EMEC Billia Croo Test Site: Environmental Appraisal

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ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
AEP	Auditory Evoked Potentials
AESI	Adverse Effects on Site Integrity
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
BGS	British Geological Survey
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CPA	Coast Protection Act
CTD	Connectivity Temperature Depth
CREEM	Centre for Research into Ecological & Environmental Modelling
DECC	Department for Energy and Climate Change
EC	European Commission
EEZ	Exclusive Economic Zone
ELWS	Extreme Low Water Spring
EMF	Electromagnetic Field
ELWS	Extreme Low Water Spring
EMEC	European Marine Energy Centre
EMF	Electromagnetic Fields
EPS	European Protected Species
ESAS	European Seabirds at Sea
FEPA	Food and Environment Protection Act
FCS	Favourable Conservation Status
FORESEA	Funding Ocean Renewable Energy through Strategic European Action
FPO	Fish Producer Organisation
GCR	Geological Conservation Review
GIS	Geographic Information System
HESS	High Energy Seismic Survey
HRA	Habitats Regulations Appraisal or Assessment
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for Exploration of the Seas
ICIT	The International Centre for Island Technology
IMO	International Maritime Organization
INNS	Invasive Non-Native Species
IPIECA	International Petroleum Industry Environmental Conservation Association
IROPI	Imperative Reason of Overriding Public Interest
JNCC	Joint Nature Conservation Committee
kHz	Kilohertz
KM	Kilometre
kV	Kilovolt
LSE	Likely Significant Effect
MarLIN	Marine Life Information Network
MCS	Marine Conservation Society
MLWS	Mean Low Water Spring
MPA	Marine Protected Area
MMMU	Marine Mammal Management Unit
MNNS	Marine Non-Native Species
MoD	Ministry of Defence
MPA	Marine Protected Area
MS-LOT	Marine Scotland Licensing and Operations Team
NCMPA	Nature Conservation Marine Protected Area
NM	Nautical Miles
NMFS	National Marine Fisheries Service
NMPi	National Marine Plan interactive
NWE	North-west Europe
NOAA	National Oceanic and Atmospheric Administration
NRA	Navigation Risk Assessment
OFA	Orkney Fisheries Association
OSPAR	Oslo-Paris
PEMP	Project Environmental Monitoring Programme

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PBR	Potential Biological Removal
pk-pk	Peak to Peak
PMF	Priority Marine Feature
PMF	Priority Marine Feature
pMPA	Possible Marine Protected Area
pSPA	Proposed Special Protected Area
REM	Risk of Entanglement Measure
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SBP	Sub Bottom Profile
SCI	Site of Community Importance
SCOS	Special Committee on Seals
SLVIA	Seascape, Landscape and Visual Impact Assessment/Appraisal
SMRU	Sea Mammals Research Unit
SNH	Scottish Natural Heritage
SOP	Standard Operating Procedures
SSS	Side Scan Sonar
SSSI	Site of Special Scientific Interest
TOB	Third Octave Band
TTS	Temporary Threshold Shift
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
UK BAP	UK Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf
UXO	Unexploded Ordnance
WEC	Wave Energy Converter

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1 INTRODUCTION

1.1 Project background

The European Marine Energy Centre (EMEC) was established in 2003 in Orkney. The centre offers potential marine renewable energy developers the opportunity to test prototype devices in real sea conditions. The centre has two key sites, one to test tidal energy devices which is located at Fall of Warness, Eday and a second (the focus of this document) a test site for Wave Energy Converters (WECs) and other infrastructure associated with marine renewables, located at Billia Croo, Stromness.

1.1.1 Billia Croo test site

Billia Croo is a full-scale grid-connected test site currently composed of five deep-water test berths and two inshore test berths with associated pipelines and cables to shore. The grid-connected test berths are serviced by subsea cables from an onshore substation, buried under the beach to 5 m below the Mean Low Water Spring (MLWS) mark, and then laid directly onto the seabed with cast iron cable protection for the first 250 m, the remaining length of each cable is unprotected. The test site is situated at Billia Croo off the west coast of the Orkney Mainland. The site is currently being expanded to accommodate future developer testing requirements. The current extent and agreed lease area extension are shown in Figure 1-1.

