the selected landfall location. However the importance of these areas is relatively low as described above and it is expected that any displacement during trenching would have no discernible effect on the harbour or grey seal at a population level. The impact significance would remain negligible.

There is high confidence in this assessment based on the known distance to the designated haul out sites from the AfL.

13.12.1.4 Indirect Effects on Prey Species

Sensitivity

Grey and harbour seal feed on a variety of prey species, and are both considered to be opportunistic feeders with the species in highest abundance in the area when they feed usually providing the predominant component of their diet (see Section 13.9.2).

Due to the increasing size of grey seal population within the UK, prey availability is not considered to be limiting (SCOS, 2012) and the population is resilient to small scale changes in prey. Grey seal are therefore considered to have low sensitivity to changes in prey resources.

Given the declining harbour seal population and the uncertainty regarding the cause(s), which could include competition for prey (see Section13.9.2.2), this species is likely to be more sensitive to changes than grey seal. Harbour seal also range less distance when foraging, compared with grey seal and so any localised changes may have more impact. Harbour seal are therefore considered to have medium sensitivity.

The diet of harbour porpoise over recent years is thought to reflect changes in the composition of food resources (Section 13.9.3.1). Re-distribution of harbour porpoise between the 1995 SCANS and 2005 SCANS II surveys (Hammond *et al.* 2013) are thought to, in part reflect re-distribution of their major prey species, and over this time the size of the population did not change. However, there are limited data linking prey abundance to diet trends in this species, and the diet of harbour porpoise had large overlap with commercial fisheries catch (Santos & Pierce 2003). As discussed previously, harbour porpoise, have relatively high daily energy demands and need to consume between 4% and 9.5% of their body weight in food per day (Kastelein *et al.* 1997). If a harbour porpoise does not capture enough prey to meet its daily energy requirements it can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.* 1997). Harbour porpoise are therefore considered to have medium sensitivity to this impact.

White-beaked dolphin and minke whale have a varied diet; depending on the regions (see Sections 13.9.3.2 and 13.9.3.3, respectively). Both species can be considered more opportunistic feeders than harbour porpoise, with the major prey species in their diet reflecting local densities of prey species, and larger body mass may mean they are more robust to fluctuations in prey availability. As such they are considered to have low sensitivity to indirect effects on prey species.

In order to meet their energy requirements basking sharks must select foraging locations with high plankton concentrations, such as frontal areas, and their use of these areas appears to be consistent between years (Sims & Reid 2002). Research suggests that declines in plankton may lead to declines in occurrence of sharks in areas, but it is not clear whether they successfully find alternate foraging locations elsewhere (Sims & Reid 2002). In this assessment basking shark are considered to have medium sensitivity to indirect effects on prey species.

Magnitude

Chapter 12 Fish Ecology outlines a worst case scenario impact of minor consequence on species that could be prey resource for marine mammals. Impacts on prey are anticipated to be localised around the AfL area and any small scale spatial changes are likely to be tracked by marine mammals within the wider study area. The magnitude of the effect on marine mammals is therefore deemed to be negligible.

There is no known mechanism for the installation works to have a discernible impact on plankton and therefore there will be no impact on basking shark prey resource.

Summary of Residual Effects

Table 13.23 summarises the residual effects.

Table 13.23: Changes to prey resource impact significance during construction

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Gravity bases - habitat loss, Drilled pin pile tripod - smothering and Drilled monopile - noise	Harbour seal	Medium	No specific suggested mitigation (See Chapter 12 Fish Ecology)	Negligible	Negligible
	Harbour porpoise	Medium		Negligible	Negligible
	Basking shark	Medium		No impact	No impact
	Grey seal	Low		Negligible	Negligible
	Minke whale	Low		Negligible	Negligible
	White-beaked dolphin	Low		Negligible	Negligible

There is a high level of confidence in this assessment based on the evidence used to assess the sensitivity of marine mammals to this type of impact and the small scale potential impacts on prey species.

13.12.2 Impacts during Operation and Maintenance

13.12.2.1 Underwater Noise

Sensitivity

As described in Section 13.12.1.1, the sensitivity of harbour porpoise, minke whale and white beaked dolphin is assessed as medium, and the sensitivity of harbour, grey sea and basking shark is low.

Magnitude

Supporting Document: Xodus (2015) provides noise modelling for a 16m diameter shrouded device with a source peak sound pressure level of approximately 155 dB re 1µPa @ 1m based on existing data for the Open Hydro device. Xodus (2015) also outlines that during periods of peak tidal flow (when turbine noise is also greatest) the ambient noise is likely to be in the order of 120-139dB re 1µPa. The noise modelling is therefore likely to be highly conservative.

As with construction noise, operational noise is not predicted to reach thresholds which could result in fatalities or physical injury (Supporting Document: Xodus, 2015). Modelling of behavioural disturbance, using the threshold criteria described in Section 13.12.1.1, provides the predicted avoidance areas and numbers of animals potentially disturbed outlined in:

- Table 13.24 for Stage 1; and
- Table 13.25 for Stages 1 and 2 combined.

As described in Section 13.9, there is no known reference population for basking shark and the sightings data are too low to determine a density estimate for white-beaked dolphin. In addition, Supporting Document: Xodus (2015) outlines the low level of available data for disturbance effects for fish, including elasmobranchs and so no quantitative noise modelling is available. These species are therefore considered qualitatively, with input from the noise modelling where possible.

Table 13.24: Underwater noise impact areas and estimated number of animals disturbed for Stage 1

Species	Mean density estimate (per km^2)	Avoidance area (km^2)	Estimated mean number of animals potentially disturbed
Grey seal	0.090	30	0.25
Harbour seal	0.020	30	0.06
Harbour porpoise	0.137	30	0.38
White-beaked dolphin	No. sightings too low	30	Unknown
Minke whale	0.001	30	0.003
Basking shark	0.001	Unknown	Unknown

Table 13.25: Underwater noise impact areas and estimated number of animals disturbed for Stage 1 and 2

Species	Mean density estimate (per km^2)	Avoidance area (km^2)	Estimated mean number of animals potentially disturbed
Grey seal	0.090	30	2.70
Harbour seal	0.020	30	0.60
Harbour porpoise	0.137	30	4.11
White-beaked dolphin	No. sightings too low	30	Unknown
Minke whale	0.001	30	0.03
Basking shark	0.001	Unknown	Unknown

Table 13.26 outlines the percentage of the reference population potentially disturbed and the resultant magnitude of the effect, along with a summary of the sensitivity of each species. As basking shark are described as occasional visitors to the area, any disturbance effects are likely to be of negligible magnitude. Likewise, as the numbers of white-beaked dolphin in the study area are too low to determine density estimates the magnitude of potential disturbance is deemed to be negligible.

Table 13.26: Potential percentage of the reference population disturbed by underwater noise for Stages 1 and 2 combined

Species	Sensitivity	Reference population	Estimated mean number of animals disturbed	Percentage of reference population	Magnitude
Grey seal	Low	20,682	2.70	0.013	Negligible
Harbour seal	Low	1,938	0.60	0.031	Negligible
Harbour porpoise	Medium	227,298	4.11	0.002	Negligible
White-beaked dolphin	Medium	15.895	Unknown	Unknown	Negligible
Minke whale	Medium	23,528	0.03	<0.001	Negligible
Basking shark	Low	Unknown	Unknown	Unknown	Negligible

Summary of Residual Effects

Table 13.27 summarises the residual effects.

Table 13.27: Underwater noise impact significance during operation

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Shrouded device – operational noise	Grey seal	Low	None suggested	Negligible	Negligible
	Harbour seal	Low		Negligible	Negligible
	Harbour porpoise	Medium		Negligible	Negligible
	White-beaked dolphin	Medium		Negligible	Negligible
	Minke whale	Medium		Negligible	Negligible
	Basking shark	Low		Negligible	Negligible

There is a medium level of confidence in this assessment, based on the levels of predicted increased underwater noise from the operational devices in relation to existing underwater noise in the area.

13.12.2.2 Collision with Operational Tidal Devices

Sensitivity

Thompson (2013) undertook a telemetry study of harbour seal behaviour in an area of high tidal energy (Kyle Rhea, west Scotland). The telemetry data collected in the summer of 2012 shows extensive use of tidal race areas, with the seals seeming to move forwards and backwards with the tide. The seals repeatedly dived to or close to the bottom suggesting they were using the tidal rapids for foraging.

The moving rotors of tidal energy devices pose a potential collision risk for marine mammals and basking shark. However, there is currently limited understanding and empirical data relating interactions between marine mammals or basking shark with tidal devices. Data from telemetry studies around the SeaGen device in Strangford Lough, Northern Ireland, suggest that harbour seal may be exhibiting a degree of avoidance, with peaks in transit approximately 250m either side of the device (Lonergan *et al.* 2010). However, there are no data on how other species of marine mammal may respond to, or interact with tidal devices.

The Brims Underwater Noise Assessment (Supporting Document: Xodus, 2015) indicates that for Stage 1, the extent of the potential disturbance zone for marine mammals for the operational tidal array is a radius of approximately 1km from the centre of the array, and for Stage 2, the extent of the potential disturbance zone will be 2 to 4km. These noise ranges relate to device operation during full tidal flow, however during these periods the background noise will also be at its highest and this is not taken into consideration in the underwater noise modelling. There is therefore potential that noise from the turbines could be masked by ambient noise (Supporting Document: Xodus, 2015). Noise from the turbines will be less during lower tidal velocities; however the background noise will also be reduced. Given the potential for masking of the devices operational noise due to high background noise levels, 100% avoidance behaviour cannot be assumed to occur in response to tidal device noise. EMEC (2014) suggests the avoidance rates shown in Table 13.28 for collision risk modelling at the Falls of Warness tidal site. Band (2015) recommends presenting collision risk results using a range of avoidance rates 0, 50, 95, 98 and 99%, these are presented in Table 13.30 and Table 13.32. The collision risk using the avoidance rates in Table 13.28 are taken forward for consideration against reference populations, PBR, PCoD and in the CIA.

Table 13.28: Species avoidance rates

Species	Avoidance rate
Grey seal	98%
Harbour seal	98%
Harbour porpoise	98%
Minke whale	95-98%
White-beaked dolphin	98%
Basking shark	95-98%

There is also uncertainty associated with the potential for a collision to result in fatality, and the potential physical effect of collision impacts on marine mammals is part of on-going Marine Scotland funded research by SMRU.

Given the uncertainties around this impact the sensitivity of all marine mammal species is assessed as medium, assuming the individual receptor has limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.

As stated previously, basking sharks have slow movements, and may be unaware of their surrounding when feeding or mating, as such there is a risk of collision. However, basking sharks when feeding focus on the near surface part of the water column, as they pursue their planktonic prey. As there will be a minimum surface clearance of 30m above the rotors within the AfL area, it is likely that basking shark, if in the area, will transit over the devices and not encounter the rotors. As such the sensitivity of this species to this impact considered to be medium.

Magnitude

As discussed in Section 13.8.2, the ERM based on work by the Scottish Association for Marine Science (SAMS) (Wilson *et al.* 2007) is deemed to be most appropriate to this assessment. For three-bladed unshrouded devices the SNH guidance (Band 2015) and spreadsheet (SNH 2015) were used for the ERM and for the shrouded Open Centre (OCT) devices a modified ERM based on the EMEC spreadsheet (EMEC 2014b) was used. To provide context to the ERM results, the outputs of CRM using the SNH (2015) model template are provided in Appendices 2 and 3.

The realistic worst case parameters used for each device types are outlined in Section 13.3.1 and Table 13.2. The species size, swim speeds, dive and surface times used in the ERM are presented in Table 13.29. Species densities used in the ERM are provided in Table 13.15. All density estimates outlined in Table 13.15 have been corrected for availability to take account of the probability of detecting animals on the transect line (known as g(0)) and therefore no further adjustments were made to these density estimates in the ERM or CRM.

Table 13.29: Species parameters used in the ERM and CRM (Appendices 2 and 3)

Species	Size		Mean swim speed	Mean dive time	Mean surface time
	Length	Effective radius			
Grey seal	1.86	0.42	1.8 (vertical swim speed 0.61m/s)	297	165
Harbour seal	1.41	0.34	1.8 (vertical swim speed 0.85m/s)	180	39.5
Harbour porpoise	1.48	0.32	1.4	26.2	3.9
Minke whale	8.8	2.2	2.1	87	3.5
Basking shark	7.0	1.7	1.0	42	1

Source: Band (2015)

Table 13.30 outlines the annual collision risk for a single unshrouded device for a range of avoidance rates, using the ERM, with the density estimates provided in Table 13.15. The ERM provides an estimate of less than one individual for each of the species assessed, based on a 98% avoidance rate for harbour porpoise, grey seal and harbour seal and 95-98% avoidance rate for minke whale and basking shark.

Appendix 1 provides annual encounter rates for unshrouded turbines, using the ERM, based on SCANS and SMRU seal density estimates, as requested by SNH to provide context to the results presented in Table 13.30. As discussed in Section 13.9 the SCANS and SMRU density estimates are shown to be approximately one to two orders of magnitude greater than the MeyGen, EMEC and BTAL site specific surveys and at a resolution of 25km^2 are too crude for the localised variation across Orkney. In addition, Appendices 2 and 3 provide annual collision risk using the CRM with density estimates provided in Table 13.15 provides a summary of density estimates and reference populations.

Table 13.15 (Appendix 2) as well as the SCANS/ SMRU density estimates (Appendix 3). As discussed in Section 13.8.2, ERM is deemed to be the more appropriate model for marine mammal collision risk compared with than CRM.

For the proposed Stage 1 development of 30 unshrouded devices, the estimated annual encounter rates using the avoidance rates provided in Table 13.28 are as follows (Table 13.31):

- Approximately three grey seal (0.014% of the reference population);
- Less than one harbour seal (0.023% of the reference population);
- Three harbour porpoise (0.001% of the reference population);
- Less than one minke whale (0.0006% of the reference population); and
- Less than one basking shark (unknown reference population).

This represents a low magnitude for harbour porpoise, negligible magnitude for minke whale and basking shark, and medium magnitude for grey seal and harbour seal.

For the proposed Stage 1 and Stage 2 development of 200 unshrouded devices, the estimated annual encounter rates using the avoidance rates provided in Table 13.28 are approximately (Table 13.31):

- 20 grey seals (0.096% reference population);
- Three harbour seals (0.151% of the reference population);
- 21 harbour porpoise (0.009% of the reference population);
- One minke whale (0.004% of the reference population); and
- Four basking shark (unknown reference population).

This represents a medium magnitude for grey seal and harbour seal, and low magnitude for harbour porpoise, minke whale and basking shark.

Table 13.30: Estimated annual encounter rates (using the ERM) (individuals/year) with and without avoidance for a single three-blade device (unshrouded)

Species	3 blade turbine					
	0% avoidance	50% avoidance	90% avoidance	95% avoidance	98% avoidance	99% avoidance
Grey seal	4.97	2.49	0.50	0.25	**0.099**	0.050
Harbour seal	0.73	0.37	0.07	0.04	**0.015**	0.007
Harbour porpoise	5.38	2.69	0.54	0.27	**0.108**	0.054
Minke whale	0.10	0.05	0.01	**0.005**	**0.002**	0.001
Basking shark	0.38	0.19	0.04	**0.02**	**0.008**	0.004

Table 13.31: Summary of estimated annual encounter rate (using the ERM) (individuals/year) with avoidance for three-blade unshrouded turbines

Species	Avoidance	1 turbine	30 turbines	200 turbines	30 turbines	200 turbines
		ERM for three-blade turbines			% Reference population	
Grey seal	98%	0.099	2.982	19.880	0.014%	0.096%
Harbour seal	98%	0.015	0.438	2.920	0.023%	0.151%
Harbour porpoise	98%	0.108	3.228	21.520	0.001%	0.009%
Minke whale	98-95%	0.002-0.005	0.06-0.15	0.4-1	0.0003-0.0006%	0.002-0.004%
Basking shark	98-95%	0.0076-0.019	0.228-0.57	1.52-3.8	N/A	N/A

Table 13.32 provides the estimated annual encounter rates for the OCT device using the modified ERM. The modelling shows that for one device, less than one individual for each of the species is predicted, based on a 98% avoidance rate for harbour porpoise, grey seal and harbour seal and 95-98% avoidance rate for minke whale and basking shark.

For the proposed Stage 1 development of 30 OCT devices, the estimated annual encounter rates using the avoidance rates provided in Table 13.28 are approximately (Table 13.33):

- Two grey seal (0.01% of the reference population);
- Less than one harbour seal (0.02% of the reference population);
- Three harbour porpoise (0.001% of the reference population);
- Less than one minke whale (0.0001% of the reference population); and
- Less than one basking shark (unknown reference population).

This represents a low magnitude for harbour porpoise, minke whale and basking shark, and medium magnitude for grey seal and harbour seal.

For the proposed Stage 1 and Stage 2 development of 200 OCT devices, the estimated annual encounter rates using the avoidance rates provided in Table 13.28 are approximately (Table 13.33):

- 14 grey seals (0.07% of the reference population);
- Two harbour seals (0.13% of the reference population);
- 18 harbour porpoise (0.008% of the reference population);
- Less than one minke whale (0.0007% of the reference population); and
- Less than one basking shark (unknown reference population).

This represents a low magnitude for harbour porpoise, minke whale and basking shark, and medium magnitude for grey seal and harbour seal.

Table 13.32: Estimated annual encounter rate (individuals/year) with and without avoidance for single open-centre turbine

Species	OCT					
	0% avoidance	50% avoidance	90% avoidance	95% avoidance	98% avoidance	99% avoidance
Grey seal	3.44	1.72	0.34	0.17	**0.07**	0.03
Harbour seal	0.62	0.31	0.06	0.03	**0.01**	0.01
Harbour porpoise	4.44	2.22	0.44	0.22	**0.09**	0.04
Minke whale	0.02	0.01	0.0017	**0.0008**	**0.0003**	0.0002
Basking shark	0.08	0.04	0.01	**0.004**	**0.0017**	0.0008

Table 13.33: Summary of estimated annual encounter rate (ERM) (individuals/year) with avoidance for shrouded turbines open centre turbines (OCT)

Species	Avoidance	1 turbine	30 turbines	200 turbines	30 turbines	200 turbines
			ERM for OCT		% Reference population	
Grey seal	98%	0.07	2.06	13.75	0.01%	0.07%
Harbour seal	98%	0.01	0.37	2.47	0.02%	0.13%
Harbour porpoise	98%	0.09	2.66	17.75	0.001%	0.008%
Minke whale	98-95%	0.0003-0.0008	0.01-0.024	0.06-0.16	0.0001%	0.0002-0.0007%
Basking shark	98-95%	0.0017-0.004	0.05-0.13	0.33-0.83	N/A	N/A

Under the Marine (Scotland) Act 2010, licences can be issued to shoot seals, e.g. for fish farm protection. The management of the maximum number of licences is controlled using the concept of Potential Biological Removal (PBR). PBR is the number of individual seals that can be removed from the population without causing a decline in the population and is calculated annually by SMRU using the latest seal counts. The most recent, 2015, grey seal PBR for the Orkney and North Coast MU is 1,240, with 220 licences granted and for harbour seal the PBR is 11, with no licences granted (Scottish Government, 2015). The results indicate that the Project is unlikely to result in potential collision risk which exceeds the PBR for either seal species.

There is ongoing discussion as to whether PBR is appropriate for use in potential collision risk as a strike may not result in a fatality. As discussed in Section 13.8.2.1, the interim PCoD has been developed as an approach for assessing and quantifying the potential consequences for marine mammal populations of any disturbance and/or injury that may result from offshore energy developments (Harwood *et al*. 2014).

The Interim PCoD was run for grey seal, harbour seal, harbour porpoise and minke whale (see Section 13.8.2.1) using the collision risk outlined in Table 13.31 and Table 13.33. Table 13.34 and Table 13.35 outline the predicted additional risk caused by the Project, comparing the predicted undisturbed population and the disturbed population based on 30 (Stage 1) and 200 (Stage 1 and 2) unshrouded devices (Table 13.34) as well as 30 and 200 OCT devices (Table 13.35). The results are presented as a probability (on a scale of 1 to 0, where 1 is 100% probability) of 1%, 2%, and 5% declines in the population at 1 year, 6 years, 12 years and 18 years after the installation of Stage 1 or Stage 1 and 2. All scenarios were run for 1000 simulations which can result in very small scale variations in the results. Appendix 5 provides the predicted probability of declines for the undisturbed population and the disturbed populations.

The results indicate that for all species and populations assessed, the probability of the array (Stage 1 or Stage 1 and 2) causing an additional risk of population decline is extremely low (Table 13.34 and Table 13.35).

Table 13.34: Predicted additional risk of population decline of Stage 1: 30 three-blade unshrouded devices and Stage 1 and 2: 200 three-blade unshrouded devices

Year	Stage 1: 30 three-blade unshrouded devices			Stage 1 and 2: 200 three-blade unshrouded devices		
	Probability of 1% decline	Probability of 2% decline	Probability of 5% decline	Probability of 1% decline	Probability of 2% decline	Probability of 5% decline
Grey seal Orkney and North coast population						
1	0.001	0	0	0.007	0.005	0
6	0.001	0	0	0.006	0.002	0
12	0	0	0	0.005	0	0
18	0.001	0	0	NA	NA	NA
Harbour seal Orkney and North coast population						
1	0	0	0	0.001	0.005	0.004
6	0	0	0	0	0	0.002
12	0	0	0	0	0	0
18	0	0	0	0	0	0
Harbour porpoise North Sea population						
1	0	0	0	0.001	0	0
6	0.001	0	0	0.002	0.002	0
12	0	0	0	0.001	0	0
18	0.001	0.001	0	0.002	0	0
Harbour porpoise West Scotland population						
1	0.001	0.001	0	0.005	0.008	0
6	0.001	0.003	0	0.021	0.013	0.001
12	0.005	0.005	0	0.018	0.013	0
18	0.005	0.002	0	0.029	0.01	0
Minke whale Celtic and Greater North Seas population						
1	0	0	0	0	0	0.001
6	0	0	0	0	0.001	0
12	0	0	0	0.001	0.001	0

Year	Stage 1: 30 three-blade unshrouded devices			Stage 1 and 2: 200 three-blade unshrouded devices		
	Probability of 1% decline	Probability of 2% decline	Probability of 5% decline	Probability of 1% decline	Probability of 2% decline	Probability of 5% decline
18	0	0	0	0	0	0

Table 13.35: Predicted additional risk of population decline of Stage 1: 30 OCT devices and Stage 1 and 2: 200 OCT devices

Year	Stage 1: 30 OCT devices			Stage 1 and 2: 200 OCT devices		
	Probability of 1% decline	Probability of 2% decline	Probability of 5% decline	Probability of 1% decline	Probability of 2% decline	Probability of 5% decline
Grey seal Orkney and North coast population						
1	0.001	0.001	0	0.005	0	0
6	0	0.001	0	0.006	0	0
12	0	0	0	0.005	0	0
18	0	0	0	0	0	0
Harbour seal Orkney and North coast population						
1	0	0	0	0.001	0.006	0.003
6	0	0	0	0	0	0.003
12	0	0	0	0	0	0
18	0	0	0	0	0	0
Harbour porpoise North Sea population						
1	0	0	0	0.002	0.001	0
6	0	0	0	0.001	0.001	0
12	0.001	0	0	0.002	0	0
18	0	0	0	0.002	0	0
Harbour porpoise West Scotland population						
1	0	0	0	0.002	0.004	0.001
6	0	0.001	0	0.018	0.007	0
12	0.003	0.001	0	0.023	0.013	0
18	0.002	0	0	0.027	0.011	0
Minke whale Celtic and Greater North Seas population						
1	0	0	0	0	0	0
6	0	0	0	0	0	0
12	0	0	0	0	0	0
18	0	0	0	0	0	0

Summary of Residual Effects

Table 13.36 summarises the residual effects.