1.2 Requirement for Environmental Appraisal

In order to streamline licensing and testing for developers at the Billia Croo test site, a site-wide S36 consent under the Electricity Act 1989 is being sought by EMEC based on an envelope of testing activities. To support the S36 consent application, Xodus Group Limited (Xodus) has been commissioned by EMEC to undertake a full Environmental Appraisal (EA) for the Billia Croo test site. The purpose of the EA (this document) is to pre-appraise potential deployments and activities, based on the Project Envelope within the context of the wider environment. The Project Envelope will accompany this EA document as part of the S36 application (EMEC, 2019a).

to produce an EA which will inform developer licence applications for all the testing and operations described within the Project Envelope.

As part of the original development of the Billia Croo test site, EMEC commissioned an EIA (Environmental Impact Assessment) in 2002, the findings of which were reported in an Environmental Statement (ES) (Carl Bro Group Ltd, 2002). This ES supported the Food and Environment Protection Act 1985 (FEPA) and Coast Protection Act 1949 (CPA) licences (Table 1-1). These licences allowed the presence of the test site but did not cover the deployment of individual wave devices by developers. An updated Environmental Description (from that contained in the 2002 ES) was produced in 2005 (Aurora Environmental, 2005) and subsequently updated by EMEC in 2009.

A Navigational Risk Assessment (NRA) was undertaken in 2008 and a subsequent report based on the NRA was produced to provide information to allow developers to produce a project-specific annex to the NRA (Abbott Risk Consulting Ltd, 2009). A new NRA has been undertaken in 2018/2019 and will be submitted with the S36 application (Marine and Risk Consultants Ltd, 2019).

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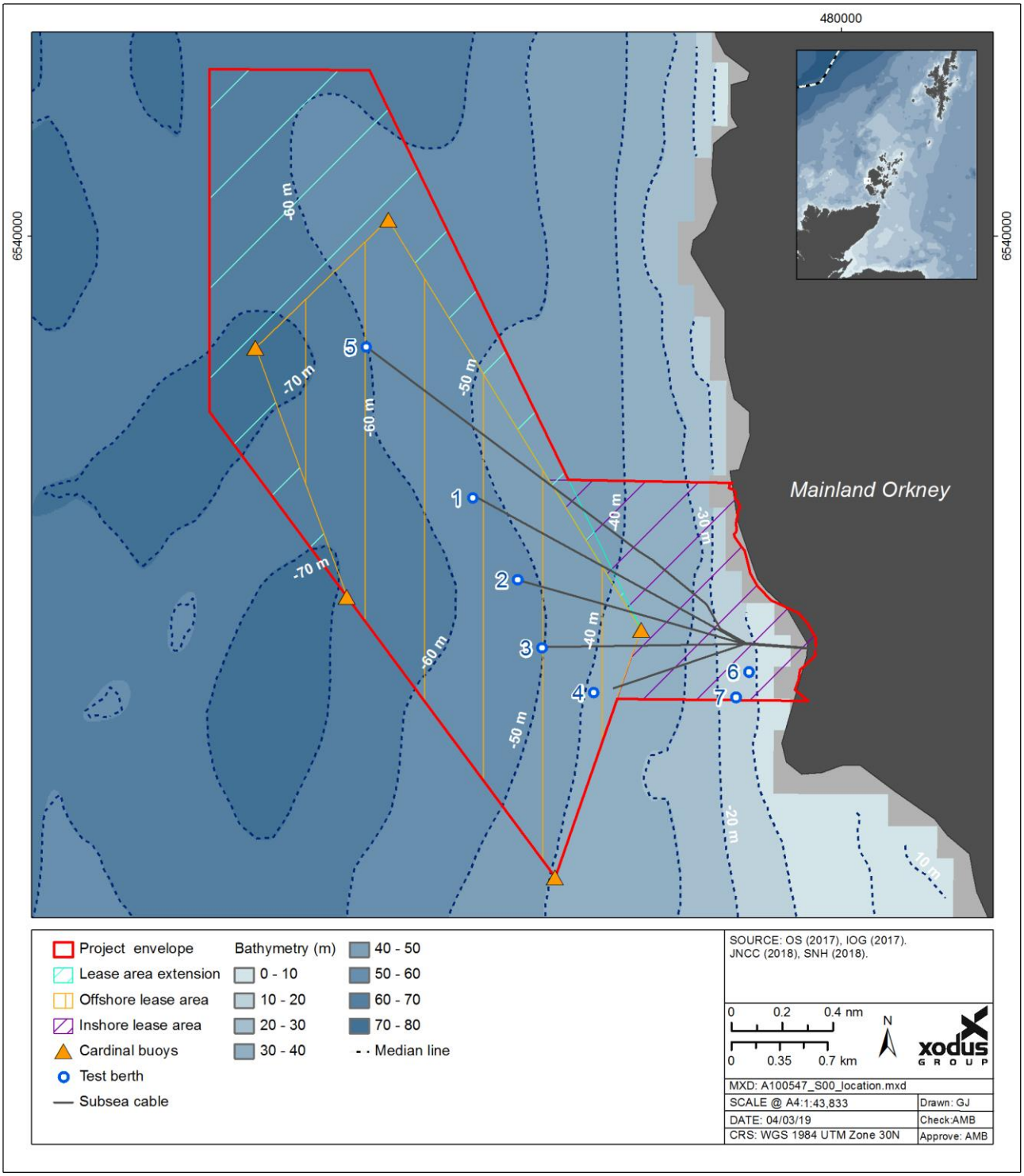
Figure 1-1 Location of Billia Croo test site including proposed extension[1]