Table 13.36: Collision with devices impact significance during operation

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Unshrouded 3-blade or Shrouded OCT	Harbour porpoise	Medium	No specific mitigation suggested. A monitoring programme will be agreed with SNH and MS. This will form an adaptive management plan allowing mitigation to be implemented if required. GM04 GM14	Low for Stage 1 and Stage 1 & 2	Minor for Stage 1 and Stage 1 & 2
Unshrouded 3-blade or Shrouded OCT	Grey seal	Medium		Medium for Stage 1 and Stage 1 & 2	Moderate for Stage 1 and Stage 1 & 2
Unshrouded 3-blade or Shrouded OCT	Harbour seal	Medium		Medium for Stage 1 and Stage 1 & 2	Moderate for Stage 1 and Stage 1 & 2
Unshrouded 3-blade or Shrouded OCT	Minke whale	Medium		Negligible for Stage 1 And Low for Stage 1 & 2	Minor for Stage 1 and Stage 1 & 2
Unshrouded 3-blade or Shrouded OCT	Basking shark	Medium		Negligible for Stage 1 and Low for Stage 1 & 2	Minor for Stage 1 and Stage 1 & 2

There is a medium to low level of confidence in this assessment based on the lack of available evidence which shows an understanding of the potential physical interactions between marine mammals and operational rotors. The approach taken is deemed to be conservative.

13.12.2.3 Collision with Vessels

Sensitivity

As described in Section 13.12.1.2, cetaceans, grey seal and harbour seal in the study area are assessed as having medium sensitivity to the potential risk of collision with vessels, basking shark are deemed to have high sensitivity.

Magnitude

As described in Section 13.3 and in Chapter 15 Shipping and Navigation, the Project shipping survey shows levels of existing shipping activity of 25 unique vessels per day in winter 2013, and 21 per day in summer 2014 on average. The largest proportion of these was cargo vessels and tankers using the Outer Sound of the Pentland Firth and passing south of the AfL area.

During the Project O&M there is likely to be one vessel on site each day, on average. While working on maintenance activities, vessels will be stationary or very slow moving and so pose minimal collision risk to marine mammals and basking shark. During O&M one return trip between the selected port and the AfL area is expected per day. In the context of the existing vessel traffic, this level of increase would represent a negligible magnitude of effect for marine mammals and basking shark.

Summary of Residual Effects

Table 13.37 summarises the residual effects.

Table 13.37: Collision with vessels impact significance during operation

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Maintenance of all devices and hubs	Small cetaceans	Medium	Vessel Management Plan to standardise BTAL traffic routes and speeds to and from the AfL area GM07	Negligible	Negligible
	Grey and harbour seal	Medium		Negligible	Negligible
	Minke whale	High		Negligible	Minor
	Basking shark	High		Negligible	Minor

There is a medium level of confidence in this assessment, based on the evidence used to assess the sensitivity of marine mammals and basking shark to this type of impact and the levels of predicted Project vessel traffic in relation to existing vessel data.

13.12.2.4 Electromagnetic Fields

Sensitivity

It has been hypothesised that the Earth's magnetic fields are used in the navigation system of some marine species, therefore there may be potential for marine mammals to exhibit behavioural changes, including displacement due to the presence of electromagnetic fields (EMF) around subsea cables (Gill *et al.* 2005). There is currently limited information on this effect but it is widely believed that marine mammals use the geomagnetic field of the earth to navigate during long distance migrations (Kirschvink *et al.* 1986, Klinowska 1985, Normandeau *et al*. 2011).

Buchanan *et al*. (2011) report that cetaceans appear able to use geomagnetic cues for navigation, citing several studies that have correlated mass strandings with anomalies originating from solar storms. However, they also highlight other studies which show no consistent pattern in geomagnetic anomalies and mass strandings. Murphy *et al.* (2012) summarise the state of understanding as there being no evidence to suggest that seals are sensitive to electromagnetic fields but that some large whale species appear to use variations in the geomagnetic field to navigate.

Gill *et al.* (2005) report the harbour porpoise, bottlenose dolphin and other small dolphins are potentially responsive to fields from subsea electrical transmission cabling, however there is also, at present, little evidence to suggest that existing subsea cables have significantly influenced cetacean movements. Harbour porpoise move in and out of the Baltic Sea, with several crossings over operating subsea high voltage direct current cables in the Skagerrak and western Baltic Sea without any apparent effect on their migration pattern. While it is possible that some of the species found at the site may make some limited use of magnetic fields for navigation, even if only to a limited degree, Buchanan *et al*. (2011) comment that it is highly likely that these fields would be one of only a range of cues used to navigate (e.g. sun angle, olfactory, current strength). There is no evidence that pinnipeds respond to EMF and, therefore, marine mammal sensitivity is deemed to be low.

Elasmobranchs are the species group that is considered to be the most electro-sensitive. These species naturally detect bioelectric emissions from prey, conspecifics and potential predators and competitors (Gill *et al.* 2005). They are also known to detect magnetic fields. Laboratory and field experiments using AC cables of the type used by the offshore renewable energy industry showed that EMF emitted was within the range of detection by electro sensitive species such as elasmobranchs. It was not possible to determine whether the EMF emitted from the power cables had a direct impact on the species used (Gill & Taylor 2001, Gill *et al.* 2005, Gill *et al.* 2009, CMACS 2004).

It has been speculated that elasmobranchs may be confused by anthropogenic E field sources that lie within similar ranges to natural bioelectric fields. Laboratory behavioural studies have demonstrated both AC and DC artificial electric fields stimulating feeding responses in elasmobranchs (Kalmijn 1982, Tricas & Sisneros 2004, Kimber *et al.* 2011). Information gathered as part of the monitoring programme at the Burbo Bank offshore wind farm suggested that certain elasmobranch species feed inside the windfarm and demonstrated that they are not excluded during periods of low power generation (Cefas 2009). Monitoring at the Kentish Flats offshore wind farm found an increase in elasmobranchs during post-construction surveys in comparison to surveys before construction. There appeared to be no discernible difference however, between the data for the windfarm and reference areas in terms of changes to population structure and it was concluded that the population increase observed was unlikely to be related to the operation of the windfarm (Cefas 2009).

At worst, any EMF-related effects are therefore only expected to result in very small scale behavioural reactions rather than to cause a barrier to migration or result in impacts upon feeding or confusion in elasmobranch species and so basking shark sensitivity is deemed to be low.

Magnitude

As described in Chapter 5 Project Description the inter-array cabling will have a voltage of 33kV with up to 208 inter-array cables between the devices covering an area of approximately 0.36km^2 (width 0.0005km (0.5m) and length 720km). This represents around 3% of the AfL area for the Stage 1 and 2 combined. The cables will be shielded to meet industry standards.

In addition to the inter-array cables, it is anticipated that up to 16 export cables (four for Stage 1 and 12 for Phase 2) may be required to connect the tidal array to shore. Each cable will have a voltage of up to 132kV. The export cables will be surface laid as much of the seabed within the AfL area and along proposed export cable routes comprises hard rock substrate limiting cable burial. The subsea export cables will be shielded to meet industry standards. The maximum cable route (to the Aith Hope landfall option) is approximately 6.5km.

For AC cables rated between 33kV and 132kV iE fields which could cause avoidance in electro-sensitive species are not expected. Such iE fields are only expected to occur up to a maximum of 1m from the cable surface of 220kV and 275kV HVAC cables and will therefore not impact on marine mammals and basking shark transiting in the water column (Gill *et* *al.* (2005). The EMF levels emitting into the water column from these low voltage cables over relatively short distances are therefore likely to be of negligible magnitude.

Summary of Residual Effects

Table 13.38 summarises the residual effects.

Table 13.38: EMF impact significance during operation

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
1MW devices x 200 and subsea hubs	Marine mammals	Negligible	None suggested	Negligible		Negligible
	Basking shark	Medium		Negligible		Minor

There is a high level of confidence in this assessment based on the evidence used to assess the sensitivity of marine mammals and basking shark to the type of cables which may be used at the Project site.

13.12.2.5 Disturbance at Haul Out Sites

Sensitivity

As described in Section 13.10.1, the sensitivity of seals in the study area is deemed to be low, due to the absence of important haul out sites in close proximity to the site.

Magnitude

The works associated with O&M will be more limited compared with the construction phase, with low level vessel activity (approximately one vessel on site each day).

Due to the low levels of activity and predicted noise, the magnitude is predicted to be negligible.

Summary of Residual Effects

Table 13.39 summarises the residual effects.

Table 13.39: Disturbance to haul out sites impact significance during operation

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
All devices and hubs	Harbour and grey seal	Low	Routing of maintenance vessels to avoid designated haul out sites GM07	Negligible		Negligible

There is high confidence in this assessment based on the known distance to the designated haul out sites from the AfL.

13.12.2.6 Indirect Effects on Prey Species

Sensitivity

As described in Section 13.12.1.4, harbour porpoise, harbour seal and basking shark are assessed as having medium sensitivity to the potential indirect impact associated with changes to prey availability, grey seal, white-beaked dolphin and minke whale are deemed to have low sensitivity.

Magnitude

Chapter 12 Fish Ecology outlines a worst case scenario impact of minor consequence on species that could be prey for marine mammals. This impact is anticipated to be localised around the AfL area and is likely to be primarily displacement which marine mammals can track rather than a decline in prey availability within the wider study area. The magnitude of the effect on marine mammals is therefore deemed to be negligible.

There is no known mechanism for the installation works to have a discernible impact on plankton and therefore there will be no impact on basking shark prey resource.

Summary of Residual Effects

Table 13.40 summarises the residual effects.

Table 13.40: Changes to prey resource impact significance during operation

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
Gravity bases - habitat loss, Drilled pin pile tripod - smothering and Drilled monopile - noise	Harbour seal	Medium	No specific suggested mitigation	Negligible		Minor
	Harbour porpoise	Medium		Negligible		Minor
	Basking shark	Medium		Negligible		Minor
	Grey seal	Low		Negligible		Negligible
	Minke whale	Low		Negligible		Negligible
	White-beaked dolphin	Low		Negligible		Negligible

There is a high level of confidence in this assessment based on the evidence used to assess the sensitivity of marine mammals to this type of impact and the small scale potential impacts on prey species.

13.12.3 Impacts during Decommissioning

13.12.3.1 Underwater Noise

Sensitivity

As described in Section 13.12.1.1, the sensitivity of harbour porpoise, minke whale and white beaked dolphin is assessed as medium, and the sensitivity of harbour, grey sea and basking shark is low.

Magnitude

Supporting Document: Xodus (2015) provides noise modelling for predicted noise sources during decommissioning. This includes the vessels associated with decommissioning.

As described previously, the modelled noise ranges do not take into account existing noise in the environment, including anthropogenic noise from vessels (e.g. ferries) as well as the high natural noise sources present in areas of high tidal currents. Consequently, the predicted ranges for onset of disturbance during operation are considered to be highly precautionary and exceeding the criteria for potential onset of disturbance effects does not in itself mean that disturbance will necessarily occur.

As described previously, there is no known reference population for basking shark and the sightings data are too low to determine a density estimate for white-beaked dolphin. In addition, Supporting Document: Xodus (2015) outlines the low level of available data for disturbance effects for fish, including elasmobranchs and so no quantitative noise modelling is available. These species are therefore considered qualitatively, with input from the noise modelling where possible.

Table 13.41: Underwater noise impact areas and estimated number of animals disturbed based on greatest area of potential disturbance during decommissioning

Species	Mean density estimate (per km^2)	Avoidance area (km^2)	Estimated mean number of animals potentially disturbed
Grey seal	0.090	616	55.44
Harbour seal	0.020	616	12.32
Harbour porpoise	0.137	616	84.39
White-beaked dolphin	No. sightings too low	616	Unknown
Minke whale	0.001	616	0.62
Basking shark	0.001	Unknown	Unknown

Table 13.41 estimates the number of animals disturbed by noise based on the greatest area of potential disturbance and Table 13.42 outlines the percentage of the reference population potentially disturbed and the resultant magnitude of the effect, along with a summary of the sensitivity of each species. As basking shark are described as occasional visitors to the area, any disturbance effects are likely to be of negligible magnitude. Likewise, as the numbers of white-beaked dolphin in the study area are too low to determine density estimates the magnitude of potential disturbance is deemed to be negligible.

Table 13.42: Potential percentage of the reference population disturbed by underwater noise

Species	Sensitivity	Reference population	Estimated mean number of animals disturbed	Percentage of reference population	Magnitude
Grey seal	Low	20,682	55.44	0.268	Negligible
Harbour seal	Low	1,938	12.32	0.636	Negligible
Harbour porpoise	Medium	227,298	84.39	0.037	Negligible
White-beaked dolphin	Medium	15.895	Unknown	Unknown	Negligible
Minke whale	Medium		0.62	0.003	Negligible
Basking shark	Low	Unknown	Unknown	Unknown	Negligible

Summary of Residual Effects

Table 13.43 summarises the residual effects.

Table 13.43 Underwater noise impact significance during decommissioning

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Decommissioning of unshrouded devices – increased vessels	Grey seal	Low	None suggested	Negligible	Negligible
	Harbour seal	Low		Negligible	Negligible
	Harbour porpoise	Medium		Negligible	Minor
	White-beaked dolphin	Medium		Negligible	Minor
	Minke whale	Medium		Negligible	Minor
	Basking shark	Low		Negligible	Negligible

As with the installation, the worst case scenario is based on the decommissioning of unshrouded device types, which would require the greater number of vessels and therefore greatest potential disturbance from underwater noise. The decommissioning of shrouded devices, such as the Open Hydro device, would require fewer vessels and therefore the potential for disturbance from underwater noise would be lower.

There is a medium level of confidence in this assessment, based on the levels of predicted increased underwater noise during decommissioning of the proposed Project in relation to existing underwater noise in the area.

13.12.3.2 Collision with Vessels

Sensitivity

As described in Section 13.12.1.2, cetaceans, grey seal and harbour seal in the study area are assessed as having medium sensitivity to the potential risk of collision with vessels, basking shark are deemed to have high sensitivity.

Magnitude

As described in Section 13.3 and in Chapter 15 Shipping and Navigation, the shipping survey shows levels of existing shipping activity of 25 unique vessels per day in winter 2013, and 21 per day in summer 2014 on average.

The Project decommissioning process will involve similar vessel types and movements to the construction process and is therefore expected to be of negligible magnitude for all other marine mammals and basking shark.

Summary of Residual Effects

Table 13.44 summarises the residual effects.

Table 13.44: Collision with vessels impact significance during decommissioning

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Residual Significance
Unshrouded devices	Cetaceans	Medium	Vessel Management Plan to standardise BTAL traffic routes and speeds to and from the AfL area GM07	Negligible	Minor
Unshrouded devices	Grey seal	Medium		Negligible	Minor
Unshrouded devices	Harbour seal	Medium		Negligible	Minor
Unshrouded devices	Basking shark	High		Negligible	Minor

As with the installation, the decommissioning worst case scenario for the number of vessels movements during construction is based on the unshrouded device types. The decommissioning process for these device types is anticipated to be in two parts, foundations and then turbine. This requires more vessel movements than installing a device as one unit which is the expected process for installation of shrouded devices, such as the Open Hydro device. The potential impact associated with this will therefore be less magnitude, with the impact significance remaining minor.

There is a medium level of confidence in this assessment, based on the evidence used to assess the sensitivity of marine mammals and basking shark to this type of impact and the levels of predicted vessel traffic in relation to existing vessel data.

13.13 ACCIDENTAL AND UNPLANNED EVENTS

13.13.1 Accidental Contamination from Vessels during Construction, O&M, and Decommissioning

13.13.1.1 Sensitivity

There is potential for accidental release of contaminates in all phases of the Project, although it should be noted that vessel management plans and other measures in the Project Environmental Management Plan (PEMP) are designed to limit the potential for this impact occurring, and provide measures for managing any spillage should an incident occur.

Should an incident occur, the mobile nature of marine mammal and basking shark means that they are likely to be able to avoid the area, and contaminants may be rapidly dispersed in the high energy environment. Accumulation of contamination, such as oil may occur on beaches, provides a greater risk to hauled-out and breeding seals. As such harbour and grey seal are assessed as having medium sensitivity to this impact, and cetaceans and basking shark are assessed as having low sensitivity.

13.13.1.2 Magnitude

For the purpose of the assessment, vessel fuel inventory is based on the amount of marine diesel carried on board a standard large DP installation vessel. Large DP vessels carry between 6,000,000 and 8,000,000 litres of marine diesel in a number of separate tanks. The worst case scenario for assessing accidental spillages of fuel from vessels is to assume leakage of one tank of approximately 600,000 litres of marine diesel. Hydrocarbon based spills can have a range of environmental impacts which will vary depending on a factors such as, the volume, tidal currents, sea state and weather conditions at the time of the spill. Any spill would be rapidly dispersed and the risk of such a spill occurring is considered to be very low due to the safety procedures in place to avoid such an incident (see Chapter 15 Shipping and Navigation), therefore the magnitude of this potential impact is considered to be low.

13.13.1.3 Summary of Residual Effects

Table 13.45 summarises the residual effects.

Table 13.45: Accidental contamination impact significance during construction, O&M and decommissioning

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
All devices	Harbour and grey seal	Medium	General mitigation vessel management and pollution prevention GM07, GM05	Low		Minor
	Cetaceans and basking shark	Low		Low		Negligible

13.13.2 Accidental Contamination from Devices

13.13.2.1 Sensitivity

As described in Section 13.13.1, cetaceans and basking shark are assessed as having low sensitivity due to their mobile and likely ability to avoid the area. Harbour and grey seal are assessed as having medium sensitivity to this impact due to potential that haul out sites could become contaminated.

13.13.2.2 Magnitude

Lubricants, oils and other liquids used in the device operation include mineral oil, grease, hydraulic fluid, low toxicity biodegradable oil, and biodegradable ethanol. The total volume of liquids could be up to 1,000 litres per device. Under normal operation there is no pathway for these substances to enter the marine environment and so any spillage would be the result of a serious incident involving a tidal device. Chapter 15 Shipping and Navigation describes the safety procedures that will be in place to avoid any incidents and therefore the likelihood of accidental contamination is very low and the magnitude is assessed as low.

13.13.2.3 Summary of Residual Effects

Table 13.46 summarises the residual effects.

Table 13.46: Accidental contamination from devices during operation impact significance

Technology Option	Receptor	Sensitivity	Mitigation	Residual Magnitude	Summary	Residual Significance
All devices	Harbour and grey seal	Medium		Low		Minor
	Cetaceans and basking shark	Low		Low		Negligible

13.14 SUMMARY

- Key species that occur in the study area and have been included in the impact assessment are:
  - Grey seal;
  - Harbour (common) seal;
  - Harbour porpoise;
  - White beaked dolphin;
  - Minke whale; and
  - Basking shark.
- The existing environment for these species was characterised by two years of boat based surveys, supplemented with additional, available information.
- The following potential impacts have been assessed:
  - Underwater noise during construction, O&M, and decommissioning;
  - Collision with vessels during construction, O&M, and decommissioning;
  - Collision with tidal devices during operation;
  - Disturbance at haul out sites during construction, O&M, and decommissioning;
  - Indirect effect as a result of changes to prey resource during construction, O&M, and decommissioning;
  - Accidental contamination from vessels or devices during construction, O&M, and decommissioning; and
  - Disturbance to navigation from Electromagnetic Fields emitted from the export or inter-array cables.
- The following impacts were found to be potentially significant with all others deemed to be non-significant:
  - Grey seal and harbour seal potential collision risk with tidal turbines for Stage 1 (interim total of 30 turbines) as well as Stages 1 & 2 (combined total of 200 turbines); and
- BTAL will agree mitigation and monitoring measures with relevant stakeholders pre-construction once the final details of the Project design are known. This will be done through the development of a Project Environmental Management Plan (PEMP) which is likely to include the following components, of relevance to marine mammals:
  - Marine Mammal Management Plan (MMMP);
  - Pollution Control Plan; and
  - Vessel Management Plan (VMP).

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APPENDIX 1 – ERM RESULTS INCORPORATING THE SMRU SEAL DENSITY ESTIMATES AND SCANS CETACEAN DENSITY ESTIMATES

This appendix provides the collision risk results for a single 3-bladed unshrouded device using ERM based on contextual marine mammal density estimates

Table 13.47: Estimated annual collision risk (using the ERM) (individuals / year) with and without avoidance for a single three-blade device (unshrouded)

Species	3 blade turbine					
	0% avoidance	50% avoidance	90% avoidance	95% avoidance	98% avoidance	99% avoidance
Grey seal	114.40	57.20	11.44	5.72	**2.288**	1.144
Harbour seal	54.25	27.13	5.43	2.71	**1.085**	0.543
Harbour porpoise	10.75	5.38	1.08	0.54	**0.215**	0.108
Minke whale	10.27	5.14	1.03	**0.51**	**0.205**	0.103

*There are no contextual density estimates available for basking shark and therefore these are not included.

Table 13.48: Summary of estimated annual collision risk (using the CRM) (individuals / year) with avoidance for three-blade unshrouded turbines

Species	Avoidance	1 turbine	30 turbines	200 turbines	30 turbines	200 turbines
		ERM for three-blade turbines			% Reference population	
Grey seal	98%	2.288	68.64	457.6	0.33%	2.21%
Harbour seal	98%	1.085	32.55	217.0	1.68%	11.20%
Harbour porpoise	98%	0.215	6.45	43.0	0.003%	0.019%
Minke whale	98-95%	0.205-0.51	6.16-15.41	41.08-102.7	0.026-0.065%	0.175-0.437%

*There are no contextual density estimates available for basking shark and therefore these are not included.

APPENDIX 2 – CRM RESULTS USING THE DENSITY ESTIMATES PROVIDED IN TABLE 13.5

Table 13.49: Estimated annual collision risk (using the CRM) (individuals / year) with and without avoidance for a single three-blade device (unshrouded)

Species	3 blade turbine					
	0% avoidance	50% avoidance	90% avoidance	95% avoidance	98% avoidance	99% avoidance
Grey seal	7.80	3.90	0.78	0.39	**0.156**	0.078
Harbour seal	1.09	0.55	0.11	0.05	**0.022**	0.011
Harbour porpoise	8.18	4.09	0.82	0.41	**0.164**	0.082
Minke whale	0.10	0.05	0.01	**0.005**	**0.002**	0.001
Basking shark	0.40	0.20	0.04	**0.02**	**0.008**	0.004

Table 13.50: Summary of estimated annual collision risk (using the CRM) (individuals / year) with avoidance for three-blade unshrouded turbines

Species	Avoidance	1 turbine	30 turbines	200 turbines	30 turbines	200 turbines
		ERM for three-blade turbines			% Reference population	
Grey seal	98%	0.156	4.68	31.20	0.02%	0.15%
Harbour seal	98%	0.022	0.65	4.36	0.03%	0.23%
Harbour porpoise	98%	0.164	4.91	32.72	0.002%	0.014%
Minke whale	98-95%	0.002-0.005	0.06-0.15	0.4-1	0.0003-0.0006%	0.0017-0.004%
Basking shark	98-95%	0.008-0.02	0.24-0.6	1.6-4	N/A	N/A

APPENDIX 3 – CRM RESULTS INCORPORATING THE SMRU SEAL DENSITY ESTIMATES AND SCANS CETACEAN DENSITY ESTIMATES

Table 13.51: Estimated annual collision risk (using the CRM) (individuals / year) with and without avoidance for a single three-blade device (unshrouded)

Species	3 blade turbine					
	0% avoidance	50% avoidance	90% avoidance	95% avoidance	98% avoidance	99% avoidance
Grey seal	179.70	89.85	17.97	8.99	**3.594**	1.797
Harbour seal	81.00	40.50	8.10	4.05	**1.620**	0.810
Harbour porpoise	16.35	8.18	1.64	0.82	**0.327**	0.164
Minke whale	7.70	3.85	0.77	**0.39**	**0.154**	0.077

*There are no contextual density estimates available for basking shark and therefore these are not included.

Table 13.52: Summary of estimated annual collision risk (using the CRM) (individuals / year) with avoidance for three-blade unshrouded turbines

Species	Avoidance	1 turbine	30 turbines	200 turbines	30 turbines	200 turbines
		ERM for three-blade turbines			% Reference population	
Grey seal	98%	3.59	107.82	718.8	0.521%	3.476%
Harbour seal	98%	1.62	48.60	324.0	2.507%	16.718%
Harbour porpoise	98%	0.33	9.81	65.4	0.004%	0.029%
Minke whale	98-95%	0.154-0.39	4.62-11.55	30.8-77.0	0.02-0.05%	0.131-0.327%

*There are no contextual density estimates available for basking shark and therefore these are not included.

APPENDIX 4 – OCT MODIFIED ERM RESULTS INCORPORATING THE SMRU SEAL DENSITY ESTIMATES AND SCANS CETACEAN DENSITY ESTIMATES

Table 13.53: Estimated annual collision risk (using the ERM) (individuals / year) with and without avoidance for a single three-blade device (unshrouded)

Species	3 blade turbine					
	0% avoidance	50% avoidance	90% avoidance	95% avoidance	98% avoidance	99% avoidance
Grey seal	79.04	39.52	7.90	3.95	**1.581**	0.790
Harbour seal	45.96	22.98	4.60	2.30	**0.919**	0.460
Harbour porpoise	8.87	4.44	0.89	0.44	**0.177**	0.089
Minke whale	1.70	0.85	0.17	**0.09**	**0.034**	0.017

*There are no contextual density estimates available for basking shark and therefore these are not included.

Table 13.54: Summary of estimated annual collision risk (using the CRM) (individuals / year) with avoidance for three-blade unshrouded turbines

Species	Avoidance	1 turbine	30 turbines	200 turbines	30 turbines	200 turbines
		ERM for three-blade turbines			% Reference population	
Grey seal	98%	1.581	47.424	316.160	0.229%	1.529%
Harbour seal	98%	0.919	27.576	183.840	1.423%	9.486%
Harbour porpoise	98%	0.177	5.322	35.480	0.002%	0.016%
Minke whale	98-95%	0.034-0.09	1.02-2.55	6.8-17	0.004-0.011%	0.029-0.072%

*There are no contextual density estimates available for basking shark and therefore these are not included.

APPENDIX 5 – INTERIM PCOD PREDICTED RISK OF POPULATION DECLINE FOR UNDISTURBED AND DISTURBED POPULATIONS

This appendix provides the predicted probabilities of population declines for undisturbed populations and disturbed populations based on the following scenarios:

- Phase 1: 3-blade unshrouded devices Table 13.55
- Phase 1 and 2: 3-blade unshrouded devices Table 13.56
- Phase 1: Shrouded OCT devices Table 13.57
- Phase 1 and 2: Shrouded OCT devices Table 13.58

Table 13.55: Predicted probabilities of population decline for undisturbed populations and disturbed populations based on Phase 1 of 30 three-blade unshrouded devices (on a probability scale of 0 to 1)

Year	Undisturbed			Disturbed		
	Probability of 1% decline	Probability of 2% decline	Probability of 5% decline	Probability of 1% decline	Probability of 2% decline	Probability of 5% decline
Grey seal Orkney and North coast population						
1	0.187	0.107	0.012	0.188	0.107	0.012
6	0.047	0.01	0	0.048	0.01	0
12	0.009	0	0	0.009	0	0
18	0.003	0	0	0.004	0	0
Harbour seal Orkney and North coast population						
1	0.929	0.82	0.364	0.929	0.82	0.364
6	1	1	0.954	1	1	0.954
12	1	1	1	1	1	1
18	1	1	1	1	1	1
Harbour porpoise North Sea population						
1	0.313	0.188	0.043	0.313	0.188	0.043
6	0.262	0.121	0.004	0.263	0.121	0.004
12	0.227	0.059	0	0.227	0.059	0
18	0.213	0.039	0	0.214	0.04	0
Harbour porpoise West Scotland population						
1	0.273	0.183	0.048	0.274	0.184	0.048
6	0.283	0.135	0.006	0.284	0.138	0.006
12	0.242	0.094	0.002	0.247	0.099	0.002
18	0.211	0.047	0	0.216	0.049	0
Minke whale Celtic and Greater North Seas population						
1	0.32	0.216	0.038	0.32	0.216	0.038
6	0.251	0.064	0	0.251	0.064	0
12	0.152	0.013	0	0.152	0.013	0
18	0.11	0.003	0	0.11	0.003	0

Table 13.56: Predicted probabilities of population decline for undisturbed populations and disturbed populations based on Phase 1 and 2 of 200 three-blade unshrouded devices (on a probability scale of 0 to 1)

Year	Undisturbed			Disturbed		
	Probability of 1% decline	Probability of 2% decline	Probability of 5% decline	Probability of 1% decline	Probability of 2% decline	Probability of 5% decline
Grey seal Orkney and North coast population						
1	0.178	0.097	0.007	0.185	0.102	0.007
6	0.051	0.006	0	0.057	0.008	0
12	0.015	0.002	0	0.02	0.002	0
18	NA	NA	NA	0.008	0	0
Harbour seal Orkney and North coast population						
1	0.931	0.819	0.336	0.932	0.824	0.34
6	1	1	0.962	1	1	0.964
12	1	1	1	1	1	1
Harbour porpoise North Sea population						
1	0.316	0.209	0.047	0.317	0.209	0.047
6	0.275	0.131	0.002	0.277	0.133	0.002
12	0.235	0.066	0	0.236	0.066	0
18	0.2	0.039	0	0.202	0.039	0
Harbour porpoise West Scotland population						
1	0.309	0.205	0.046	0.314	0.213	0.046
6	0.265	0.124	0.005	0.286	0.137	0.006
12	0.23	0.062	0	0.248	0.075	0
18	0.19	0.041	0	0.219	0.051	0
Minke whale Celtic and Greater North Seas population						
1	0.329	0.199	0.036	0.329	0.199	0.037
6	0.243	0.075	0	0.243	0.076	0
12	0.16	0.017	0	0.161	0.018	0
18	0.119	0	0	0.119	0	0

Table 13.57: Predicted probabilities of population decline for undisturbed populations and disturbed populations based on Phase 1 of 30 shrouded OCT devices (on a probability scale of 0 to 1)

Year	Undisturbed Probability of 1% decline	Probability of 2% decline	Probability of 5% decline	Disturbed Probability of 1% decline	Probability of 2% decline	Probability of 5% decline
Grey seal Orkney and North coast population						
1	0.2	0.1	0.014	0.201	0.101	0.014
6	0.049	0.005	0	0.049	0.006	0
12	0.012	0	0	0.012	0	0
18	0.004	0	0	0.004	0	0
Harbour seal Orkney and North coast population						
1	0.929	0.82	0.364	0.929	0.82	0.364
6	1	1	0.954	1	1	0.954
12	1	1	1	1	1	1
18	1	1	1	1	1	1
Harbour porpoise North Sea population						
1	0.329	0.228	0.042	0.329	0.228	0.042
6	0.337	0.155	0.007	0.337	0.155	0.007
12	0.247	0.076	0	0.248	0.076	0
18	0.21	0.054	0	0.21	0.054	0
Harbour porpoise West Scotland population						
1	0.301	0.21	0.04	0.301	0.21	0.04
6	0.297	0.137	0.004	0.297	0.138	0.004
12	0.231	0.075	0	0.234	0.076	0
18	0.189	0.042	0	0.191	0.042	0
Minke whale Celtic and Greater North Seas population						
1	0.32	0.218	0.046	0.32	0.218	0.046
6	0.252	0.072	0	0.252	0.072	0
12	0.151	0.019	0	0.151	0.019	0
18	0.113	0.005	0	0.113	0.005	0

Table 13.58: Predicted probabilities of population decline for undisturbed populations and disturbed populations based on Phase 1 and 2 of 200 shrouded OCT devices (on a probability scale of 0 to 1)

Year	Undisturbed Probability of 1% decline	Probability of 2% decline	Probability of 5% decline	Disturbed Probability of 1% decline	Probability of 2% decline	Probability of 5% decline
Grey seal Orkney and North coast population						
1	0.2	0.107	0.012	0.195	0.107	0.012
6	0.06	0.012	0	0.054	0.012	0
12	0.022	0.002	0	0.017	0.002	0
18	0.006	0.001	0	0.006	0.001	0
Harbour seal Orkney and North coast population						
1	0.93	0.817	0.341	0.931	0.823	0.344
6	1	1	0.959	1	1	0.962
12	1	1	1	1	1	1
18	1	1	1	1	1	1
Harbour porpoise North Sea population						
1	0.307	0.198	0.04	0.309	0.199	0.04
6	0.263	0.113	0.001	0.264	0.114	0.001
12	0.221	0.06	0	0.223	0.06	0
18	0.176	0.035	0	0.178	0.035	0
Harbour porpoise West Scotland population						
1	0.315	0.208	0.038	0.317	0.212	0.039
6	0.322	0.155	0.003	0.34	0.162	0.003
12	0.26	0.081	0	0.283	0.094	0
18	0.217	0.055	0	0.244	0.066	0
Minke whale Celtic and Greater North Seas population						
1	0.32	0.218	0.046	0.32	0.218	0.046
6	0.252	0.072	0	0.252	0.072	0
12	0.151	0.019	0	0.151	0.019	0
18	0.113	0.005	0	0.113	0.005	0

Ornithology

Chapter 14

14 ORNITHOLOGY

14.1 INTRODUCTION

This chapter of the Environmental Statement (ES) considers the potential effects of the proposed Brims Tidal Array Project (the Project) on seabird populations that are predicted to occur through the construction & installation, operation & maintenance (O&M), and decommissioning phases.This technical chapter has been completed by Natural Research (Projects) Limited (NRP) and complements the separate evaluation of potential ecological effects in Chapter 11 Coastal and Terrestrial Ecology, Chapter 12 Fish Ecology, Chapter 11 Benthic Ecology and Chapter 13 Marine Mammals.

The chapter set outs the methods that are used and summarises the baseline conditions as determined by a two-year programme of commissioned boat-based surveys. The types of potential impacts on birds arising from the Project are described and their magnitude and significance under the EIA regulations are evaluated. An assessment of the cumulative impacts resulting from the Project acting together with the impacts from other developments that potentially affect the same bird receptor populations is also presented. The chapter will cover all components of the Project seaward of the Mean High Water Spring (MHWS).

The chapter is informed by three Supporting Documents:

- Seabirds Technical Report (Supporting Document: NRP, 2015a);
- Collision Risk to Diving Seabirds (Supporting Document: NRP, 2015b); and,
- Distance sampling analyses of ESAS survey results for the Project (Supporting Document: Caloo, 2015).

The results of Habitats Regulations Assessment in which the impacts on Natura 2000 and Ramsar sites designated for birds are presented separately in the 'Information to Support the HRA' Report. References to SPAs in the EIA are used for context only.

14.1.1 Study Area

The Project survey area, directly to the south of the island of Hoy in the Pentland Firth, consists of the area surveyed during the two-year programme of baseline seabird surveys, encompassing the Agreement for Lease area (AfL, 11.1km^2) plus a surrounding 4km buffer, though in parts the extent of the buffer was clipped by the coast of Hoy and South Walls (Figure 14.1).

The survey design is in line with the recommendations of Jackson and Whitfield (2011) that for sites of 5 – 10km^2 in area in open sea situations the surveyed buffer should extend to at least 2km. The total surface area of the Project survey area is 112.9km^2. Water depths in the AfL range from 70m - 90m.

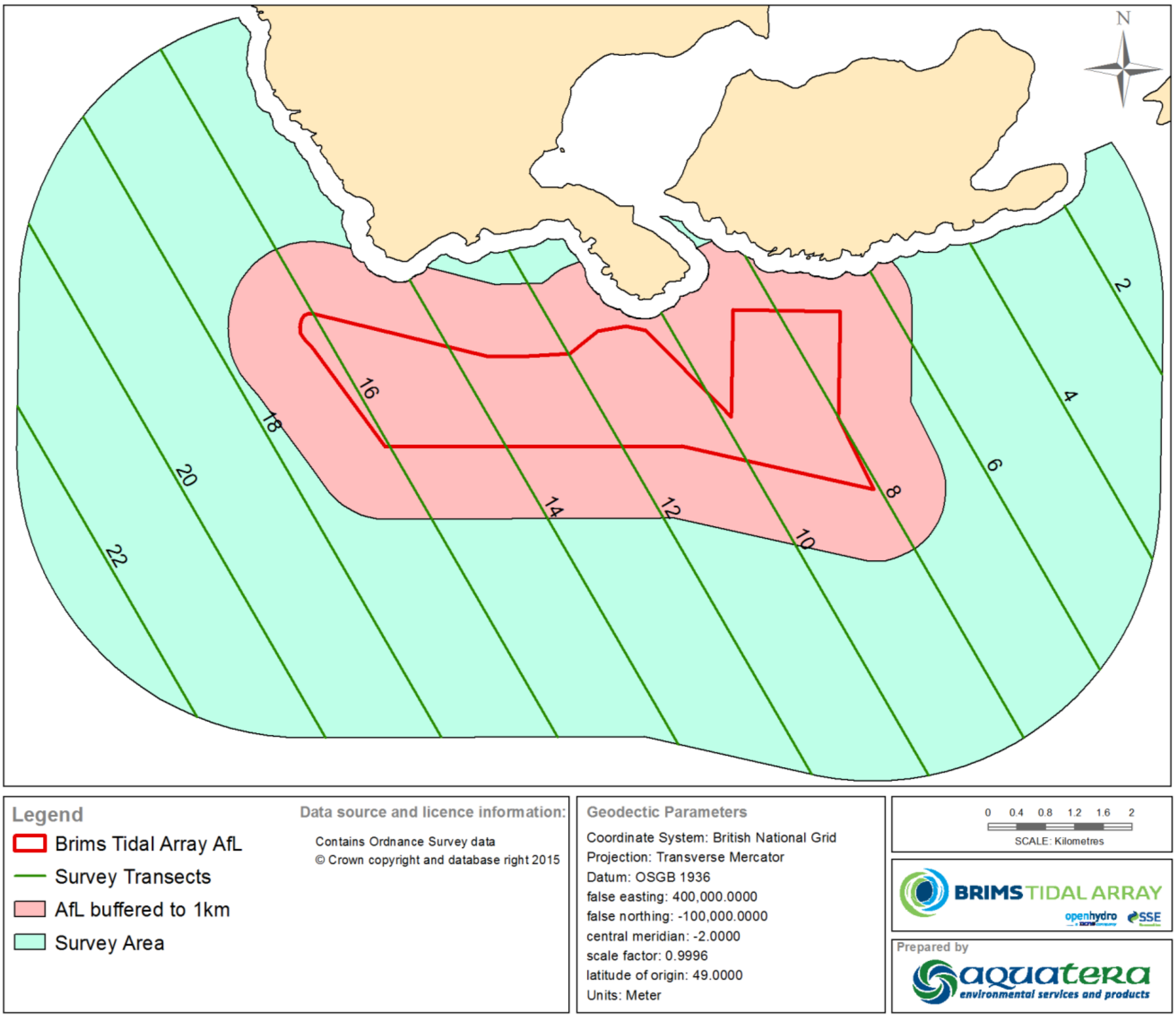

Figure 14.1: Project Survey Area and transect layout

14.2 DESIGN ENVELOPE CONSIDERATIONS

14.2.1 Project Design Envelope

The Scoping Report referred to a Project design Envelope which included four different potential devices to be used, however since then BTAL have removed surface-piercing devices as an option. Therefore, only seabed-mounted shrouded or unshrouded devices are considered in this assessment.

The Agreement for Lease area (AfL), which was the focal point for the Project survey area, consists of two sections as far as the anticipated turbine envelope is concerned: the smaller Stage 1 and the larger Stage 2, which encompasses both Stage 1 and the remainder of the AfL (Figure 14.1). The Project survey area covers most of the export cable corridor options, except for shallow inshore waters which cannot be feasibly (and safely) surveyed by the survey vessel.

A detailed project description, including all worst case parameters, is presented in Chapter 5 Project Description. Technical details relevant to underwater collision risk modelling are provided in the Supporting Document: NRP, 2015b. A summary of parameters relevant to this assessment is presented in Table 14.1. The maximum extent of project parameters in relation to physical footprint on the seabed within the AfL area is 0.11km^2 for Stage 1 and 0.6km^2 for Stage 1 & 2.

Table 14.1: Design envelope parameters for ornithological assessment

Project parameters relevant to the assessment	Maximum Project parameters for the impact assessment	Explanation of maximum Project parameters
Stage 1		
Number of turbines	30	Worst case assumption of 1MW turbines
Area of turbine deployment within AfL area	2.9km^2	Size of search area for Stage 1 turbines within AfL
Device type	1. Shrouded turbine (12.8m device diameter, 4.4m blade length, 10 blades, open-centred) and 2. unshrouded turbine device (23m device diameter, 11.5m blade length, 3 blades)	n/a
Minimum surface clearance LAT	30m	n/a
Minimum seabed clearance	4m	n/a
Device footprint	Up to 0.036km^2 or 0.3% of the AfL area	Steel structure with flat rock bottom that sits on seabed. Total footprint is 30m x 40m per device = 1,200m^2
Inventory of lubricants/oils and other liquids	30,000 litres	Volumes (maximum 1000 litres per device) are approximate covering range of liquids including mineral oil, grease, hydraulic fluid, low toxicity biodegradable oil, bio-degradable ethanol.
Footprint of inter-array cables	Up to 0.07km^2 or 0.6% of the AfL area	Assuming worst case of cable protection with corridor of 5m on all inter-array cables within AfL
Subsea cable connection hub footprint	0.00004km^2	Assuming requirement for 1 hub, at -37.5m^2 per hub
Subsea cable corridor	0.13km^2	Assuming worst case of longest cable route (6.5km) and affected corridor width of 20m (4 cables in total).
Vessels (construction)	6-10 vessels	Possible need for two construction vessels, a heavy-lifting barge, workboat, RIBs, tugs, 2-3 cable-laying and cable protection vessels.
Construction/Installation duration	15 months	Q2 2019-Q3 2020, overlap with two breeding seasons.
Vessels (O&M)	Average 1 vessel/day, year-round, at times 2-3 vessels required	Inspections, minor maintenance. Major maintenance only expected every 5-10 years.

Project parameters relevant to the assessment	Maximum Project parameters for the impact assessment	Explanation of maximum Project parameters
Stage 1 & 2		
Number of turbines	200 (Including Stage 1 & 2; Stage 2 170MW, total 200MW)	Worst case assumption of 1MW turbines
Area of turbine deployment within AfL area	11.1km^2 5.6km^2 (including Stage 1 & 2; Stage 2 additional 5.6km^2)	Size of search area for Stage 1 & 2 turbines within AfL
Device type	1. Shrouded turbine (12.8m device diameter, 4.4m blade length, 10 blades, open-centred) and 2. unshrouded turbine device (23m device diameter, 11.5m blade length, 3 blades)	n/a
Minimum clearance LAT	30m	n/a
Minimum seabed clearance	4m	n/a
Device footprint	Up to 0.24km^2(200 x 1200)or 2.2% of the AfL	Steel structure with flat rock bottom that sits on seabed. Total footprint is 1200m^2 per device
Inventory of lubricants/oils and other liquids	200,000 litres	Volumes (at 1000 litres per device) are approximate covering range of liquids including mineral oil, grease, hydraulic fluid, low toxicity biodegradable oil, and biodegradable ethanol.
Footprint of inter-array cables	Up to 0.36km^2 or 3% of the AfL area	Assuming worst case of cable protection with maximum of 208 33kV cables, cross-sectional area: 500mm^2 Assuming cable protection with footprint width of 5m
Subsea cable connection hub footprint	Total 0.0003km^2	Assuming requirement for 8 hubs, at 37.5m^2 per hub.
Subsea cable corridor	Total 0.52km^2	Assuming worst case of longest cable route (6.5km) and affected Aith Hope route corridor width of 80m (16 cables in total).
Vessels (construction)	6-10 vessels	Possible need for two construction vessels, a heavy-lifting barge, workboat, RIBs, tugs, 2-3 cable-laying and cable protection vessels.
Construction/Installation duration	39 months	Q2 2021-Q2 2023, overlap with up to three breeding seasons.
Vessels (O&M)	Average 1 vessel/day, year-round, at times 2-3 vessels required	Inspections, minor maintenance. Major maintenance only expected every 5 years for each turbine.
Decommissioning activities	As per installation/construction	n/a

14.3 LEGISLATIVE FRAMEWORK AND POLICY CONTEXT

14.3.1 Legislation

In addition to the 'Marine Works (Environmental Impact Assessment) Regulations 2007' (the EIA Regulations), key legislation in relation to birds includes:

- EU Birds Directive 79/409/EEC codified by directive 2009/147/EC;
- The Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora 1992/43/EEC (EU Habitats Directive);
- OSPAR - Convention for the Protection of the Marine Environment of the North east Atlantic;
- The Nature Conservation (Scotland) Act 2004 (as amended);
- Wildlife and Natural Environment (Scotland) Act 2011;
- Conservation (Natural Habitats, etc.) Regulations 1994 (as amended);
- The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000 as amended in 2008;
- Conservation of Habitats and Species Regulations 2010;
- The Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 (as amended);
- UKBAP; and
- RAMSAR Convention.

14.3.1.1 EU Birds Directive

The European Union (EU) meets its obligations for birds through Directive 2009/147/EC (EC Birds Directive) on the conservation of wild birds (codified version of the European Council Directive 79/409/EEC as amended). This legislation was adopted in 1979 in response to increasing concern about declines in Europe's wild bird populations. The Directive emphasises the protection of habitat for endangered and vulnerable bird species listed on Annex I and migratory birds through a network of SPAs.

14.3.1.2 EU Habitats Directive

European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (EC Habitats Directive) was adopted in response to the Bern Convention. This Directive is transposed into UK law by the Conservation of Habitats and Species Regulations 2010 (together with the Conservation (Natural Habitats, &c.) Regulations 1994). The Directive requires Member States to maintain habitats and species at a favourable conservation status across their full range, as well as through a network of protected sites (Natura 2000) - comprising Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

14.3.1.3 OSPAR

OSPAR – or the Convention for the Protection of the Marine Environment of the North east Atlantic - is the current legal instrument by which European governments, together with the European Union, cooperate to protect the marine environment of the North east Atlantic. Instigated in 1972 with the Oslo Convention against marine pollution it was broadened to cover land-based sources and the offshore industry by the Paris Convention of 1974. These two conventions were unified, up-dated and extended by the 1992 OSPAR Convention. The latest annex on biodiversity and ecosystems was adopted in 1998 to cover non-polluting human activities that can adversely affect the sea.