This EA will supply sufficient information for EMEC to produce an ES for the purposes of S36 application. The EA reviews all relevant environmental information (including protected sites as per Figure 1-2).

[1] One lease area with areas within differentiated for clarity and assessment, all within the 12 nm limit.

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As discussed, previous EMEC consents have supported the existence of the site rather than individual device deployments. Consequently, to date, all developers need to apply for their own Marine Licence (under the Marine Scotland Act 2010, following the replacement of FEPA and CPA licences in 2010). Those developers with deployments over 1 MW also require S36 and need to provide appropriate supporting information to assess the potential impact associated with their project.

In 2014, an EA was undertaken in support of a site-wide S36 application for the EMEC Fall of Warness tidal test site. The EA appraised potential impacts on sensitive receptors at the site and it is now assumed that all activities described as part of the Fall of Warness Project Envelope are pre-appraised (EMEC, 2014). It is intended that this EA for the Billia Croo test site will result in the same streamlining of assessments.

The Billia Croo test site is currently being expanded to accommodate future developer testing requirements. This expansion is included as part of the Project Envelope and is therefore considered throughout the EA process. The Crown Estate Lease is currently in the process of being extended to 2040, any appraisals in this document are valid until 2040.

Table 1-1 Billia Croo licences and consents

Type of consent/licence/appraisal	EMEC	Developers
Previous and existing consents	> 3 CPAs for cables. > 4 FEPA for cable protectors. > Planning permission for onshore facilities. > Marine Licence for the deployment of scientific instrumentation.	> Various CPA/FEPA/Marine Licences held by individual developers for device deployments. > Various S36 consents for projects with greater than 1 MW generating capacity.
Crown Estate (Scotland) lease	Current lease until 2025. Variation process underway for a 21-year lease extension from 2019 to 2040.	N/A
Embedded Generation Connection Agreement	Agreement commenced in 2004 and limits total export capacity to 7 MW.	N/A
Navigational Hazard Identification and Risk Assessment	Undertaken in 2002 to support the presence of the test site.	N/A
Navigational Risk Assessment	An NRA was undertaken in 2008 to inform device specific NRAs (Abbott Risk Consulting Ltd, 2009).	Various device specific NRAs in support of device specific deployments.
	Updated NRA carried out by Marine and Risk Consultants Ltd in 2018, to support site-wide S36 application (Marine and Risk Consultants Ltd, 2019).	Not applicable to specific developers, but a site wide source of information.
Appraisals and assessments	EIA undertaken with associated ES undertaken in 2002 to support FEPA and CPA applications. An updated environmental description was then prepared in 2005 (Aurora Environmental, 2005) and subsequently updated by EMEC in 2009.	Individual developers have produced appraisals in support of their respective deployments. Each focussing on the specifics of individual deployments.
Seascape Landscape and Visual Appraisal	Conducted in 2019 by Land Use Consultants Ltd, to support site-wide S36 application.	N/A