14.3.1.4 Nature Conservation Act 2004

The Nature Conservation (Scotland) Act 2004 places a duty on public bodies to further the conservation of biodiversity. It requires Scottish Ministers to designate one or more strategies for the conservation of biodiversity as the Scottish Biodiversity Strategy, and to publish lists of species and habitats of importance. Chapter 1 of Part 2, and Schedules 1 and 5, of the Act, repeal the Sites of Special Scientific Interest (SSSI) provisions of the Wildlife and Countryside Act 1981 (as amended), enhancing the protection of SSSIs. Part 3 and Schedule 6 of the Act amend the Wildlife and Countryside Act 1981, strengthening the legal protection for wild bird species.

14.3.1.5 Wildlife and Natural Environment (Scotland) Act 2011

The Act amends the Wildlife and Countryside Act 1981 (among others) and consolidates existing national legislation to implement the Bern Convention and Birds Directive in the UK. It protects native species, controls the release of non-native species, enhances the protection of SSSIs and builds upon rights of way rules. Special penalties are available for offences related to rare and endangered bird species listed on Schedule 1.

14.3.1.6 Conservation (Natural Habitats, etc.) Regulations 1994 (as amended), Conservation of Habitats and Species Regulations 2010

In Scotland, the Conservation of Habitats and Species Regulations 1994, as amended, most notably in 2004 and 2007, transpose the EC Habitats Directive into domestic law. The Regulations protect sites, species and habitats identified by the Habitats Directive. The Conservation of Habitats and Species Regulations 2010 apply in Scotland in relation to certain specific activities, including consents granted under Sections 36 and 37 of the Electricity Act 1989. The 2010 Regulations are very similar to the 1994 Regulations (as amended in Scotland) in the protection they give to Natura sites, so in practice proposals are assessed in exactly the same way.

14.3.1.7 The Offshore Marine Conservation (Natural Habitats, etc.) Regulations 2007 (as amended)

These regulations transpose Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive) and Council Directive 79/409/EEC on the conservation of wild birds (Wild Birds Directive) into national law. They came into force on 21 August 2007. These regulations apply to the UK's offshore marine area which covers waters beyond 12 nautical miles, within British Fishery Limits and the seabed within the UK Continental Shelf Designated Area.

14.3.1.8 UKBAP

The UK Biodiversity Action Plan (UK BAP) was published in 1994, and was the UK Government's response to the Convention on Biological Diversity, which the UK signed in 1992. The 'UK Post-2010 Biodiversity Framework', published in July 2012, succeeds the UK BAP. The Framework demonstrates how the UK contributes to achieving biodiversity targets, and identifies the activities required to complement the country biodiversity strategies in achieving the targets. Species relevant to the assessment and listed on the original UKBAP are herring gull and Arctic skua.

14.3.2 Guidance

Guidance on ornithological assessments for tidal energy developments was derived from the following sources:

- Guidelines for ecological impact assessment in Britain and Ireland – Marine and Coastal (IEEM 2010);
- The Crown Estate (2012) Pentland Firth and Orkney Waters – Enabling Actions Report.

14.4 SUPPORTING SURVEYS AND STUDIES

14.4.1 Desk Study

- Background information on seabird distributions within the bio-geographic region and the North Sea in particular was taken from Stone *et al.* (1995), Furness (2014), Forrester *et al.* (2007), Mitchell *et al.* (2004), Kober *et al.* (2010), Thaxter *et al.* (2012) and other sources as appropriate;
- Colony counts were derived from the JNCC Seabird Monitoring Programme Database (SMP Database) unless specified otherwise. These sources were used to determine regional breeding, passage and non-breeding or wintering numbers and distributions for each species;
- Much of the generic information on bird behaviour and ecology has been taken from Birds of the Western Palearctic (Snow and Perrins 1998 and Forrester *et al.* (2007), which provide comprehensive information on each species; and
- Extensive use has also been made of Marine Scotland commissioned reports on the vulnerability of Scottish seabirds to tidal energy developments (Furness *et al.* 2012).

14.4.2 Seabird Surveys

The ornithological community of the Project survey area was characterised by undertaking a two-year programme of commissioned boat-based surveys following European Seabirds at Sea (ESAS) protocols. The surveys were conducted by Natural Research (Projects) Limited between March 2012 and March 2014 and the methodology was discussed and agreed prior to commencement with SNH.

14.4.2.1 Design and Methods

A brief account of the survey programme is provided below. Full details of the programme of survey work, including survey design and methods, survey effort, survey results and supporting contextual information are presented in Supporting Document: NRP, 2015a. The study design was consulted upon and agreed with Marine Scotland (letter, 16 April 2014).

The Project survey area comprised the AfL and a surrounding 4km buffer as well as the majority of the export cable corridor options, except where those are too close to Hoy for safe operation of the survey vessel. The survey design comprised 11 parallel transects spaced 1.6km apart covering the entire Project survey area and with a total length of 79.5km. Data on both seabirds and marine mammals were collected during the ESAS surveys, following standard survey protocols as set out in Camphuysen *et al.* (2004).

The majority of survey work was conducted from the MV Karin, with a single survey undertaken on the MV Scotia. These vessels comply with ESAS recommended survey standards. Recording was undertaken from one side of the vessel only, whichever side presented the best conditions for detecting birds at the time. Surveyors have a ranging stick to facilitate accurate determination of distance bands.

All birds and marine mammals seen were recorded. For each bird record, surveyors recorded the species, number in the group, age, plumage, activity, together with information on environmental conditions at the time of each sighting in terms of sea state, swell, wind force and direction, and sun glare intensity.

For birds on the sea, the perpendicular distance from the transect line was recorded as one of five distance bands (0-50m, 50-100m, 100-200m, 200-300m, >300m) (Camphuysen *et al.* 2004).

Flying birds that passed through the survey corridor were recorded and assigned as being in-transect or not-in-transect according to whether they are inside a 300m x 300m box at the time of snapshots taken at regular intervals (Camphuysen *et al.* 2004). The snapshot interval is the time taken for the vessel to travel 300m; at 10 knots, in this case the interval was one minute.

14.4.2.2 Survey Effort

A total of 18 surveys visits (approximating 135 hours of survey effort) were undertaken between March 2012 and March 2014. On the majority of survey dates conditions were good or sufficient for survey work and well within ESAS guidelines for seabird surveys (up to sea state 4). However on two of the winter survey visits conditions of sea state 5 were temporally experienced. Full details of sea state, wind direction, swell and survey times for each transect are presented in Supporting Document: NRP, 2015a.

Eleven survey visits were made in the period between late March and mid-August, encompassing the entire breeding season for most seabird species. This is one visit more than was planned for at the start of the survey programme. Virtually all transects were surveyed in these months and sea conditions at the time of surveys were generally very good in 2013 (predominantly sea state 1 to 3) yet merely good in 2012 (predominantly sea states 3 and 4, but never exceeding sea state 4).

Eight autumn/winter survey visits were made in the months September to early March. Unsuitable sea conditions prevented any survey visits in November and January, whereas September and October were only sampled in 2013. Despite the weather related problems, all of the winter survey effort was conducted in sea conditions that complied with ESAS guidance. The potential effect of lower survey coverage during autumn and winter on the baseline dataset is considered in Section 14.6.3.

14.5 CONSULTATIONS

A list of feedback from all consultees is summarised in Chapter 6 Consultation Process. An extensive consultation process was undertaken up to submission of the EIA. An overview of the key consultation items and the associated timeline is presented in Table 14.2. The key points raised by stakeholders regarding ornithological receptors are presented in Table 14.3.

Table 14.2: Key consultation items and timeline for the Project.

Consultation item	Stakeholders involved	Medium and date
Project initiation	OpenHydro, SNH, Marine Scotland (MS), Royal Haskoning and Scottish and Southern Energy	Meeting, 28 May 2012
Bird, marine mammal and basking shark survey methodology	Marine Scotland	Letter to MS, 29 August 2012
Project meeting	OpenHydro, SNH, Marine Scotland	Meeting, 26 February 2013
Interim survey reports and EIA strategies	SNH	Letter to MS, 12 March 2013
Survey design, interim survey reports and EIA strategies	Marine Scotland	Letter, 16 April 2013
Scoping report and initial HRA screening	Marine Scotland, SNH	Submitted, 23 August 2013
Scoping Opinion	SNH	Letter to MS, 31 October 2013
Project meeting	Marine Scotland, OpenHydro	Meeting, 22 November 2013
Bird, marine mammal and basking shark survey methodology	Marine Scotland	Letter, post-meeting 22 November 2013
2nd Interim survey report	Marine Scotland, SNH	Submitted, 28 November 2013
Interim survey report, collision risk assessment	SNH	Letter to MS, 17 January 2014
Scoping Opinion (final)	Marine Scotland	Letter, 23 April 2014
Survey update, approach to EIA assessment	SNH	Letter to MS, 21 August 2014
EIA Ornithology Methodology	Marine Scotland, SNH	Submitted, 10 April 2015
Project long list for inclusion in cumulative impact assessment	Marine Scotland	Letter, 18 June 2015
EIA Ornithology Methodology	Marine Scotland	Letter, 9 July 2015
Information to Inform HRA	SNH	Letter, 14 December 2015

Table 14.3: Key issues raised by stakeholder during consultation

Topic	Stakeholder	Comment	Response/Action taken	Section cross-reference
Study design/analysis	SNH, 02/11/2012	"Analyses should not only aim to support an assessment of impacts upon species at different times of year, but also at different stages of the tidal cycle. Consequently, surveys should be timed, where possible, to provide data that gives representation across the tidal cycle. If practical limitations make boat-based survey during maximum tidal velocities difficult, it may be pertinent for the land-based vantage point surveyor to cover these periods."	Within existing tidal and navigational constraints present every attempt was made to cover different tidal cycles. Note however that the Project survey area is regularly subject to very challenging weather conditions, being in direct connection with the Atlantic Ocean. Survey windows with suitable (and safe) conditions for survey are therefore limited. Some land-based work was undertaken during the breeding season to assess whether auk behaviour on the sea surface was limited to loafing or whether foraging behaviour occurred as well (both types of behaviour were recorded). Full scale land-based surveys to fill in for boat-based surveys would have had to cope with similar poor weather conditions, likely affecting bird detection. Regardless, such surveys were not considered feasible as the distance to the Study Area is too far to allow for meaningful data collection for baseline purposes.	Supporting Document Technical Report – Seabirds (Supporting Document: NRP, 2015a); Section 14.4.2
Study design/analysis	MSS, 22/11/2012 & 13/04/2013	[Paraphrased]: Increasing survey effort within the lease area by reducing the size of the buffer and reducing the spacing between transect to 1km or a reduction in buffer size with the addition of transects within the lease area. Potential of zig zag transect design to be considered.	Using boat-based transect methods for relatively small marine sites inevitably leads to problems meeting the ideal requirements for distance sampling, and there is a limit to which these can be resolved by reducing transect interval (if these are too narrow, one runs the risk of disturbing animals on the next line), larger buffers (potential for	n/a

Topic	Stakeholder	Comment	Response/Action taken	Section cross-reference
			sampling the wrong place) or more frequent visits (extra disturbance of animals). Although it is acknowledged that there can be small potential benefits from a zig zag layout and this was duly considered during the design process. For practical reasons it is considered such a design would not be of benefit at this site, particularly in relation to potential for double-counting where transect lines meet and to on-site navigation. Assessment by the vessel's skipper considered the zig zag layout not feasible to achieve in the conditions likely to be encountered, ignoring prevailing conditions would have affected the standard of data collection.	
ESAS surveyor's fatigue	SNH	"For bird surveys, two ESAS surveyors is the minimum requirement, with recording only being undertaken from one side (which ever provides the best conditions). We understand the surveys should take approximately 7 hours, including short breaks between transects. If surveys continue for longer periods (or the 7 hours doesn't include breaks) we advise the need for a relief observer to prevent observer fatigue."	The nature of the implemented survey design means that surveyors get up to a 10 minute break between transects, when the vessel traverses to the next transect and has to be manoeuvred into a starting position. Across a given survey day this provides surveyors with ample time 'off effort' to avoid fatigue. On average, survey days did not last much longer than 7 hours at a time.	n/a
Accounting for autumn/winter data gap	SNH, 12/03/2013	"The deficiencies in the autumn and winter year-1 data [..] Also apply to bird species. While this is not an uncommon problem when working in locations with difficult sea conditions, it does not	Every effort was made to launch monthly boat-based surveys and utilize appropriate weather windows. Throughout autumn and winter the vessel and the team were continuously available, ready to	Supporting Document Technical Report – Seabirds (Supporting

Topic	Stakeholder	Comment	Response/Action taken	Section cross-reference
		preclude the necessity for the applicants to fill this data gap. APEM is the primary potential data source which is proposed for this purpose. Nevertheless, it remains important that considerable effort is applied to securing site survey data during autumn 2013, perhaps by increasing flexibility and opportunism for capitalising on good weather windows."	use viable weather windows. Sea conditions were extremely challenging, with prolonged poor weather in autumn/winter 2012-13 and again in winter 2013-14, with a succession of major winter storms moving across the UK during December and January. After such events - given the location of the Project survey area, which lies in open connection with the Atlantic – it takes substantial additional time for sea conditions to decrease to a point which falls within ESAS requirements. Consideration of APEM data led to the conclusion that it has very limited value for the purpose of filling the winter data gap, particularly in relation to the large number of observations of birds which are not identified to species level and the lack of differentiation between the different auk species. Instead a comparison of relative abundance was made with results from the nearby MeyGen Inner Sound (tidal array) baseline surveys, which was recommended by SNH as an option to address the issue (letter, 21 August 2014).	Document: NRP, 2015a) Section 14.6.3
Collision risk modelling	SNH, 17/01/2014	Considering the location of the proposed tidal array within the Pentland Firth and partially within the Hoy SPA, and the species numbers presented so far from the 1st year of surveys, we recommend that collision risk modelling is	Noted, all species mentioned were initially considered for inclusion in the collision risk modelling process. Shag and black guillemot were screened out as neither species was recorded within the AfL area, which is largely deeper than the	Section 14.12.2.6

Topic	Stakeholder	Comment	Response/Action taken	Section cross-reference
		undertaken for the key species recorded at the site. Once survey results provide further information on species densities, we will be able to provide further advice on which species should be assessed for collision risk. However, such an assessment is likely to include the key diving bird species (i.e. common guillemot, razorbill, puffin, shag, and black guillemot)	known maximum diving range for both species, rendering the benthic habitat out of reach. The other three auk species were included in the modelling.	
Collision risk modelling	SNH, 17/01/2014	In our scoping response of the 31st October 2013, we stated that for the Project collision risk assessment the ERM was preferred. However, considering the open-centre tidal turbine is the preferred device, and our recent collision risk assessment for EMEC Fall of Warness, it may be preferable to use the modified CRM as used for the recent EMEC collision risk assessment.	Both the CRM and the ERM model were used for the purpose of the Project EIA.	Supporting Document Collision risk to diving seabirds (Supporting Document: NRP, 2015b)
Anticipated impact footprint (disturbance)	MSS, 09/07/2015	For disturbance we agree that the disturbance scores created by Furness *et al.* (2012) may be used as a basis for appropriate levels of effect of disturbance on birds. We note that none of the disturbance information used in that assessment comes from tidal renewable devices, so care and judgement must be exercised when translating these scores to levels of disturbance and displacement. For boat traffic, more sensitive species flush at more than 1000m (see table 7 of	Advice on disturbance distances in relation to the anticipated impact footprint has been fully implemented in the assessment.	Section 14.7, Table 14.4

Topic	Stakeholder	Comment	Response/Action taken	Section cross-reference
		Furness *et al.* (2012) We advise a 2km buffer for sensitive species, which is consistent with advice for the Westray South tidal array. Some species allocated a score of 4 in Furness *et al.* (2012) flush between 400 and 1000m, so for less sensitive species a 1km buffer is appropriate (for ship traffic). For example, common guillemot (scoring 3 in the list) is considered to fly when boats approach within 100s of metres. For many of the species listed as scoring 1 or 2, for which the proposal here is to have no buffer, we advise a buffer of 500m. This is due to there still being a recorded reaction when boats are close to some of these species (termed 'slight avoidance at short range' in the supplementary tables of Furness *et al.* (2012).		

Topic	Stakeholder	Comment	Response/Action taken	Section cross-reference
Anticipated impact footprint (displacement)	MSS, 09/07/2015	For surface structures we advise a 500m buffer for more sensitive species. It is not clear at this stage what surface structures will be present. For sensitive species a buffer of 4km is suggested for offshore wind farms. Although a buffer of just 250m was advised for the Lewis Tidal Array project in 2012, we recommend more precaution in this case as the surface structures are unknown at present. Once surface structures are described, it may be possible to consider if a smaller buffer is appropriate.	Advice has been noted. Since receiving this advice design changes have been implemented – the entire Project will be seabed-mounted, with no surface-piercing structures present.	Section 14.7, Table 14.4
Avoidance rate for collision risk modelling	SNH, 14/12/2015	The HRA report presents predicted collisions on the basis of a 90% avoidance rate, although other avoidance rates are provided for context. Although there is a large amount of uncertainty regarding avoidance, it may be more useful to present the collisions on the basis of a 98% avoidance rate, with other avoidance rates for context, which would be similar to what collision risk assessments for other tidal projects have used.	Advice taken on board with input parameters revised in the Collision Risk to Diving Seabirds supporting document and revised outputs used to inform EIA	Supporting Document Collision Risk to Diving Seabirds (Supporting Document: NRP, 2015b); Section 14.12.

14.6 DATA GAPS AND UNCERTAINTIES

14.6.1 Seabird Breeding Population Estimates

A recurring issue for impact assessments relating to seabirds is the patchiness of monitoring data as well as the time lapse since the last national census was undertaken (approximately 15 years ago, Mitchell *et al.* 2004). In certain parts of the UK long–running monitoring at large colonies has provided invaluable information on population trends, as well as survival and productivity rates. Away from these areas (including the Pentland Firth for a range of species) monitoring data is often sparse or non-existent, meaning that an assessment has to rely on information 'foreign' to the region under consideration. Where possible this assessment has used region-specific data on survival and productivity data.

Furthermore, some seabird populations have undergone or are suspected to have undergone substantial changes in the past 15 years, mostly involving declines. As limited information is available at a regional level for most species, the validity of adjusting regional breeding population size using a national population trend is uncertain. Using a mix of older and more recent colony data has drawbacks as well, mainly of compatibility and uncertainty regarding trends between colonies. Using the national census data has the disadvantage that the information is dated, but the advantage that it provides the last comprehensive, nationwide count data. Therefore this assessment has adopted the use of national census data as per Mitchell *et al.* (2004).

For gannet sufficient recent information is available to base current regional population size on, whereas for kittiwake declines in northern Scotland have been of such a magnitude that a trend adjustment was considered a necessity - despite acknowledged drawbacks – so as to avoid substantially underestimating potential Project impacts. A decline of 45% was applied to Seabird 2000 data, based on the trend for Scotland since 2000 (SNH, 2012).

The assessment acknowledges the difficulties involved in relation to these data sources and has incorporated a conservative approach to assessing impacts, in particular by taking into account likely population trend and conservation status when considering effects on populations of uncertain size.

14.6.2 Uncertainty around Estimates

The implemented survey design is a robust, industry-standard approach to data collection and population estimates. For the purpose of maintaining a conservative assessment, the 95% upper confidence limit of the mean number of birds estimated to be present in a given season and area (e.g. the AfL+1km) is used when determining potential impact levels.

For particularly abundant (or rare) receptors this value provides a solid indication of a likely upper range of numbers present as estimates will be based on a large sample size (or at least a sample with many zero counts). For regularly observed yet relatively scarce species however, confidence intervals around mean seasonal density estimates can be quite large. This is particularly prevalent in estimates for shag and black guillemot, where UCLs indicate the presence of relatively large bird numbers, immediately triggering regional importance levels.

To maintain consistency in approach to each receptor, 95% UCLs of seasonal means have been used as the initial focal point for impacts on all receptors, including shag and black guillemot. To deal with the uncertainty involved in estimates for these two receptors, assessment conclusions take into account that said estimates represent a particularly conservative benchmark.

14.6.3 Seasonal Survey Gaps

The autumn/winter gap in the survey programme due to poor weather conditions was extensively considered during consultation with SNH/MS (Table 14.3). SNH (letter, 21 August 2014) recommended that a comparison with other data sources, including information from the nearby MeyGen Inner Sound tidal energy development could be used to show that the existing Project autumn/winter dataset is sufficient to allow for a robust impact assessment.

Therefore an effort was made to compare data from the Project Survey Area with alternative data sources. Sources considered were: older ESAS information (e.g. Stone *et al.* 1995), APEM aerial survey data for the wider Pentland Firth, MeyGen baseline survey data and more informal information (e.g. Forrester *et al.* 2007).

Ultimately it was considered that the MeyGen data would provide the best benchmark for comparison. Firstly, the site is situated within the Pentland Firth at just 11km distance from the Project Survey Area. ESAS boat-based surveys for this site were undertaken between 2009 and 2011. Although it is acknowledged that any comparison will be limited by inherent differences between usage patterns of tidal passes by diving birds across Scotland (e.g. Waggitt *et al.* in prep) it is considered that the type of data available from the MeyGen surveys has several advantages compared to other available data sources:

- The proximity of the MeyGen survey area to the Project survey area, maximising the likelihood for at least similar patterns to occur;
- Identical methods of data collection and survey effort (comparing like with like). ESAS boat-based surveys were deployed for both projects;
- No compatibility issues regarding species identification, available digital aerial data from APEM is not considered to be of sufficient quality or scope to allow for a sensible comparison of (autumn/winter) datasets, in particular in relation to species identification and its inability to distinguish between different auk species;
- Available MeyGen data is very recent (as opposed to older ESAS data); and
- Spatial units, MeyGen project area and the Project AfL+1km area are roughly the same size.

A detailed examination of seasonal densities and patterns is presented in Supporting Document: NRP, 2015a. In each species account a quantitative comparison is made of average monthly densities of birds on the sea surface (the reported unit in the MeyGen Ornithological Chapter) for the AfL+1km and the MeyGen project area. In summary, it is concluded that for the majority of species seasonal patterns and autumn/winter monthly densities (where surveys covered the same month) are very similar. Although densities for shag and black guillemot at MeyGen are consistently higher than the AfL+1km throughout the year, this is easily explained by the more favourable bathymetry and foraging conditions at the MeyGen site as well its proximity to the large numbers of breeding birds of both species on the nearby island of Stroma.

Given the strong similarity between both sites in terms of seasonal patterns and estimated densities, including during the autumn/winter period, as well as the clear reasons for those species where consistent differences do exist, it is concluded that the existing Project survey dataset is entirely fit for purpose and forms the basis for a robust impact assessment.

14.7 ANTICIPATED IMPACT FOOTPRINT

The assessment considers the geographical area over which impacts from the Project may affect birds, i.e. the anticipated impact footprint (AIF). The definition of the AIF for a particular impact is based on a combination of the best information available and where necessary expert judgement. The area over which an impact may affect a species will vary according to the nature of the effect and the vulnerability of the species. E.g. collision risk clearly cannot extend beyond the turbines, and therefore the AIF for this impact is defined by the AfL area. Other potential impact sources may affect birds at some distance from the source of the effect. Following consultation with SNH/MSS a range of impact-specific footprints were defined to be used in the assessment (letter, 9 July 2015; Table 14.4).

Table 14.4: Anticipated impact footprint in relation to potential impact sources and spatial parameters used.

Potential impact	Anticipated impact footprint	Parameters used	Rationale
Direct disturbance	AfL+2km (sensitive species, e.g. divers, seaduck)	Abundance within AfL+2km	In line with consultation advice, 9 July 2015 (Table 14.3).
	AfL+1km (moderately sensitive species, e.g. common guillemot)	Abundance within AfL+1km	In line with consultation advice, 9 July 2015 (Table 14.3).
	AfL+0.5km (less sensitive species)	Abundance within AfL+1km	In line with consultation advice, 9 July 2015 (Table 14.3). Using 1km buffer is precautionary approach.
Accidental contamination	Pentland Firth	Regional populations	Impact assessment made against the regional populations is considered appropriate spatial scale.
Direct habitat loss	Device footprint (within AfL area), export cable corridor footprint (out with AfL area)	Abundance within AfL+1km	Impact assessment made against AfL+1km is considered appropriate spatial scale.
Collision risk to diving seabirds	AfL area	Density within AfL +1km area (birds on the sea surface only, except for gannet – all birds within the AfL +1km area)	Use of AfL+1km area deviates from consultation advice, 9 July 2015 (AfL only). This choice is based on tighter confidence intervals around mean density for AfL+1km compared to AfL only, making these values more robust for use in modelling. Abundance of birds on the sea surface is considered an appropriate estimate of population size at risk of potential collision. Gannet is an exception as

Potential impact	Anticipated impact footprint	Parameters used	Rationale
			diving movements are initiated in flight.
Indirect impacts through habitats and prey species	AfL+3km area	Abundance within AfL+3km	Choice of area is in line with impact zone used in ES Chapters 9. Physical Processes and 11. Benthic Ecology
Note: consultation advice from MSS/SNH received on 9 July 2015 supersedes any previous advice in relation to impact footprints (which differed in advice on several parameters)			

14.8 ASSESSMENT METHODOLOGY

14.8.1 Approach to Assessment

The approach to impact assessment was not agreed in advance with SNH/MSS and was submitted on (10 April 2015) for consideration. A formal response was received on 9 July 2015 from MSS (Supporting Document: BTAL, 2015c). Recommendations were incorporated into the assessment where feasible. Where project specific guidance was not available, BTAL adopted the approach of using feedback on the proposed Westray South tidal energy development to inform the approach.

In doing so the assessment incorporates the most relevant approach based on the latest advice to a project of a similar size and nature, situated in the same region, where project specific guidance is not available.

The approach to the assessment of ornithological impacts has drawn on published guidance on Environmental Impact Assessment in Scotland (SNH 2009; Scottish Government 1999), as well as advice provided by SNH and MSS in discussions over the approach to impact assessment for tidal developments in the Pentland Firth area (in particular Westray South (see Table 14.3).

14.8.2 Assessment Criteria

Impact is defined as a change in the population of bird species as a result of the Project in isolation. Where the response of a population has varying degrees of likelihood, the probability of these differing outcomes is considered. Note that impacts can be adverse, neutral or beneficial.

Judgement is made against the general expectation that the Project would not have a significant adverse effect on the overall receptor population, range or distribution of bird species considered. In assessing the impacts, consideration is given to the relevant populations of the species. Trivial or inconsequential impacts are excluded.

For breeding seabird species, the appropriate regional ecological unit is defined according to the likely connectivity of seabird colonies with the proposed Project, in turn based on species-specific foraging ranges (e.g. Thaxter *et al.* 2012). Thus the regional breeding populations of a species is determined to be the sum of the birds breeding within an area defined around the development area by the species' foraging range (mean maximum or maximum) plus a case by case margin (and associated rationale) to include or exclude colonies on or near the range edge. Regional non-breeding population sizes were based on the boundaries used to define the biologically defined minimum population size (BDMPS) for the non-breeding period of the year (Furness 2014).

The assessment determines the potential impacts of the Project and the likelihood of their occurrence. In judging whether a potential impact is significant or not, several factors are taken into account:

- The sensitivity of the receptor to the impact;
- The spatial magnitude of the likely impact;
- The temporal magnitude of the likely impact; and
- The nature conservation importance (NCI) value of the species involved.

The significance of potential impacts is determined by integrating the assessments of magnitude, sensitivity and nature conservation importance in a reasoned way (IEEM 2010). In judging significance, consideration is also given to the population status and trend of the potentially affected species. If a potential impact is determined to have greater than negligible significance, mitigation measures to avoid, reduce or remedy the impact are suggested wherever possible. Best practice measures are also suggested for impacts of negligible significance but which are nonetheless undesirable.

14.8.2.1 Sensitivity and Vulnerability

Sensitivity and vulnerability are related but different concepts. Sensitivity as used here is a characteristic of the receptor population under consideration and is a measure of how sensitive it is to a particular impact. Sensitivity is a measure of likely size of change to a population in terms of its size, reproductive output or geographical range that would result as a consequence of it experiencing a given impact. It can also be thought of as a measure of the capacity of a population to absorb an impact. The term vulnerability as used here is a characteristic of a species, and is a measure of how likely individuals of a species are to experience a given impact or a collection of impacts.

The question of how vulnerable seabird species are to impacts caused by tidal devices has recently been reviewed by Furness *et al.* (2012). As part of this review species were rated on a number of criteria and the scores combined to give an overall vulnerability score, with a higher score indicating a greater level of vulnerability. These scores were then used to produce an overall score and this is used as a basis for categorising each species into one of five generic vulnerability categories ranging from very low to very high. The criteria used included the potential for collision with tidal devices (based on dive depth), response to vessel disturbance and displacement response to fixed structures. The scores for these criteria and a species overall generic vulnerability score are summarised in Table 14.5. Note that these scores include several other factors not presented, namely: drowning risk, benthic foraging, use of tidal races for foraging, feeding range, and habitat specialization.

The methods used by Furness *et al.* (2012) and their resulting generic vulnerability scores are considered to be appropriate with respect to the Project and are therefore adopted. However, it should be noted that these are scores of generic vulnerability to tidal devices and the actual vulnerability of a species to the proposed devices may be lower. For example, if a species has a high generic vulnerability score but does not use the development area, then its vulnerability to the tidal devices of the Project will be negligible.

Table 14.5: Ranked species-specific generic vulnerability to overall tidal device impacts, disturbance, displacement (after Furness *et al.* 2012) and surface pollutants (Wiens *et al.* 1995)

Species	Vulnerability to surface pollutants	Vulnerability (score[1] out of 5)		Diving depth	Generic vulnerability to potential tidal device impacts	
		Vessel disturbance	Displacement by structures	(score[1] out of 5)	Overall score	Category
Black guillemot	Very high	3	2	4	9.9	High
Shag	Very high	4	2	4	9.6	High
Razorbill	High	3	2	5	9.6	High
Guillemot	High	3	1	5	9	High
Cormorant	High	4	2	4	7	High
Great northern diver	Very high	5	3	3	4.1	Moderate
Red-throated diver	Very high	5	2	3	3.8	Moderate
Puffin	High	2	2	4	3.8	Moderate
Black-throated diver	Very high	5	3	3	3.6	Moderate
Arctic tern	Medium	2	2	1	1.9	Low
Manx shearwater	Medium	1	1	3	1.5	Low
Eider	Medium	3	1	3	1.5	Low
Gannet	High	2	2	3	1.4	Low
Great black-backed gull	High	2	1	1	1	Very low
Kittiwake	Medium	2	1	1	0.9	Very low
Herring gull	Medium	2	1	1	0.8	Very low
Great skua	Very high	1	1	1	0.7	Very low
Common gull	Medium	2	1	1	0.7	Very low
Arctic skua	Very high	1	1	1	0.6	Very low
Fulmar	Medium	1	1	1	0.5	Very low
Storm petrel	Medium	1	1	1	0.5	Very low

1. Score 1 is lowest vulnerability and score 5 highest.

2. Score ranges from 0 (no risk) to 9.9 (highest risk) and is derived from species-specific information on e.g. diving behaviour, habitat flexibility, sensitivity to disturbance etcetera (Furness *et al.* 2012). Note, the overall score cannot be derived solely from scores for disturbance and displacement presented in this table. These are included to provide impact-specific context.

In determining the significance of impacts, the sensitivity and ability to recover from temporary adverse conditions is considered in respect of each potentially affected population. Sensitivity is determined according to each receptor populations' conservation status (Eaton *et al.* 2009; JNCC 2014) and its ability to tolerate the impact and/or recover from the effect of an impact, using the broad criteria set out in Table 14.6.

The assessment of sensitivity takes account of information on the responses of seabirds to potential impacts from marine developments (e.g. collision, noise and disturbance by human activities). Note, however, that behavioural sensitivity can differ even between similar species (Garthe and Hüppop 2004) and that, within a particular species, some populations may be more sensitive than others, and that sensitivity may change over time, for example due to habituation and changing conservation status. Sensitivity also depends on the type of activity of the bird, with, for example, a species likely to be more sensitive to disturbance whilst breeding than at other times in its life, especially when in the vicinity of nests or young.

Table 14.6: Definitions for sensitivity of ornithological receptors

Sensitivity	Criteria
High	Receptor population has very limited tolerance of effect. Example; likely to have no capacity to absorb change, so a population level effect likely. Likely to be limited to populations with poor existing conservation status
Medium	Receptor population has limited tolerance of effect. Example; very minor capacity to absorb change so a population level effect possible. Likely to include but not be limited to populations with poor existing conservation status
Low	Receptor population has some tolerance of effect. Example; likely to have minor capacity to absorb additional mortality or reduction in productivity or habitat loss, so a population level effect unlikely.
Negligible	Receptor population generally tolerant of effect. Example; likely to have moderate capacity to absorb additional mortality or reduction in productivity or habitat loss, so a population level effect very unlikely.

The nature conservation importance of the bird species potentially affected by the Project is defined according to Table 14.7. It should be noted that high nature conservation importance and high sensitivity are not necessarily linked within a particular impact.

Table 14.7: Definitions of the nature conservation importance (value) levels for ornithological receptors

Value	Definition
High	Species listed in Annex 1 of the EU Birds Directive Species listed on the IUCN threatened list Breeding species listed on Schedule 1 of the Wildlife and Countryside Act (WCA) Species making use of the area in nationally important numbers (>1% national population)
Medium	Other species listed on the Birds of Conservation Concern (BOCC) ‘Red’ list Regularly occurring migratory species, which are either rare or vulnerable, or warrant special consideration on account of the proximity of migration routes, or breeding, moulting, wintering or staging areas in relation to the Project Species making use of the area in regionally important numbers (>1 of the regional population)
Low	Other species listed on the Birds of Conservation Concern (BOCC) ‘Amber’ list Species making use of the area in numbers equating to 0.1-1% of the regional population
Negligible	All other species Species making use of the area in numbers equating to <0.1% of the regional population or otherwise so scarce as to amount to the same

14.8.2.2 Magnitude

Impacts on receptor populations are categorised in terms of their spatial and temporal magnitude as detailed in Table 14.8.

Table 14.8: Definition of spatial scale of magnitude for impacts affecting ornithological receptors

Magnitude	Criteria
High	Major reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Guide: >20% of population affected, >20% change in mortality or productivity rate.
Medium	Partial reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Guide: >5-20% of population affected, >5-20% change in mortality or productivity rate.
Low	Small but discernible reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Guide: 1-5% of population affected, 1-5% change in mortality or productivity rate.
Negligible	Very slight reduction in the status or productivity of a bird population due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the “no change” situation. Guide: <1% population affected, <1% change in mortality or productivity rate.

14.8.2.3 Impact Significance

The matrix presented in Table 14.9 is used as a starting point for determining the significance of impacts, combining (spatial) magnitude (Table 14.8) and receptor sensitivity (Table 14.6). Nature conservation importance (Table 14.7), information on a receptor's population conservation status, and the extent of any uncertainty are also taken into consideration where appropriate in reaching a judgement on impact significance. Any impact determined to be moderate or above is considered significant under EIA regulations. Significance definitions are presented in Table 14.10.

Table 14.9: Assignment of impact significance for ornithological receptors based on sensitivity of receptor and magnitude of effect

Sensitivity of Receptor	Magnitude of effect			
	High	Medium	Low	Negligible
High	*MAJOR*	*MAJOR*	*MODERATE*	*MINOR*
Medium	*MAJOR*	*MODERATE*	*MINOR*	*MINOR*
Low	*MODERATE*	*MINOR*	*NEGLIGIBLE*	*NEGLIGIBLE*
Negligible	*MINOR*	*NEGLIGIBLE*	*NEGLIGIBLE*	*NEGLIGIBLE*

Table 14.10: Definitions of impact significance for ornithological receptors

Impact significance	Criteria
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional level because they contribute to achieving national, regional or local objectives, or, could result in exceeding of statutory objectives and/or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a regional or local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore no change in receptor condition.

14.8.2.4 Site Importance and Receptor Priority

The ornithological importance of the Project survey area, in particular the AfL+1km, is evaluated by comparing seasonal estimates of 95%UCL of seasonal mean abundance with regional receptor population sizes. The importance of the AfL+1km to a receptor population was defined on the basis on the mean percentage of a population present, as follows:

- High importance, >5% of the population;
- Medium importance, 1 - 5% of the population;
- Low importance, 0.1 - <1% of the population; and
- Negligible, <0.1% of the population.

To maximise focus on relevant seabird receptors and associated issues in the EIA process, a system of prioritisation was used. Each species was rated as high, medium or low priority for the EIA, as detailed in Table 14.11. If there was uncertainty as to which category was most appropriate for a species a more precautionary (higher) category was chosen.

Low priority species receptor populations are those that could not plausibly be subject to adverse impacts beyond a negligible significance level from the Project due to a combination of very low to low vulnerability and the Area for Lease having negligible importance as a habitat for sustaining that population. Prioritisation criteria do not take into account nature conservation importance value and conservation status as these do not affect the likelihood of an impact occurring.

All receptor populations of species rated as having low or very low generic vulnerability to tidal devices (Table 14.5; Furness *et al.* 2012) and for which the AfL+1km has negligible importance for the regional population (defined as 95% UCL of the seasonal mean using the AIF that corresponds to below 0.1% of the population) are rated as low priority. In addition, all species, irrespective of their generic vulnerability rating, for which baseline surveys found no evidence of them using the ecological resources of the AIF are also categorised as low priority (e.g., overflying migrants/passage birds). Low priority species receptor populations are not individually considered in the impact assessment, but instead are grouped into a single community.

Table 14.11: Criteria used to categorise species priority for EIA

Priority Category	Species Criteria
High	>1% of the regional receptor population at times uses the Area for Lease (High or Medium site importance). And at least moderate generic vulnerability to the impacts of tidal devices.
Medium	Between 0.1% and 1% of the regional receptor population at times uses the Area for Lease (Low site importance). And at least moderate generic vulnerability to the impacts of tidal devices. Or >1% of the regional receptor population at times uses the Area for Lease (High or Medium site importance). And, low or very low generic vulnerability to the impacts of tidal devices.
Low	Between 0.1% and 1% of the regional receptor population at times uses the Anticipated Impact Footprint (Low site importance). And low or very low generic vulnerability to the impacts of tidal devices. Or Receptor population makes no use of the Anticipated Impact Footprint (e.g. only recorded flying over) or occurs in numbers <0.1% of the regional receptor population (Negligible site importance). And any category of generic vulnerability to the impacts of tidal devices.

14.9 BASELINE DESCRIPTION

14.9.1 Introduction

Full details of the ESAS survey results and supporting contextual information are presented in Supporting Document: NRP, 2015a. A summary of the key results is provided in this section, focussing on the aspects that have greatest relevance to the assessments of impacts.

The surveys showed that the Project survey area, including the Area of Lease buffered to 1km (AfL+1km), generally has low importance for seabirds, with most species present in low numbers relative to their background populations (Table 14.12). With a few exceptions, the range of species and numbers present in the Project survey area were particularly low during the non-breeding season, reflecting seabird dispersal and migratory movements away from the Pentland Firth area.

A total of 16 seabird species were regularly recorded and very small numbers of nine other species of seabird were recorded occasionally (on less than five occasions) (Supporting Document: NRP, 2015a). A range of waterfowl, shorebirds and songbirds were recorded crossing the airspace over the Project survey area.

14.9.1.1 Regularly Recorded Species

Detailed information on the status of all recorded seabird species is provided in Supporting Document: NRP, 2015a. Table 14.12 provides an overview of the commonly recorded species, abundance estimates, vulnerability to tidal developments, site importance as well as a priority categorisation based on the latter two factors.

14.9.1.2 Seabird Receptor Priority in EIA

Information on receptor priority captured in Table 14.12 is summarised for each category and season.

Low priority

The breeding receptor populations categorised as low priority are the regional breeding populations of fulmar, Manx shearwater, storm petrel, gannet, Arctic skua, great skua, herring gull, great black-backed gull, common gull, and Arctic tern.

The non-breeding receptor populations categorised as low priority are the regional wintering populations of red-throated diver, fulmar, gannet, herring gull, great black-backed gull, common gull, kittiwake, common guillemot, razorbill and puffin.

Medium priority

Medium priority receptor populations are those of species that could plausibly be subject to an adverse impact from the Project on account of a combination of at least moderate generic vulnerability to tidal devices and the AfL+1km having at least low importance for sustaining that population (Table 14.12). These populations merit detailed consideration. Even though the low importance of the AfL+1km for sustaining the population makes it likely that any impacts would be of relatively small magnitude, it is desirable to identify such impacts so that they can be reduced where possible through mitigation.

The breeding receptor populations categorised as medium priority are those of red-throated diver, kittiwake, common guillemot and puffin. For common guillemot this includes the chicks-on-sea period, as some uncertainty exists whether the very low densities of common guillemots recorded in the Project survey area in August 2012 are a regular feature.

Shag is the single regional species receptor population categorised as having medium priority in the non-breeding season.

High priority

High priority species receptor populations are those that could plausibly be subject to an adverse impact from the Project on account of a combination of at least moderate generic vulnerability to tidal devices and the AfL+1km having at least moderate importance for sustaining that population (defined as at least 1% of the population at times present in the

AfL+1km). High priority receptor populations are those that merit the greatest level of scrutiny because the impacts on these could potentially lead to significant changes to their regional population status.

The breeding receptor populations categorised as high priority are those of shag, razorbill and black guillemot. For razorbill this includes the chicks-on-sea period, as some uncertainty exists as to whether the occurrence of very low densities of razorbills recorded in the Project survey area in August 2012 are a regular feature.

The non-breeding receptor populations categorised as high priority are the regional wintering populations of black guillemot.

14.9.1.3 Scarce Species

Nine seabird species were recorded in very small numbers on a few occasions only (<3 observations, with 4 or less individuals per survey) during the entire survey programme. These include (number of observations and peak number of individuals per survey in brackets): black-throated diver (1/1), great northern diver (1/2), sooty shearwater (1/1), cormorant (3/3), eider (3/4), pomarine skua (1/1), black-headed gull (1/1), common tern (3/3) and little auk (1/3) (Table 7, Supporting Document: NRP, 2015a). Although this is an arbitrary threshold and although several of these are species which are deemed to have high to moderate vulnerability to potential impacts from tidal energy developments (cormorant, diver species; Furness *et al.* 2012) the numbers involved are so small, and site importance clearly very limited that all of these are considered to be of low priority at all times of year. For the sake of brevity these species have not been presented in Table 14.12. Red-throated diver is similarly scarce, but has been included due to the proximity of the important breeding population on nearby Hoy.

Migratory waterfowl, shorebirds and songbirds recorded during surveys are not considered in this assessment as these species do not depend on or physically interact with offshore habitats and thus will not be affected by the presence of the proposed (and wholly submerged) Project. Risk of collision for these species is therefore non-existent.

14.9.2 Summary

The AfL+1km supported shag numbers of high importance during the breeding season, while the area supported red-throated diver, kittiwake, razorbill and black guillemot numbers of medium importance during this time of year (Table 14.12). In the non-breeding season, with the exception of black guillemot (medium site importance), importance did not exceed negligible or low levels for any other receptors (Table 14.12).

Note that importance levels for shag and black guillemot are exclusively a result of both species using the 1km buffer around the AfL (and more specifically only the section of the buffer between the AfL and Hoy). Neither species was recorded on the sea surface within the AfL (Section 14.9.3).

The importance level for red-throated diver is based on a peak survey count of a single bird. The species was only recorded on three occasions during the 2012 and 2013 breeding seasons in the 1km buffer around the AfL. None of these observations were ‘in-transect’ (i.e. either on the sea surface within 300m from the vessel or in flight within snapshot) and thus no reliable density estimates could be calculated.

Table 14.12: Summary of the importance of the AfL+1km to regional receptor populations of seabirds based on the 95%UCL of the seasonal mean

Species	Season	Nature conservation value	Regional population		95%UCL of mean in AfL+1km		Importance of AfL+1km to RP	Vulnerability to tidal devices	Receptor priority for EIA
			Number	Units	Number	% of RP			
Red-throated diver	Nest attendance	High	111	adults	1 (peak count)	0.9%	Low	Moderate	Medium
	Winter	High	1,523	birds	1 (peak count)	<0.1%	Negligible	Moderate	Low
Fulmar	Colony attendance	Low	965,822	adults	733	0.1%	Low	Very low	Low
	Winter		568,736	birds	773	0.1%	Low		
Manx shearwater	Summer (non-breeding)	Low	8,507	birds	17	0.2%	Low	Very low	Low
European storm-petrel	Colony attendance	Low	4,636	birds	6	0.1%	Low	Very low	Low
Gannet	Colony attendance	Low	75,870	adults	63	0.1%	Low	Low	Low
	Winter		248,385	birds	25	<0.1%	Negligible		
Shag	Colony attendance	Medium	754	adults	165	21.9%	High	High	High
	Winter	Low	39,468	birds	132	0.3%	Low		Medium
Arctic skua	Colony attendance	High	930	birds	3	0.3%	Low	Very low	Low
Great skua	Colony attendance	Low	4,470	birds	39	0.9%	Low	Very low	Low

Species	Season	Nature conservation value	Regional population		95%UCL of mean in AfL+1km		Importance of AfL+1km to RP	Vulnerability to tidal devices	Receptor priority for EIA
			Number	Units	Number	% of RP			
Herring gull	Colony attendance	Medium	5,294	adults	0	0%	Negligible	Very low	Low
	Winter		466,511	birds	10	<0.1%	Negligible		
Great black-backed gull	Colony attendance	Low	5,156	adults	5	0.1%	Low	Very low	Low
	Winter		91,399	birds	13	<0.1%	Negligible		
Common gull	Colony attendance	Low	5,930	adults	4	0.1%	Low	Very low	Low
	Winter		710,000	birds	7	<0.1%	Negligible		
Kittiwake	Colony attendance	Medium	62,792	adults	690	1.1%	Medium	Very low	Medium
	Winter	Low	627,816	birds	34	0%	Negligible		Low
Arctic tern	Colony attendance	High	1,724	adults	9	0.5%	Low	Low	Low
Common guillemot	Colony attendance	Low	609,250	adults	825	0.1%	Negligible	High	Medium
	Chicks on sea		609,250	adults	0	0%	Negligible		
	Winter		1,617,306	birds	253	<0.1%	Negligible		Low
Razorbill	Colony attendance	Medium	10,739	adults	433	4%	Medium	High	High
	Chicks on sea		10,739	adults	369	3.4%	Medium		
	Winter	Low	218,622	birds	44	<0.1%	Negligible		Low
Black guillemot	Colony attendance	Medium	1,576	adults	48	3%	Medium	High	High

Species	Season	Nature conservation value	Regional population		95%UCL of mean in AfL+1km		Importance of AfL+1km to RP	Vulnerability to tidal devices	Receptor priority for EIA
			Number	Units	Number	% of RP			
	Winter		3,656	birds	46	1.3%			
Puffin	Colony attendance	Low	142,670	adults	339	0.2%	Low	Moderate	Medium
	Winter		231,957	birds	7	<0.1%	Negligible		Low

14.9.3 Species Accounts

The following species accounts outline population trends, site abundance and distribution as well as vulnerability considerations for those receptors of medium or high priority to the EIA process. Low priority receptor populations are not individually described in the species accounts (see Section 14.8.2.4).

14.9.3.1 Red-Throated Diver

The UK conservation status of red-throated diver is categorised as Amber UK on the birds of conservation concern criteria (BOCC) due to its unfavourable conservation status in Europe (Eaton *et al.* 2009). The species is also listed on Schedule 1 of the Wildlife and Countryside Act 1981 and as an Annex 1 species on the EU Birds Directive. The entire UK breeding population of 4,146 adult birds occurs within Scotland, where numbers increased by approximately 34% between 1994 and 2006 (Dillon *et al.* 2009).

Red-throated divers were very scarce in the Project survey area throughout the year, and were only recorded on eight occasions during the entire survey programme (totalling 8 individuals), a single one of which was seen on the water. The species has a very short foraging range of up to 9km, foraging in near-shore waters before returning to its upland breeding lochs (Thaxter *et al.* 2012).

The few birds seen in the Project survey area during the breeding season are likely to be exclusively from the Hoy breeding population of 111 adults (Dillon *et al.* 2009). Within the defined regional population the species is a notified feature at Hoy SSSI (SNH Sitelink). During the winter period birds from outside the UK join the population (Wernham *et al.* 2002). The NW North Sea population is estimated at 1,523 birds (Furness, 2014).

Recent work on establishing the spatial extent of important foraging areas for red-throated divers around SPAs during the breeding season indicates that the south coast of Hoy and South Walls is very unlikely to represent important habitat for the species (Black *et al.* 2015). Instead, core foraging areas are considered to lie to the east and north of Hoy, well away from the Project survey area. This is largely explained by the species' preference for foraging in shallow waters of less than 20m to 30m depth, a depth range that is absent from the AfL+1km and indeed the vast majority of the Project survey area.

Given what is known of red-throated diver distribution on Orkney, with the vast majority of birds during the non-breeding season residing in and around Scapa Flow and northern Orkney (Dawson *et al.* 2009, Lawson *et al.* 2015), and very small numbers along exposed coastlines elsewhere on the islands, it is clear that the Survey Area (let alone the AfL+2km) is of very limited importance to the species during this time of year.

Red-throated divers are considered to have very high vulnerability to vessel disturbance, low vulnerability to displacement by structures and moderate vulnerability in relation to tidal energy developments in general (Table 14.5).

14.9.3.2 Shag

The UK conservation status of shag is categorised as Amber UK on the BOCC criteria due to population declines in the past 25 years (Eaton *et al.* 2009). The UK population has been in decline since the late eighties, with a 41% decrease between 2000 and 2013 (JNCC 2014). Three colonies within 80km of the Pentland Firth have decreased by 65% since designation (MacArthur Green 2013). It is unclear whether declines at large colonies are representative for the population as a whole as smaller colonies are less likely to be affected by density dependence processes such as competition, one of the main drivers behind declining numbers (Furness 2014).

Using the maximum foraging range the population in the defined breeding region is 754 adults based on the Seabird 2000 census results (Mitchell *et al.* 2004). The actual number of shags present in the region during the breeding season is likely to be substantially greater than this figure because of the presence of immature birds. Modelling of the age distribution undertaken by Furness (2014) indicates that at the end of the breeding season 51% of shag populations consist of adult birds, with the remainder made up of immature and juvenile individuals. An estimated 41,503 birds are present in the NW North Sea region during the non-breeding period (Furness, 2014).

Shags were relatively common in the Project survey area throughout the year and were recorded on nearly every survey. Based on the estimates for the AfL+1km, the site is considered to have medium nature conservation value for this species as regionally important numbers occurred in the breeding season in the AfL+1km (95%UCL of the estimated mean: 165 birds or 21.9% of the population, assuming all birds are adults, Table 14.12). Note that this estimate comes with some uncertainty as it represents a wide interval around the mean estimate (Section 14.6.2). A high proportion of birds seen were present on the sea surface. The AfL+1km did not support regionally important numbers in the non-breeding season.

The species has a short foraging range from breeding colonies (mean maximum range: 14.5km, maximum: 17km, Thaxter *et al.* 2012). Therefore, the birds seen in the Project survey area are likely to be almost exclusively from breeding colonies in southern Orkney. Within the defined regional population shag is a notified feature at Duncansby Head SSSI and Stroma SSSI as a component of important seabird assemblages (SNH Sitelink).

Distribution of shags across the Project survey area was heavily biased to the near-shore sections within the 1km buffer, with no birds actually within the AfL itself (see Supporting Document: NRP, 2015a). This is explained by the species' heavily depending on benthic habitat for foraging as well as the substantial water depths within the AfL which, at 70-90m deep, are essentially in excess of the known diving range of the species (see overview of source material in Furness *et al.* 2012).

Shags are considered to have high vulnerability to vessel disturbance and low vulnerability to displacement by structures, as well as high vulnerability in relation to the potential impacts of tidal developments specifically, particularly as it habitually spends a lot of time on the sea surface while foraging and dives to moderate depths (Table 14.5).

14.9.3.3 Kittiwake

Kittiwake is a species of Amber conservation concern due to substantial population declines, with the Scottish population having an unfavourable conservation status as it has declined by approximately 66% over the past 25 years, equating to an average decline rate of 4.2% per annum (Mitchell *et al.* 2004, Eaton *et al.* 2009, SNH 2012). The decline is linked to food supply and sea temperature changes and is likely to continue (JNCC 2014).

Colonies in Orkney have been declining at an average rate of 12.3% per annum (JNCC 2014). No recent information is available for the large colonies in Caithness.

Taking the average decline rate of the Scottish population into account, and using the mean maximum foraging range (MMFR: 60km, Thaxter *et al.* 2012) the current regional breeding population is assumed to be the number estimated by the Seabird 2000 census (133,528 adults) multiplied by 0.55, which is 73,440 adults. The actual number of kittiwakes present in this defined region during the breeding season is likely to be greater than this figure because of the presence of immature birds. However, poor breeding success in recent years (a feature of the decline) means that relatively few immature birds are to be expected, as transpired in survey results. Modelling of age distribution undertaken by Furness (2014) indicates that at the end of the breeding season, for a stable population, 53% of kittiwake individuals in the population would consist of adult birds, with the remainder made up of immature and juvenile individuals. An estimated 627,816 birds are present in the North Sea region during the non-breeding period (Furness, 2014).

Kittiwakes were regularly present in the Project survey area in moderate numbers in the breeding season and smaller numbers in the non-breeding period. Based on the estimates for the AfL+1km, the site is considered to have medium nature conservation value for this species as regionally important numbers occurred in the breeding season (95%UCL of the estimated mean: 690 birds or 1.1% of the population, assuming all birds are adults, Table 14.12). During the breeding season a high proportion (70%) of birds seen were present on the sea surface, with 50% of all birds seen during this time of year displaying foraging behaviour.

The species has a moderate foraging range around breeding colonies and it is considered that birds in the Project survey area predominantly originate from as far north as colonies on mainland Orkney and Copinsay, and as far south as the large colonies on the Sutherland and Caithness coasts. Within the defined regional population kittiwake is a notified feature at Rousay SSSI, Copinsay SSSI, Marwick Head SSSI, Stroma SSSI, West Westray SSSI, Duncansby Head SSSI and a notified seabird assemblage at Hoy SSSI and Dunnet Head SSSI.

The baseline survey kittiwake distribution maps indicate that during the breeding season in 2012 and 2013 birds seen on the sea were concentrated towards the west and east of the Project survey area respectively, with almost all such observations on the very edge of the 1km buffer or further out and none within the AfL (Supporting Document: NRP, 2015a). Birds in flight did range across the AfL, but the majority were observed outside this area. Statistical analysis established that for kittiwakes on the sea surface there was only a 5% chance that the absence of birds on the surface in the AfL (without buffer) was a chance occurrence, indicating perhaps that the AfL is relatively unattractive for foraging (Caloo 2015).

Kittiwakes are considered to have low vulnerability to vessel disturbance and displacement by structures as well as very low vulnerability to potential impacts from tidal energy developments generally (Table 14.5). The species is not considered vulnerable to underwater collision risk as it predominantly feeds at the sea surface.

14.9.3.4 Common Guillemot

Common guillemot is a species of Amber UK conservation concern due to 50% of the UK population occurring in fewer than ten sites, making the population geographically vulnerable (Eaton *et al.* 2009). Between 2000 and 2013 the UK population as a whole has shown a 9% increase (JNCC 2014), but this trend is not necessarily applicable at regional levels. In fact, the Scottish population has an unfavourable conservation status, as it has shown moderate long-term decline amounting to -26% since 1986 (SNH 2012; Mitchell *et al.* 2004).

Twelve SPA populations within 80km of the Pentland Firth have increased by 5% since designation (MacArthur Green 2013). However, this comparison is heavily affected by several large SPA colonies for which the most recent estimate itself is 15 years old. Restricting the comparison to the five colonies on Orkney for which count data since 2006 are available shows that these have on average declined by approximately 20% (MacArthur Green 2013). The Orkney Bird Report (2009) indicates that common guillemot has declined across all monitoring plots in the first decade of the 21st century.

The defined regional breeding population is based on the Seabird 2000 census results and after accounting for adults that were not attending the colonies at the time of counting (using a correction factor of x1.34, Mitchell *et al.* 2004), the size of the regional population for the colony-attendance part of the breeding season is estimated at 609,250 adults (the chicks-on-sea period has been defined similarly). The actual number of birds present in this period is likely to be larger because of the presence of non-breeding immature birds. A recent study into correction factors for breeding auks indicated there is substantial variation in the correction factor between colonies depending on local conditions (Harris *et al.* 2015). Pending advice from JNCC/SNH on this matter the established factor has been used in this assessment.

Modelling of the age distribution undertaken by Furness (2014) indicates that at the end of the breeding season 57% of common guillemot populations consist of adult birds, with the remainder made up of immature and juvenile individuals. An estimated 1,617,306 birds are present in the North Sea and Channel region during the non-breeding period (Furness, 2014).

Breeding common guillemots travel moderate distances to forage, the maximum foraging distance is reported to be 135km and the MMFR is 84km (Thaxter *et al.* 2012). During the colony-attendance part of the breeding season the birds using the Project site are most likely from colonies from most of Orkney, except possibly the far north east, Sule Skerry and Sule Stack and on mainland Scotland as far west as Cape Wrath and as far south as the East Caithness Cliffs SPA. Large colonies exist across the Pentland Firth on Stroma and at Dunnet Head. Within the defined regional population common guillemot is a notified feature at Duncansby Head SSSI, Hoy SSSI, Stroma SSSI, Red Point SSSI, Dunnet Head SSSI, Copinsay SSSI, Rousay SSSI, Marwick Head SSSI, West Westray SSSI, Cape Wrath SSSI and Sule Skerry SSSI.

Common guillemots were present in the Project survey area (including the AfL+1km) in large to very large numbers throughout the year, with the vast majority of birds seen on the sea surface, however, at most, these numbers only represent a small proportion of the regional populations. The distribution of common guillemot observations shows an approximately even spread over the Project survey area (Supporting Document: NRP, 2015a). Statistical analysis did not reveal a trend in spatial distribution across the Project survey area (Caloo 2015).

Based on the estimates for the AfL+1km, the site is considered to have low nature conservation value for the species, both in the breeding season and non-breeding period as regionally important numbers did not occur, even if it is assumed all birds present are adults (Table 14.12). For example, in the breeding season the 95% UCL of the estimated mean number in the AfL + 1km was 825 birds, which represents just 0.1% of the regional breeding population (Table 14.12).

Common guillemots are considered to have moderate vulnerability to vessel disturbance and low vulnerability to displacement by structures (Table 14.5); their vulnerability to disturbance is heightened during the chicks-on-sea part of the breeding season due to the presence of dependent chicks and because adults undergo complete wing moult at this time of year rendering them temporarily flightless. The species is considered to have high vulnerability to tidal energy developments in general, largely as a result of its diving behaviour (Furness *et al.* 2012).

14.9.3.5 Razorbill

Razorbill is a species of Amber UK conservation concern due to population declines in the past 25 years (Eaton *et al.* 2009). However, between 2000 and 2013 the UK population as a whole has shown a 13% increase (JNCC 2014), but this trend is not necessarily applicable at regional levels as there is uncertainty about recent population trends for Scottish breeding razorbill due to low monitoring effort. Between 2005 and 2010 the UK population was one of slow decline, but since then the population appears to have increased again, although estimates come with wide confidence intervals, requiring caution in interpretation. In recent years productivity at monitoring sites has decreased again, and this may possibly lead to future population declines (JNCC 2014).

Five SPA populations within 80km of the Pentland Firth have decreased by 23% since designation (MacArthur Green 2013). However, this comparison is heavily affected by several large SPA colonies for which the most recent estimate itself is 15 years old or more. When comparing three colonies on Orkney for which the latest estimates are from the last five to eight years it turns out that these have suffered a 45% decrease. The Orkney Bird Report (2009) indicates that declines of 5-34% were found across all monitoring plots between 2006 and 2009.

The defined regional breeding population is based on the Seabird 2000 census results (Mitchell *et al.* 2004). After accounting for adults that were not attending the colonies at the time of counting using a correction factor of x1.34 (Mitchell *et al.* 2004), the size of the regional breeding population is estimated at 10,739 adults (the chicks-on-sea period has been defined similarly). The actual number of razorbills present in the defined region during the breeding season is likely to be greater than this figure because of the presence of non-breeding immature birds. A recent study into correction factors for breeding auks indicated there is substantial variation in this factor between colonies depending on local conditions (Harris *et al.* in prep.). Pending advice from JNCC/SNH on this matter the established factor has been used in this report.

Modelling of the age distribution undertaken by Furness (2014) indicates that at the end of the breeding season 57% of razorbill populations consist of adult birds, with the remainder made up of immature and juvenile individuals. An estimated 218,622 birds are present in the North Sea and Channel region during the non-breeding period (Furness, 2014).

Breeding razorbills travel moderate distances to forage; the maximum foraging distance is reported to be 95km and the MMFR is 48.5km (Thaxter *et al.* 2012). Using the latter value the regional breeding population includes mainland Orkney, Copinsay and parts of the Caithness coast. Within the defined regional population razorbill is a notified seabird assemblage feature at Marwick Head SSSI, Copinsay SSSI, Duncansby Head SSSI, Dunnet Head SSSI, Hoy SSSI, Red Point SSSI and Stroma SSSI.

Razorbills were present in the Project survey area (including the AfL+1km) in moderate to large numbers throughout the year, with the vast majority of birds seen being on the sea surface. Distribution of razorbill observations shows an approximately evenly spread over the Project survey area, with birds on the sea surface most prevalent towards the eastern and the north west parts of the area (see Supporting Document: NRP, 2015a). Statistical analysis did not reveal a trend in spatial distribution across the Project survey area (Supporting Document: Caloo, 2015).

Based on the estimates for the AfL+1km, the site is considered to have medium nature conservation value for the species as regionally important numbers occurred in the breeding and chicks-on-sea season (95%UCL of the estimated mean: 433 and 369 birds or 4% and 3.4% of the population respectively, assuming all birds are adults, Table 14.12).

Razorbills are considered to have moderate vulnerability to vessel disturbance and low vulnerability to displacement by structures (Table 14.5); their vulnerability to disturbance is heightened during the chicks-on-sea part of the breeding season due to the presence of dependent chicks and because adults undergo complete wing moult at this time of year rendering them temporarily flightless. The species is considered to have high vulnerability to tidal energy developments in general, largely as a result of its diving behaviour (Furness *et al.* 2012).

14.9.3.6 Black Guillemot

Black guillemot is a species of Amber UK conservation concern as it is a species of European concern (Eaton *et al.* 2009). The species breeds at relatively low densities at often difficult to access sites and therefore there is a limited amount of monitoring data available. As a result no national trend is available for the UK breeding population (JNCC 2014).

No information on population trends was available for Orkney (Furness 2014). A recent survey at the East Caithness Cliffs SPA found an apparently substantial increase since Seabird 2000: a total of 1,569 individuals in breeding plumage were counted in 2014, compared to 939 counted in 2000 (Swann 2014). Parts of north Caithness have seen similar increases since the national census (Swann 2013). Recent counts on Stroma (May 2015) found a total of 417 individuals, a substantially higher number than recorded during Seabird 2000 (Mitchell *et al.* 2004, SMP database).

The defined regional breeding population based on the Seabird 2000 census results is 1,576 adults (Mitchell *et al.* 2004). The actual number of black guillemots present in the defined region during the breeding season is likely to be greater still because of the presence of non-breeding immature birds. Modelling of the stable age distribution undertaken by Furness (2014) indicates that at the end of the breeding season 43% of black guillemot populations consist of adult birds, with the remainder made up of immature and juvenile individuals. An estimated 3,656 birds are present within 20km from the Project survey area during the non-breeding period (including immature birds, as per recommendation in Furness, 2014).

Breeding black guillemots travel short distances to forage, ranges from 0.5 to 15km have been published (BirdLife International 2000). The species is relatively common around the Pentland Firth, breeding on Orkney and the Caithness coast as well as smaller islands in the Firth. Within the defined regional population black guillemot is a notified seabird assemblage feature at Stroma SSSI (SNH SiteLink).

Black guillemots were present in the Project survey area year-round in very low to low numbers. Based on the estimates for the AfL+1km, the site is considered to have medium nature conservation value for the species as regionally important numbers occurred in the breeding and winter season (95%UCL of the estimated mean: 48 and 46 birds or 3% and 1.3% of the population respectively, assuming all birds are adults, Table 14.12). Note however, that although the Project survey area is probably of some regional importance due to the relatively small background population, substantial uncertainty is associated with the mean estimate as it is based on a small sample size (n=16) and therefore the associated 95%UCL is rather wide (Section 14.6.2; Supporting Document 14A: Technical Report - Seabirds).

Distribution of black guillemots across the Project survey area was heavily biased to the near-shore sections within the 1km buffer, with no birds recorded within the AfL itself (see Supporting Document 14A: Technical Report - Seabirds). This is explained by the species' heavily depending on benthic habitat for foraging as well as the substantial water depths within the AfL which, at 70m-90m deep, are essentially out with the known diving depth range of the species (see overview of source material in Furness *et al.* 2012, and Masden *et al.* 2013).

Black guillemots are considered to have moderate to low vulnerability to vessel disturbance and displacement by structures respectively, and a high vulnerability to the potential impacts of tidal developments in general, largely as a result of its diving behaviour (Table 14.5).

14.9.3.7 Puffin

Puffin is a species of Amber UK conservation concern as it is a species of European concern (Eaton *et al.* 2009). Between the mid-1980s and 2000 numbers breeding in Scotland increased by 13% (Mitchell *et al.* 2004). No trend is available for the period since then as insufficient monitoring data are available (JNCC 2014). Limited information on population trends was available for Orkney and the Pentland Firth, although it is likely the population is much reduced (Furness 2014).

The defined regional breeding population based on the Seabird 2000 census results is 142,670 adults (Mitchell *et al.* 2004). The actual number of puffins present in the defined region during the breeding season is likely to be greater than this figure because of the presence of non-breeding immature birds. Modelling of the age distribution undertaken by Furness (2014) indicates that at the end of the breeding season 55% of puffin populations consist of adult birds, with the remainder made up of immature and juvenile individuals. An estimated 231,957 birds are present in the North Sea and Channel region during the non-breeding period (Furness, 2014).

Breeding puffins travel large distances to forage; the maximum foraging distance is reported to be 200km and the MMFR is 105km (Thaxter *et al.* 2012). Substantial numbers breed within the MMFR from the Project survey area, particularly along the Caithness and Sutherland coast line and across Orkney. Within the defined regional population puffin is a notified feature at Sule Skerry SSSI and a seabird assemblage feature at Duncansby Head SSSI, Dunnet Head SSSI, Hoy SSSI, Red Point SSSI, Rousay SSSI, Stroma SSSI, Copinsay SSSI, Marwick Head SSSI, West Westray SSSI.

Puffins were present in the Project survey area (including the AfL+1km) in moderate numbers in the breeding season but were scarce in the non-breeding period. Based on the estimates for the AfL+1km, the site is considered to have low nature conservation value for the species as regionally important numbers did not occur in the breeding season (95%UCL of the estimated mean: 339 birds or 0.2% of the population respectively, assuming all birds are adults, Table 14.12).

Distribution of puffin observations shows an approximately evenly spread over the Project survey area, with birds on the sea surface possibly slightly more prevalent outside the AfL (Supporting Document 14A: Technical Report - Seabirds). Statistical analysis did not reveal a trend in spatial distribution across the Project survey area (Caloo 2015).

Puffins are considered to have low vulnerability to vessel disturbance and displacement by structures (Table 14.5) and a moderate vulnerability to the potential impacts of tidal developments specifically, mainly as a result of its typical diving depth (Furness *et al.* 2012).

14.10 POTENTIAL IMPACTS

Ornithological interests have the potential to be affected by the following phases/activities of the Project:

- Construction and installation activities;
- Operational activities, including device function and maintenance works; and
- Decommissioning.

Potential impacts on seabird communities as a result of the proposed Project were identified and discussed in some detail in the scoping report (BTAL 2013). Those adopted for the assessment are summarised below:

- Disturbance of foraging seabirds by vessels;
- Accidental release of contaminants into the marine environment, including oil;
- Mortality of diving seabirds through collision with Tidal Energy Converters (TEC);
- Indirect impacts caused by hydrodynamic changes to surrounding seabed habitats and associated prey species (included on basis of Scoping Opinion, 23 April 2014); and
- Direct sea-bed habitat loss and modification.

Since receipt of the Scoping Opinion several design changes have been implemented, the most important of which is the removal of all surface-piercing structures. Therefore, the offshore component of the proposed Project will be situated entirely below the sea surface at all times, regardless of tidal conditions. This change negates the need to assess displacement, as no part of the Project will be visible above the sea surface. Similarly, there is no longer a need for lighting of TECS and other infrastructure. Thus, both potential impact sources were screened out of the EIA.

Potential impacts scoped out of the EIA due to design changes:

- Displacement of seabirds from foraging habitat by project infrastructure (e.g. tidal devices); and
- Lighting of TECs and other infrastructure.

The potential for these impacts to affect bird populations is reviewed by e.g. Jackson and Whitfield (2011), McCluskie *et al.* (2012) and Furness *et al.* (2012). These reviews show that seabird species differ in their vulnerability to the various impacts, and that some species have no potential exposure to some impacts. Notably, TECs do not pose a collision risk to species that do not dive down to the depth where the TECs will operate. For this reason potential impacts are assessed at the species level.

The potential impacts identified for each phase of the Project are listed below:

14.10.1 Construction and Installation

- Disturbance of cliff nesting seabirds during construction and installation of the export cable landfall location or near-shore portion of the cable corridor (referred to as 'direct disturbance');
- Disturbance of foraging or loafing seabirds by vessels and installation activities (referred to as 'direct disturbance'); and
- Accidental release of contaminants into the environment, including oil (referred to as 'accidental contamination').

14.10.2 Operation and Maintenance

- Disturbance of foraging or loafing seabirds by vessels (as above);
- Direct seabed habitat loss and modification (referred to as 'direct habitat loss');
- Mortality of diving seabirds through collision with Tidal Energy Converters (referred to as 'collision risk to diving seabirds');

- Accidental release of contaminants into the environment, including oil (as above); and
- Indirect impacts caused by hydrodynamic changes to surrounding seabed habitats and associated prey species (referred to as 'indirect impacts through habitats and prey species').

14.10.3 Decommissioning

- Disturbance of foraging or loafing seabirds by vessels (as above); and
- Accidental release of contaminants into the environment, including oil (as above).

14.11 MITIGATION MEASURES

14.11.1 Project Design and General Mitigation Measures

All Project Design Mitigation and General Mitigation measures are set out in Chapter 5 Project Description, Table 5.15 and Table 5.16 respectively. These are standard practice measures based on specific legislation, regulations, standards, guidance and recognised industry good practice that are put in place to ensure significant impacts do not occur.

14.11.2 Specific Mitigation

The following mitigation measures will be implemented specifically to minimise the impacts on ornithology.

Table 14.13: Mitigation Measures Specific to Ornithology

Ref	Mitigation Measure Description
OR01	To avoid accidental contamination (in the presence of important numbers of seabirds sensitive to sea surface pollution), vessels associated with all Project operations will carry on-board oil and chemical spill mop up kits.
OR02	To avoid accidental contamination (in the presence of important numbers of seabirds sensitive to sea surface pollution), installation activities will only take place during suitable weather windows.

14.12 RESIDUAL EFFECTS

The assessment considers the potential impacts identified for each stage of the Project – Construction and Installation, Operation and Maintenance and Decommissioning (Section 14.10). Each impact is considered in the context of Stage 1 as well as Stage 1 & 2 combined. Impact conclusions for Stage 2 (referred to as Stage 1 & 2) are therefore not additional to those for Stage 1 but comprise the sum of the whole expected impact magnitude and significance.

14.12.1 Construction and Installation

14.12.1.1 Direct Disturbance

Construction and installation activities, especially those involving fast moving vessels, have the potential to disturb seabirds foraging in the marine environment. Construction and installation disturbance would involve a series of temporary short-term events over the duration of this stage. The consequences of disturbance by vessels and other activities would be to temporarily displace birds from the vicinity of the disturbance and is thus akin to temporary habitat loss.

Construction and installation disturbance would occur throughout the AfL but at any one time will be focussed around only those parts of the array under construction. It would also occur along the route of the subsea cable corridor. Vessels moving between their embarkation port and the development area would also have the potential to disturb seabirds, but this would be relatively infrequent (e.g. a few vessel movements per day at most), and result in very short-term and spatially limited disturbance as a vessel passed through an area.

14.12.1.2 Offshore Disturbance

Consultation indicated that disturbance distances of 2km for vulnerable species (divers, seaduck), 1km for moderately vulnerable species (e.g. guillemot) and 500m for all other species would be appropriate for assessment purposes (Table 14.3; MSS/SNH, letter 9 July 2015; Table 14.4 for anticipated impact footprint).

Red-throated diver and shag are the only receptors which use the AfL or the subsea cable corridor area and which are considered to have a very high and high vulnerability to vessel disturbance respectively (Table 14.5, Furness *et al.* 2012). Common guillemot, razorbill and black guillemot have moderate vulnerability to disturbance and all other receptors (including medium priority receptors kittiwake and puffin) have low or very low vulnerability. The receptor populations of all six receptor species are categorised as having negligible sensitivity to disturbance (Table 14.6) as they clearly have some tolerance to short-term, localised disturbance events in relation to available areas within their respective foraging ranges, none of which are likely to have an effect at the population level.

For the purposes of assessment it is initially assumed that vessel disturbance causes all seabirds to leave their respective anticipated impact footprints throughout the duration of the construction phase. This is very unlikely and therefore an extremely cautious assumption. In reality no species would be expected to respond so severely, as physiological stress is likely to last very short periods of time (until a bird moves away from a perceived threat) and disturbance would be restricted to only a small portion of the AIF at any one time. Therefore it is likely that birds may re-distribute around a construction zone, making use of non-impacted areas during periods of construction and installation activity.

It is certain that construction and installation activities will not take place across the whole of Stage 1 and Stage 1 & 2 at the same time but that works will be spatially concentrated around device locations and along inter-array cable routes within the AfL and along the export cable corridor outside the AfL. The majority of vessels thus engaged will be slow-moving or possibly not moving (moored barges) as construction is undertaken sequentially across the AfL and cable corridors.

Disturbance in the breeding season could potentially be compensated for by a large foraging range, i.e. activities which disturb species with a restricted foraging range are likely to have a larger impact than the same activities would have on a wide-ranging bird species. Of the species under consideration here, red-throated diver and shag are particularly restricted in their foraging range during the breeding season, with maximum foraging ranges of 9 and 17km respectively (Thaxter *et al.* 2012). Red-throated diver is not considered particularly flexible in terms of habitat use, while shag is deemed to be moderately flexible (Furness and Wade 2012).

Distribution information based on two years of baseline surveys shows that red-throated diver and shag are absent from the AfL area, with the former a very scarce presence in the 1km buffer and concentrations of shag exclusively present in the 1km buffer zone between the AfL and the Hoy/South Walls coastline (Supporting Document: NRP, 2015a). For red-throated diver this means that any disturbance up to 2km will affect very few birds whereas any realistic disturbance effect for shag– which is known to be sensitive to disturbance to at least 500m distance (Velando and Munilla 2011) – is likely to only extend to part of the buffer zone at relatively short time intervals, whenever works are undertaken at the northern edge of Stage 1 and Stage 1 & 2 and along export cable routes.

Even if construction and installation disturbance displaced all seabirds from using the AfL+1km, the impact on all species receptor populations would be rated as having negligible spatial magnitude as disturbance would result in a series of very localised, temporary events over the short-term. As all the species receptor populations affected are considered to have low or negligible sensitivity to disturbance, this impact is judged to be of negligible significance under the terms of the EIA Regulations.

14.12.1.3 Assessment

The assessment considered seven receptors of negligible sensitivity and (offshore) direct construction and installation disturbance of negligible magnitude. Based on the highly localised extent over which direct disturbance is predicted to occur, as well as its short-term nature, the reversibility of any effect and moderate habitat flexibility in the case of most receptors, effects of construction and installation disturbance on all receptors across all seasons are evaluated as a negligible impact. It follows that impact evaluation of receptors of low priority is similarly negligible.

14.12.1.4 Disturbance of Cliff-Nesting Birds

Several seabird species breed on the cliffs in the proximity of all three proposed export cable routes (Aquatera 2012). These include fulmar, herring gull, great black-backed gull, razorbill and black guillemot. The presence of cable-laying vessels could lead to disturbance of these birds, potentially affecting breeding success or chick survival. E.g. increased alertness in breeding common guillemots in reaction to vessel disturbance has been recorded from as far away as 500m, with 78% of vessel movements to within 50m of breeding colonies leading to disturbance or flush events (Rojek *et al.* 2007).

Two corridor options – Sheep's Skerry and Moodies Eddy - make landfall within the Hoy SPA marine extension. The third option, Aith Hope, extends east of the Brims Ness peninsula. Fulmar (100 nest sites), herring gull (144 birds) and great black-backed gull (1 pair) breed at landfall locations in the Moodies Eddy corridor, whereas small numbers of fulmar and Arctic tern breed at possible landfall locations within the Aith Hope corridor option (Aquatera 2012). No information was available for Sheep's Skerry. It is considered a reasonable assumption that the bird community within the latter corridor option is similar to the other two options given their proximity. All three species are judged to be somewhat less susceptible to vessel disturbance of colonies than the auk species and are here considered to have low sensitivity to this impact source.

In a worst case scenario all birds breeding near landfall locations in the Moodies Eddy corridor would fail to breed as a result of extensive disturbance from cable-laying vessels. This would result in an effect on the regional population of fulmar of <0.1%, of 2.7% on the herring gull population and of <0.1% on the great black-backed gull population for the duration of a single breeding season. For herring gull this would be categorised as an effect of low magnitude, and an effect of negligible magnitude for the two other species.

The assessment considered three cliff-breeding receptors of low sensitivity and direct construction and installation disturbance of low magnitude (herring gull) and negligible magnitude (fulmar, great black-backed gull). Based on the localised extent over which direct disturbance is likely to occur, as well as its short-term nature (one breeding season), and the reversibility of any impact, effects of construction and installation disturbance on all receptors are evaluated as a negligible impact. It follows that impact evaluation of receptors of low priority is similarly negligible.

14.12.1.5 Mitigation and Good Practice

No mitigation is required for offshore disturbance although good practice would aim to minimise disturbance to seabirds using the offshore site and along approach routes from ports by avoiding where possible the preferred feeding and resting areas and adopting speed restrictions. Studies elsewhere indicate the severity of disturbance by vessels is related to speed (e.g. Ronconi and Cassady St. Clair 2002). Vessel speed limits are commonly used to limit disturbance to seabirds in the vicinity of colonies and feeding sites; however there is no accepted maximum permissible speed. Professional judgement considers vessel speeds of up to 15km/hr (approximately 8 knots) are likely to give most seabird species time to move away from an approaching vessel without resorting to flight.

Good practice could for example be for construction vessels to stick to defined routes (as far as feasible) between ports and the offshore site as a means of reducing disturbance of seabirds. Studies have shown that disturbance is reduced if birds can predict where the disturbance will occur (Schwemmer *et al.* 2010). Consultation with SNH and Marine Scotland will be undertaken to establish the extent of any measures required.

Good practice may be required for disturbance of cliff-nesting seabird species, and could include safe working distances where practical or considerations of seasonal timing. Consultation with SNH and Marine Scotland will be undertaken to establish the extent of any measures required.

14.12.1.6 Summary of Residual Impact

Good practice measures will reduce offshore vessel disturbance; the residual impact will remain of negligible significance for all receptors. Good practice measures in relation to cliff-breeding seabirds should aim to maintain impacts at negligible significance levels and are to be confirmed during consultation.

Table 14.14: Summary of residual effects of the direct disturbance from construction and installation

Impact	Receptor	Sensitivity	Mitigation/good practice	Residual Magnitude	Residual Significance
Direct disturbance, Stage 1 and Stage 1 & 2	Red-throated diver	Negligible	Best practice measures in relation to vessel management to be agreed with MSS/SNH General Mitigation Measure GM07	Negligible	Negligible
	Shag	Negligible		Negligible	Negligible
	Kittiwake	Negligible		Negligible	Negligible
	Common guillemot	Negligible		Negligible	Negligible
	Razorbill	Negligible		Negligible	Negligible
	Black guillemot	Negligible		Negligible	Negligible
	Puffin	Negligible		Negligible	Negligible
	All other seabirds	Negligible		Negligible	Negligible

Impact	Receptor	Sensitivity	Mitigation/good practice	Residual Magnitude	Residual Significance
Disturbance (cliff-nesting breeding birds) (Stage 1 & Phase 1 & 2)	Fulmar	Low	Best practice measures in relation to disturbance of cliff-breeders to be agreed with MSS/SNH	Negligible	Negligible
	Herring gull	Low		Negligible	Negligible
	Great black-backed gull	Low		Negligible	Negligible

14.12.2 Operation and Maintenance

14.12.2.1 Direct Disturbance

Disturbance impacts from vessels during the O&M phase will be similar in nature to the construction phase (i.e. regular vessel presence), yet occur over a much longer period of time (life span of tidal array), albeit at a much lower intensity (fewer vessels). Depending on the timing of devices becoming operational it is possible that O&M vessel disturbance for Stage 1 will overlap with construction activities for Stage 2 for up to three breeding seasons.

The assessment considered seven receptor species of negligible sensitivity and direct O&M disturbance rated as of negligible magnitude in all cases. Given the nature of the disturbance events, which is short-term and localised in the context of a breeding season (although to last over the lifetime of the array), the reversibility of any effect and the moderate habitat flexibility of most receptors (with black guillemot, low flexibility - almost exclusively foraging at the outer edge of the AfL+1km buffer, away from O&M activities), effects of O&M vessel disturbance on all these receptors across all seasons are evaluated as a negligible impact for Stage 1 and Stage 1 & 2. It follows that impact evaluation of receptors of low priority across all seasons is similarly negligible.

14.12.2.2 Mitigation and Good Practice

No mitigation is required although good practice would aim to minimise disturbance to seabirds using the offshore site and along approach routes from ports by avoiding where possible the preferred feeding and resting areas and adopting speed restrictions. Studies elsewhere indicate the severity of disturbance by vessels is related to speed (e.g. Ronconi and Cassady St. Clair 2002). Vessel speed limits are commonly used to limit disturbance to seabirds in the vicinity of colonies and feeding sites; however there is no accepted maximum permissible speed. Professional judgement considers vessel speeds of up to 15km/hr (approximately 8 knots) are likely to give most seabird species time to move away from an approaching vessel without resorting to flight.

Good practice could for example be for construction vessels to stick to defined routes (as far as feasible) between ports and the offshore site as a means of reducing disturbance of seabirds. Studies have shown that disturbance is reduced if birds can predict where the disturbance will occur (Schwemmer *et al.* 2010). Consultation with SNH and Marine Scotland will be undertaken to establish the extent of any measures required.

14.12.2.3 Summary of Residual Impact

Good practice measures will reduce vessel disturbance; the residual impact will remain of negligible significance for all receptors.

Table 14.15: Summary of residual effects of direct disturbance from operation and maintenance

Impact	Receptor	Sensitivity	Mitigation/good practice	Residual Magnitude	Residual Significance
Direct disturbance, Stage 1 and Stage 1 & 2	Red-throated diver	Negligible	Best practice measures in relation to vessel management to be agreed with MSS/SNH GM07	Negligible	Negligible
	Shag	Negligible		Negligible	Negligible
	Kittiwake	Negligible		Negligible	Negligible
	Common guillemot	Negligible		Negligible	Negligible
	Razorbill	Negligible		Negligible	Negligible
	Black guillemot	Negligible		Negligible	Negligible
	Puffin	Negligible		Negligible	Negligible
	All other seabirds	Negligible		Negligible	Negligible

14.12.2.4 Indirect Impacts Caused by Hydrodynamic Changes to Surrounding Seabed Habitats and Associated Prey Species

The benthic communities found in tidally swept areas such as that found in the AfL are adapted to living in highly energetic conditions and many of the species are dependent upon the high tidal velocities for oxygen supply, food supply and/or reduction of competition (Chapter 11 Benthic Ecology). The installation of TECs that are designed to extract energy from the water column therefore has the potential to alter the benthic community structure in the vicinity of the array and associated seabed infrastructure. If such changes are sufficiently large these could in turn affect prey species populations upon which seabirds depend.

The magnitude of reductions in baseline currents would be expected to be greatest for the full Project of Stages 1 and 2 combined. Hydrodynamic modelling conducted as part of the assessment of physical processes (Chapter 9 Physical Processes) indicated that despite some localised higher reductions in baseline currents immediately adjacent to some individual turbines (e.g. of the order of 0.5m/s locally), the magnitude of the extent of the wake of decreased current velocity derived from the turbines (typically <0.3m/s) remains largely within the boundaries of the AfL and dissipates to baseline conditions within 3km of the boundary. This change represents a relatively small percentage reduction in the generally high baseline flow conditions present in the area where peak tidal flows of 2-4m/s are encountered throughout the AfL.

Benthic habitats within the AfL are typical of the extensive tidal rapids habitat that is found throughout the Pentland Firth and are likely to be tolerant to minor changes in current speed. Hence it is unlikely that the presence of the array will cause a large scale change in benthic community structure. Overall, the changes in hydrodynamic regime in and around the AfL would not be expected to significantly alter the overall characteristics of the benthic communities present in the Project site and cable corridors (Chapter 11 Benthic Ecology).

The extent of any habitat loss and modification would be extremely small both in the context of the total area of the AIF and more importantly in the context of the geographic extent of the areas used for foraging by the seabird receptor populations potentially affected. For these reasons all seabird species that use the Project site are considered to have negligible sensitivity to the impact of indirect effects on habitats and associated prey species.

Stage 1

The two receptors which are most dependent on benthic habitat for foraging (shag, black guillemot) did not occur in the AfL, but do forage in inshore waters within 3km from the AfL. These species could therefore potentially be affected by any indirect effects on benthic habitats and associated prey species. However, as no significant changes are predicted for benthic communities it is considered any impact will be of negligible magnitude for both receptors.

Stage 1 & 2

The same reasoning outlined under Stage 1 applies to Stage 1 & 2 combined.

Assessment

The assessment considered receptors of negligible sensitivity and indirect effects on habitat and prey species of negligible magnitude for Stage 1 and Stage 1 & 2. Any changes in the benthic community are likely to be insignificant and unlikely to cause a shift in associated prey species. Therefore, such indirect effects during the O&M on all receptors across all relevant seasons are evaluated as long-term, irreversible (at least during the lifespan of the Project) and of negligible significance for Stage 1 and Stage 1 & 2. It follows that impact evaluation of receptors of low priority across all seasons is similarly negligible for both Stages.

Mitigation and Good Practice

No mitigation is required.

Summary of Residual Impact

The residual impact will remain of negligible significance for all receptors.

Table 14.16: Summary of residual effects of indirect effects through habitats and prey species from operation and maintenance

Impact	Receptor	Sensitivity	Mitigation/good practice	Residual Magnitude	Residual Significance
Indirect impacts on habitats and prey (Stage 1 & Stage 1 & 2)	Red-throated diver	Negligible	n/a	Negligible	Negligible
	Shag	Negligible		Negligible	Negligible
	Kittiwake	Negligible		Negligible	Negligible
	Common guillemot	Negligible		Negligible	Negligible
	Razorbill	Negligible		Negligible	Negligible
	Black guillemot	Negligible		Negligible	Negligible
	Puffin	Negligible		Negligible	Negligible
	All other seabirds	Negligible		Negligible	Negligible

14.12.2.5 Direct Habitat Loss

The seabed in the AfL ranges from 70m to 90m below chart datum. Therefore the seabed generally lies too deep below the surface to be attractive to deep-diving seabird species (such as shag and black guillemot) that specialise in foraging on or close to the seabed; something which is borne out by the baseline survey results through the total absence of both species from the AfL area (Supporting Document 14A: Technical Report - Seabirds). Changes to the seabed habitat are thus very unlikely to have any impacts on seabirds or affect quality of the marine resources used by seabirds. In any case, the extent of any habitat loss and modification would be extremely small both in the context of the total area of the AIF and more importantly in the context of the geographic extent of the areas used for foraging by the seabird receptor populations potentially affected. For all receptor populations the foraging area extends over tens to thousands of square kilometres. For these reasons all seabird species that use the Project site are considered to have negligible sensitivity to the impact of seabed habitat loss and modification, at least at the scale that would be caused by the Project.

The extent of seabed habitat loss and change within the AfL would be limited to a footprint of TECs and inter-array cables combined of approximately 0.11km^2 and 0.6km^2 as a result of the construction of Stage 1 and Stage 1 & 2 respectively (Table 14.17). The maximum footprint of the export cable corridor for Stage 1 is 0.13km^2, and 0.52km^2 for Stage 1 & 2.

Stage 1

The two receptors which are most dependent on benthic habitat for foraging (shag, black guillemot) did not occur in the AfL and as such will not be affected by direct habitat loss in this area. Habitat loss due to the export cable corridor is judged to be very small in relation to available foraging habitat for both species. In both cases any impact is considered of negligible magnitude.

Stage 1 & 2

The same reasoning outlined under Stage 1 applies to Stage 1 & 2 combined.

Assessment

The assessment considered seven receptors of negligible sensitivity and direct habitat loss impacts of negligible magnitude for Stage 1 and Stage 1 & 2. Given the small amount of habitat loss involved in the context of available foraging habitat, the absence of the two benthic habitat specialists from the AIF (shag, black guillemot) and the moderate habitat flexibility of five receptors (with red-throated diver being a very scarce presence in the AIF and black guillemot, with low habitat flexibility - almost exclusively foraging at the outer edge of the AfL+1km buffer, and thus outside the impact zone), effects of O&M direct habitat loss on all receptors across all relevant seasons are evaluated as long-term, irreversible (at least during the lifespan of the Project) and of negligible significance for Stage 1 and Stage 1 & 2. It follows that impact evaluation of receptors of low priority across all seasons is similarly negligible for both Stages.

Mitigation and Good Practice

No mitigation is proposed.

Summary of Residual Impact

The impacts of habitat loss and modification will remain of negligible significance for all species.

Table 14.17: Summary of residual effects of direct habitat loss from operation and maintenance

Impact	Receptor	Sensitivity	Mitigation/good practice	Residual Magnitude	Residual Significance
Direct habitat loss, Stage 1 and Stage 1 & 2	Red-throated diver	Negligible	n/a	Negligible	Negligible
	Shag	Negligible		Negligible	Negligible
	Kittiwake	Negligible		Negligible	Negligible
	Common guillemot	Negligible		Negligible	Negligible
	Razorbill	Negligible		Negligible	Negligible
	Black guillemot	Negligible		Negligible	Negligible
	Puffin	Negligible		Negligible	Negligible
	All other seabirds	Negligible		Negligible	Negligible

14.12.2.6 Collision Risk to Diving Birds

The moving parts of tidal devices pose a theoretical risk to some diving bird species. The risk is theoretical because it has yet to be empirically demonstrated. Furthermore, there is uncertainty as to whether animals of relatively small size such as diving seabirds would be struck by a rotor blade or would be swept past by hydrodynamic flow forces, and further, whether, if birds were to be struck, the blow force would be sufficient to cause injury or death (Wilson *et al.* 2007). For the purposes of this assessment, taking a cautious approach, it is assumed that TECs do pose a collision risk and that the force of collisions could be sufficient to cause fatal injury.

Two models have been developed and published to predict the number of occasions that swimming animals may encounter operating TECs and thereby give rise to the potential for harmful collision events (SNH 2015). Neither model per se takes into account avoidance or evasion behaviour by animals, nor do they consider whether the collision strike force is sufficient to result in harm to the animal. However, these points can be accounted for, post-modelling, by applying ‘avoidance rate’ adjustment factors to model predictions.

The first model considered is the encounter rate model (ERM) developed by SAMS and CEH (Wilson *et al.* 2007), and further elaborated by Band (EMEC 2014, SNH 2015), to predict the potential for swimming animals to be harmed by open rotor tidal device types. ERM estimates the number of encounter events per unit time per device based on the relative velocities (i.e., closing velocity) of a turbine and a swimming animal, and their sizes.

The second model is the ‘Band’ collision rate model (CRM), originally developed for wind turbines. The model has two stages. The first stage estimates the number of transits by a species through the rotor swept area per unit time (typically a season or a year) for the location under investigation. The second stage estimates the likelihood that a flying bird travelling through the rotor swept area will make contact with (i.e., encounter) a rotor. The encounter risk (or collision risk as referred to by the authors), before taking into account avoidance or evasion, is the product of the output from the two model stages.

The approach used in the Band CRM can also be used to estimate collision risk to diving birds from tidal devices. However, there are a number of differences between flying birds and swimming birds. The main difference is that for wind farms it is assumed that a bird passing through a rotor swept area is in level flight (a reasonable assumption based on observing flying birds) and that they pass at right angles to the plane of rotation i.e. at 90 degrees to a rotor blade (this assumption is unlikely to be always met, however the model output has low sensitivity to varying the angle of approach). For diving birds, swim trajectories are likely to be inclined to the horizontal or be approximately vertical, as they typically have v-shaped or u-shaped dive paths starting at and returning to the water surface. Indeed trajectories relative to a TEC could be orientated at any angle between horizontal and vertical.

A comparison of the outputs from the Band and ERM models for an open (i.e. unshrouded) 3-bladed turbine using the same input parameters has recently been undertaken (EMEC 2014). This concluded that for the range of scenarios tested, the two models gave broadly similar output values but with a relatively consistent difference, such that the average number of encounter events predicted by the ERM exceeded the number of collisions predicted by the Band model by a factor of approximately 1.4.

It was further agreed through consultation with MS and SNH (SNH, Scoping Opinion, 31 October 2013) that the Encounter Rate Model (ERM) (Wilson *et al.* 2007, SNH 2015) was a suitable approach to investigate the potential for collision mortality. This method has the advantage that it makes no assumptions about an animal's swimming direction relative to a rotor. Although ERM was initially considered to be the preferred method to examine the potential for collision to diving birds from Brims, SNH subsequently recommended the use of CRM for the open-centred turbines (SNH, letter 21 August 2014).

Modelling was undertaken using the ERM and CRM models for two different turbine types (shrouded and unshrouded) and three water depth scenarios of which full details are presented in Supporting Document 14B: Collision Risk to Diving Seabirds. The aim of the modelling was to predict the annual number of encounters between adult birds and turbine blades for the breeding and non-breeding season. Both mModels predicted ling found that the shrouded turbine type to result in the highest theoretical collision estimates, which and this turbine type is therefore considered as the layoutassumed for assessment of the entire technology envelope. Two of the water depth scenarios (shallow, intermediate, and deep) reflect the upper (minimum 30m below LAT) and lower (minimum 4m above seabed) limits of the possible turbine deployment within the water column (Table 14.20). As species have different diving behaviour potential collision risk levels differ with water depth. The intermediate depth scenario was chosen to reflect the turbine depth range that maximally coincides with time-at-depths utilised by common guillemot, the only species examined that spends most of its underwater time at mid water column depths. For the assessment only the depth scenario with the highest risk of collision is considered for each species.

It should be noted that the worst case collision risk predictions presented are for the worst possible case, in which turbines are positioned in the water column where they would pose the greatest potential collision risk to a species assuming a seabed depth of 65m throughout the deployment site. However, the worst possible case is unlikely to be the same as that which will transpire for the built array. This is because in many parts of the deployment area the seabed depth is greater than 65m and it is likely that engineering considerations will limit how far above the seabed turbines can be operated. Thus, the actual surface clearance is likely to be substantially greater than assumed for the worst case scenarios and, as a consequence, collision risk could be substantially lower. The 'worst case' approach adopted provides Open Hydro the greatest scope in possible engineering designs (such as turbine deployment height above the seabed); as the design details are narrowed further modelling can be undertaken to examine how the predicted collision risk to diving birds decreases.

There are several uncertainties that affect the accuracy of the model predictions, but by choosing conservative parameter values (i.e., those that err on the side of caution) it is considered that the outputs are likely to overestimate rather than underestimate the number of harmful collisions. Nevertheless, an obvious criticism of both the ERM and the Band CRM is that neither has been empirically validated for diving birds. This will not be possible until tidal device arrays are built and there are appropriate monitoring data that measure any interactions between diving birds and tidal turbines.

Aside from the uncertainty over the most appropriate avoidance rate, the model outputs are sensitive to the bird and device parameter values and the uncertainty over some of these has potential to affect the model outputs, in particular, the proportion of a bird's at-sea time spent underwater at rotor depth and mean rotor velocities.

In the case of the OpenHydro open-centred shrouded turbines, the ERM makes no allowance for the beneficial effects that might accrue from the shrouding or the open-centre design, yet common sense suggests that both of these will reduce collision risk, possibly substantially so. One way to factor in the benefits of shrouding and the open-centre in assessments would be to use a higher avoidance rate for turbines that have these characteristics than for turbines of a conventional unshrouded design.

Collision estimates are presented at a range of avoidance rates of 50%, 90%, 95%, 98% and 99%, considered appropriate for presenting and assessing diving bird collision modelling results for tidal stream arrays in Scotland (SNH, 2015). These values are considered to be reasonable and reflect the general view of many biologists working in the field that the actual number of harmful collisions will be substantially lower than the predicted number of encounters (EIMR Conference collision workshop, 2 May 2014). Following advice from SNH (letter to Marine Scotland,14 December 2015), an avoidance rate of 98% is chosen as the focus for assessment.A worst case avoidance rate of 90% is used in the assessment.

Although the encounter and collision rate model outputs are quantitative, they should be regarded as only indicative of the level of additional mortality/injury that may result. This is because the models used have not been validated empirically and several of the model parameters are only known approximately. While actual rates of behavioural avoidance and evasion and mortality/injury are unknown, model outputs are considered useful in terms of giving a first order and, most likely, cautious estimate of the absolute magnitude of the potential collision risk. Model outputs are also potentially useful for comparing different scenarios, e.g., different types and combinations of tidal devices, and in aiding the understanding of which aspects of tidal devices and array design have greatest bearing on collision risk to diving birds. Encounter and collision rate modelling are recommended by SNH to better understand the potential for collision risk to diving seabirds from tidal stream turbines (SNH, 2015).

Full details of the collision risk modelling approach can be found in Supporting Document 14B: Collision Risk to Diving Seabirds

Species Selection

The AIF for collision risk is defined as the spatial extent of the AfL area (Table 14.4). Red-throated diver, shag and black guillemot are excluded from modelling as all species were absent from the sea surface in the AfL during the breeding and non-breeding season. For the remaining species potentially vulnerable to collision risk, although technically birds outside the AfL would not be exposed to collision risk, it is considered that the mean seasonal densities for the AfL+1km and (tighter) associated confidence intervals are a more robust parameter than those for the AfL alone. Mean seasonal densities for species of moderate and high vulnerability to tidal energy developments are presented in Table 14.18. These form the basis for the collision risk modelling undertaken for the assessment.

Table 14.18: The mean seasonal surface density of receptors vulnerable to potential collision risk used to examine collision risk within the AfL area.

Species	Season	Mean density (birds/km^2)
Red-throated diver	Breeding	0 (not recorded in AfL)
	Non-breeding	0 (not recorded in AfL)
Shag	Breeding	0 (not recorded in AfL)
	Non-breeding	0 (not recorded in AfL)
Common guillemot	Breeding	10.43
	Chicks-on-sea	0
	Non-breeding	2.14
Razorbill	Breeding	5.70
	Chicks-on-sea	1.06
	Non-breeding	0.40
Black guillemot	Breeding	0 (not recorded in AfL)
	Non-breeding	0 (not recorded in AfL)
Puffin	Breeding	4.16
	Non-breeding	0.38

Sensitivity and Vulnerability

The review by Furness *et al.* (2012) considers the vulnerability of seabird species to underwater collision effects from TECs and shows that seabird receptors that use the Project survey area range from high (common guillemot, razorbill), to moderate vulnerability (puffin) to such impacts (Table 14.5).

Razorbill is deemed a receptor of low sensitivity, largely as a result of conservation status and regional declines (albeit set off against a relatively large regional breeding population). Common guillemot and puffin are considered receptors of negligible sensitivity, due to their very large background populations.

Correcting for Seasonal Background Population

For most species the composition of a population present in a given area changes after the breeding season as birds disperse or migrate away from breeding colonies over often large distances. Therefore, it would be particularly conservative to assume that collision estimates in the non-breeding season would only affect regional breeding birds. For all species it was assumed that 50% of the birds affected during the winter season originated from the regional breeding population.

For common guillemot and razorbill during the chicks-at-sea season it was assumed that all adult birds represented breeding birds from the regional population.

For common guillemot and razorbill the model-predicted number of encounters during the non-breeding period of the year was small compared to the number predicted for the breeding season; for common guillemot 14.3% of all encounters were predicted to occur in the non-breeding season and for razorbill the figure was 4.6% (Supporting Document 14B). Furthermore, the size of the BDMPS regional non-breeding populations of these species is much greater than the defined regional breeding populations; for common guillemot it is approximately three times greater and for razorbill it is approximately twenty times greater. For these reasons, and bearing in mind the small effect on adult mortality rates estimated for the regional breeding populations of these species based on many more predicted collisions affecting a much smaller population, it is not plausible that the effect of collisions on the adult mortality rate of the BDMPS regional non-breeding populations could be anything other than negligible, and for this reason it is not examined further.

Table 14.19: Annual baseline adult mortality rates and the proportion of adults from the regional breeding population used in collision risk modelling.

Species	Season	Baseline adult mortality	Proportion breeding adults1
Common guillemot	Breeding	6.1%[a]	76%
	Chicks-at-sea		
	Non-breeding		57%
Razorbill	Breeding	10.5%[b]	75%
	Chicks-at-sea		
	Non-breeding		57%
Puffin	Breeding	9.4%[c]	75%
	Non-breeding		57%
1: derived from Furness (2014); a. Lahoz-Monfort *et al.* 2011, Reynolds *et al.* 2011, Meade *et al.* 2013; b. Taylor *et al.* (2010), Lahoz-Monfort *et al.* (2011); c. Harris *et al.* (2005), Lahoz-Monfort *et al.* (2011), Taylor *et al.* (2010).			

Correcting for Age

Collision estimates were corrected for age to account for likely proportion breeding adults (Table 14.19). For the breeding season this was done on the basis of a pre-breeding census, i.e. no juveniles are present during this time of year, as these will have joined the immature age class over winter. Age distribution for the non-breeding season was based on a post-breeding census, i.e. juveniles have joined the overall population. Information on stable age distribution was derived from Furness (2014).

Modelling Results

All models predicted higher encounter rates for the OpenHydro shrouded turbine than for the 3-bladed unshrouded turbine and therefore the assessment of the OpenHydro turbine can be taken to cover the impacts associated with all turbines under consideration. An overview of the modelling results for the OpenHydro shrouded turbine device for each species and both Stages for the ERM and the CRM models is presented in Table 14.20. Change in adult annual mortality rate at 90% avoidance and associated impact magnitude are provided as well.

Typical puffin dive depths lie outside the underwater collision risk zone, explaining the predicted collision rate equating to zero.

Table 14.20: Worst case encounter rate model results and predicted indicative changes to annual baseline adult mortality rate of the regional breeding population at different avoidance rates for Stage 1 and Stage 1 & 2 for OpenHydro shrouded turbines.

Species/worst case depth scenario	Stage	Model	Predicted number of adult deaths per annum at different avoidance rates					Change in adult mortality at 90% avoidance	Impact magnitude
			0%	90%	95%	98%	99%		
Common guillemot (intermediate)	Stage 1	ERM	1607	161	80	32	16	0.09%	Negligible
		CRM	2632	263	132	53	26	0.14%	Negligible
	Stage 1 & 2	ERM	10713	1071	536	214	107	0.58%	Low
		CRM	17549	1755	877	351	175	0.94%	Low
Razorbill (shallowest)	Stage 1	ERM	5.0	0.5	0.3	0.1	<0.1	0.01%	Negligible
		CRM	7.5	0.7	0.4	0.15	<0.1	0.01%	Negligible
	Stage 1 & 2	ERM	33.4	3.3	1.7	0.7	0.3	0.06%	Negligible
		CRM	50.0	5.0	2.5	1.0	0.5	0.09%	Negligible
Puffin (all depths)	Stage 1	Both models	0	0	0	0	0	0.00%	Negligible
	Stage 1 & 2		0	0	0	0	0	0.00%	Negligible
Grey shaded values represent collision rates used for worst case impact assessment.									

Assessment

Common guillemot

The assessment considered one receptor (common guillemot) of negligible sensitivity and collision impacts (at 98% avoidance) of negligible magnitude for both Stage 1 and Stage 1 & 2 (Table 14.20). Therefore, effects of O&M collisions on common guillemot are evaluated as of negligible significance for both Stage 1 and Stage 1 & 2.

Use of a more precautionary avoidance rate, could result in an increase in magnitude level. For example for Stage 1 & 2, if a 90% avoidance rate was used (i.e. five times more precautionary than a 98% rate), a low magnitude level collision impact would be predicted, however this also be evaluated as of negligible significance.

Razorbill

The assessment considered one receptor (razorbill) of low sensitivity and collision impacts (at 98% avoidance) of negligible magnitude for both Stage 1 and Stage 1 & 2 (Table 14.20). Therefore, effects of O&M collisions on razorbill are evaluated as of negligible significance for both Stage 1 and Stage 1 & 2. .

Use of a more precautionary avoidance rate could result in an increase the the magnitude level. However, even when assessed for a 90% avoidance rate (i.e. five times more precautionary than a 98% rate), the magnitude level would remain negligible for both Stage 1 and Stage 1 & 2 and, therefore, the collision impact continue to be evaluated as of negligible significance.

Puffin

The assessment considered one receptor (puffin) of negligible sensitivity and collision impacts (at 98% avoidance) of negligible magnitude for both Stage 1 and Stage 1 & 2 (Table 14.20). Therefore, effects of O&M collisions on puffin are evaluated as of negligible significance for both Stages.

Mitigation and Good Practice

No mitigation is proposed for any receptor.

Summary of Residual Impact

The residual impact will remain of the same significance for all species receptor populations as assessed above.

Table 14.21: Summary of residual effects of collision risk to diving birds from operation and maintenance

Impact	Receptor	Sensitivity	Mitigation/good practice	Residual Magnitude	Residual Significance
Collision risk to diving seabirds (Stage 1)	Common guillemot	Negligible	PD04	Negligible	Negligible
	Razorbill	Low		Negligible	Negligible
	Puffin	Negligible		Negligible	Negligible
Collision risk to diving seabirds (Stage 1 & 2)	Common guillemot	Negligible		Negligible	Negligible
	Razorbill	Low		Negligible	Negligible
	Puffin	Negligible		Negligible	Negligible

14.12.3 Decommissioning

14.12.3.1 Direct Disturbance

Disturbance impacts from vessels during the decommissioning phase will be similar in nature to the construction phase (i.e. regular vessel presence), and is expected to occur over a similar period of time. It is assumed that Stage 1 and Stage 1 & 2 will be treated as a single decommissioning unit.

The assessment considered seven receptors of negligible sensitivity and direct disturbance of negligible magnitude. Given the nature of the disturbance, which is short-term and localised, the reversibility of any effect and the moderate habitat flexibility of most receptors (with black guillemot, low flexibility - almost exclusively foraging at the outer edge of the AfL+1km buffer, away from decommissioning activities), effects of vessel disturbance on all these receptors across all seasons are evaluated as a negligible impact for decommissioning of Stage 1 and Stage 1 & 2. It follows that impact evaluation of receptors of low priority across all seasons is similarly negligible.

Mitigation and Good Practice

No mitigation is required although good practice would aim to minimise disturbance to seabirds using the offshore site and along approach routes from ports by avoiding where possible the preferred feeding and resting areas and adopting speed restrictions. Studies elsewhere indicate the severity of disturbance by vessels is related to speed (e.g. Ronconi and Cassady St. Clair 2002). Vessel speed limits are commonly used to limit disturbance to seabirds in the vicinity of colonies and feeding sites; however there is no accepted maximum permissible speed. Professional judgement considers vessel speeds of up to 15km/hr (approximately 8 knots) are likely to give most seabird species time to move away from an approaching vessel without resorting to flight.

Good practice could for example be for construction vessels to stick to defined routes (as far as feasible) between ports and the offshore site as a means of reducing disturbance of seabirds. Studies have shown that disturbance is reduced if birds can predict where the disturbance will occur (Schwemmer *et al.* 2010). Consultation with SNH and Marine Scotland will be undertaken to establish the extent of any measures required.

Residual Impact

Good practice measures will reduce vessel disturbance; the residual impact will remain of negligible significance for all receptors.

Table 14.22: Summary of residual effects of direct disturbance from decommissioning

Impact	Receptor	Sensitivity	Mitigation/good practice	Residual Magnitude	Residual Significance
Direct disturbance, Stage 1 and Stage 1 & 2	Red-throated diver	Negligible	Best practice measures in relation to vessel management to be agreed with MSS/SNH GM07	Negligible	Negligible
	Shag	Negligible		Negligible	Negligible
	Kittiwake	Negligible		Negligible	Negligible
	Common guillemot	Negligible		Negligible	Negligible
	Razorbill	Negligible		Negligible	Negligible
	Black guillemot	Negligible		Negligible	Negligible
	Puffin	Negligible		Negligible	Negligible
	All other seabirds	Negligible		Negligible	Negligible

14.13 ACCIDENTAL AND UNPLANNED EVENTS

14.13.1 Accidental Contamination during Construction

The release of oil and other marine pollutants could have lethal and sub-lethal effects on seabirds and their prey. The potential for seabirds to be adversely affected by oil pollution is well known. For example, the release of a relatively modest quantity (ca 300 tonnes) of fuel oil from container ship MSC Napoli in Lyme Bay in 2007 resulted in the death or injury of at least 3,000 seabirds (Law 2008).

A special aspect of accidental release of contaminants, especially oil, is that they can be spread by wind and currents over very large areas and thus potentially affect birds in areas up to many tens of kilometres away from the source. For this reason it is not possible to define an AIF, except in a very broad sense, though it is obvious that the area that might be affected by an accidental release will depend on the magnitude of the event, the type of contaminant involved, and the prevailing weather conditions. It is also reasonable to conclude, based on the MSC Napoli incident, that even quite modest accidental releases of oil can affect large areas. For these reasons, the emphasis is on preventing accidental release of contaminants and having the appropriate contingency plans and equipment in place to rapidly respond and instigate containment and clean-up operations.

The installation of tidal devices into a wider marine area – the Pentland Firth - that experiences relatively high levels of vessel traffic, and the presence of Project vessels has the potential to increase the risk for vessel collisions or collisions with fixed infrastructure that could result in accidental release of contaminants. These risks are assessed in detail in Chapter 15 Shipping and Navigation. Safety zones during construction and installation will reduce the likelihood of an incident.

Due to the high/very high sensitivity of some species, mitigation measures have been identified that will be employed to ensure potential impacts are minimised:

- An Emergency Response Cooperation Plan (ERCoP) will be prepared for the Project in line with guidance set out by the MCA in MGN 371. This will be submitted to the MCA for comment and approval;
- Notices to Mariners will be issued advising other vessels in the area of activities within the AfL area and along the export cable corridor;
- Vessels associated with all Project operations will comply with IMO/MCA codes for prevention of oil pollution and any vessels over 400GT will have on board SOPEP's;
- Vessels associated with all Project operations will carry on-board oil and chemical spill mop up kits; and
- Installation activities will only take place during suitable weather windows.

Red-throated diver, shag and black guillemot are receptor species that use the AfL or the subsea cable corridor area and which are considered to have a very high vulnerability to accidental contamination (Table 14.5, Wiens *et al.* 1995). Common guillemot, razorbill and puffin have moderate vulnerability to contamination and all other receptors (including kittiwake) have medium vulnerability. Red-throated diver, shag and black guillemot are considered to have high sensitivity in relation to contamination as these species are relatively sedentary year-round (with the exception of red-throated diver), have short foraging ranges and have small regional populations. The remaining receptors are deemed to have moderate to low sensitivity as their respective background populations are much larger as are their foraging ranges, shielding these species somewhat from potential contamination effects.

The impact of the accidental release of contaminants from the construction phase of the Project on regional seabird populations is assessed as short-term, unlikely to occur and negligible spatial magnitude as a result of the embedded mitigation described above. Regional seabird populations are considered to have a low to high sensitivity to this impact for the (small) scale of an accidental contamination event, should it occur. It is judged that this impact has negligible significance for all seabird receptor populations under the terms of the EIA Regulations.

14.13.1.1 Mitigation and Good Practice

No further mitigation is proposed in addition to embedded pollution prevention and navigation safety mitigation, outlined above.

14.13.1.2 Residual Impact

Provided good practice guidelines are adhered to, the impacts of accidental release of contaminants on marine birds populations will be of negligible significance for all species.

Table 14.23: Summary of residual effects of accidental contamination from construction and installation

Impact	Receptor	Sensitivity	Mitigation/good practice	Residual Magnitude	Residual Significance
Accidental contamination, Stage 1 and Stage 1 & 2	Red-throated diver	High	Best practice vessel protocols, exclusion of non-project vessels from site, contingency plans and specialist facilities to deal with incidents. GM07, GM11, OR01	Negligible	Negligible
	Shag	High		Negligible	Negligible
	Kittiwake	Low		Negligible	Negligible
	Common guillemot	Moderate		Negligible	Negligible
	Razorbill	Moderate		Negligible	Negligible
	Black guillemot	High		Negligible	Negligible
	Puffin	Moderate		Negligible	Negligible
	All other seabirds	Negligible		Negligible	Negligible

14.13.2 Accidental Contamination during Operation and Maintenance

The potential for accidental contamination impacts to occur during the O&M phase is similar to the construction phase, albeit the risk remains over the tidal array's life span of 20-25 years. The assessment and embedded mitigation measures presented above for the construction phase are therefore also applicable here. Therefore the assessment for the O&M phase concluded that provided best practice measures are strictly adhered to, the impact of accidental contamination is of negligible significance for all seabird receptor populations for both Stage 1 and Stage 1 & 2.

Mitigation measures have been provided as a precautionary approach to ensure this remains the case. For TECs these include the following:

- Only recognised marine standard fluids and substances will be used in the turbine hydraulic systems;
- Hydraulic fluids will be mostly water based, biodegradable and be of low aquatic toxicity; and
- Project specific emergency response procedures will be implemented and include contingency arrangements in the unlikely event of a pollution incident.

Table 14.24: Summary of residual effects of accidental contamination from operation and maintenance

Impact	Receptor	Sensitivity	Mitigation/good practice	Residual Magnitude	Residual Significance
Accidental contamination, Stage 1 and Stage 1 & 2	Red-throated diver	High	Best practice vessel protocols, exclusion of non-project vessels from site, contingency plans and specialist facilities to deal with incidents. GM07, GM11, GM01	Negligible	Negligible
	Shag	High		Negligible	Negligible
	Kittiwake	Low		Negligible	Negligible
	Common guillemot	Moderate		Negligible	Negligible
	Razorbill	Moderate		Negligible	Negligible
	Black guillemot	High		Negligible	Negligible
	Puffin	Moderate		Negligible	Negligible
	All other seabirds	Negligible		Negligible	Negligible

14.13.3 Accidental Contamination during Decommissioning

The potential for accidental contamination impacts to occur during the decommissioning phase is similar to the construction and O&M phases. The assessment and embedded mitigation measures presented above for both phases are therefore also applicable here. Therefore the assessment for the decommissioning phase concluded that provided best practice measures are strictly adhered to, the impact of accidental contamination will remain of negligible significance for all seabird receptor populations.

Table 14.25: Summary of residual effects of accidental contamination from decommissioning

Impact	Receptor	Sensitivity	Mitigation/good practice	Residual Magnitude	Residual Significance
Accidental contamination, Stage 1 and Stage 1 & 2	Red-throated diver	High	Best practice vessel protocols, exclusion of non-project vessels from site, contingency plans and specialist facilities to deal with incidents. GM07 GM11 OR01	Negligible	Negligible
	Shag	High		Negligible	Negligible
	Kittiwake	Low		Negligible	Negligible
	Common guillemot	Moderate		Negligible	Negligible
	Razorbill	Moderate		Negligible	Negligible
	Black guillemot	High		Negligible	Negligible
	Puffin	Moderate		Negligible	Negligible
	All other seabirds	Negligible		Negligible	Negligible

14.14 SUMMARY

- Project design mitigation relating to the removal of surface-piercing structures of any kind removes the potential of displacement of seabird receptors due to the presence of structures at the sea surface. Further design mitigation involved increasing the minimum clearance distance between the rotor-swept area and LAT, substantially reducing the potential for collision impacts on diving seabirds;
- Impacts on ornithological receptors through direct habitat loss and indirect effects through changes to habitats and associated prey species are considered to be of negligible significance due to the very minor shift away from baseline conditions of the benthic habitat;
- Disturbance and accidental contamination impacts on receptors across all Project phases are minimised through a range of mitigation and good practice vessel management measures;
- Potential collision impacts on three species of diving seabird (common guillemot, razorbill, puffin) are of sufficiently small magnitude to avoid adverse effects at the population level.

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