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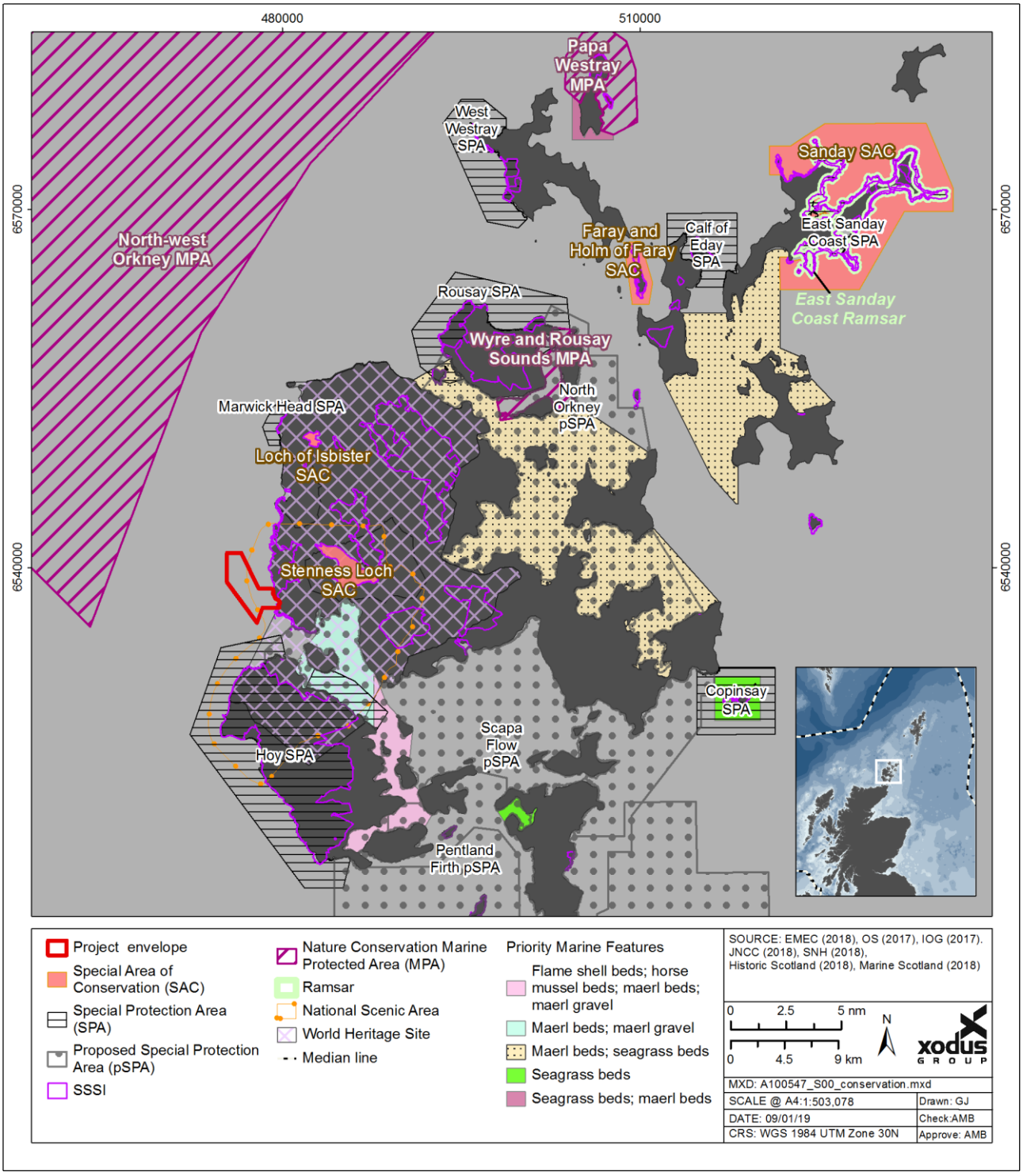
Figure 1-2 Billia Croo location in the context of the wider Orkney environment, including protected sites



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1.3 Principals of EA and consenting

This EA is undertaken according to a defined Project Envelope. This Project Envelope details the types and characteristics of devices likely to be deployed for testing at the EMEC grid-connected test site at Billia Croo. It also describes the types of marine operations and activities likely to be associated with the installation (and decommissioning), operation and maintenance of these devices. The Project Envelope includes key details including the 'worst case' parameters used in the EA process are presented in Table 2-2.

Comprehensive appraisals are provided for the key receptors encountered at and potentially impacted by activities at the Billia Croo test site and provide information to satisfy the legal requirements of legislation relating to designated sites and protected species, where relevant including Habitats Regulations Appraisal (HRA).

A series of land-based vantage point marine wildlife surveys were undertaken at Billia Croo by EMEC in the period from March 2009 to March 2015. Data collected as part of this programme has informed this EA, the raw data is available to download from the Marine Scotland interactive website[2].

Included in the EA process and reported in this document are recommendations for the development of mitigation, monitoring and research strategies to facilitate developers at the site. Certain mitigation will be expected as part of licence requirements, whereas other mitigation may be suggested as good practice and may not be applicable to all developments at Billia Croo. Each conclusion section in individual appraisal indicates where mitigation is possible/likely to form a licence condition and where it is suggested as good practice. This EA will be made available to EMEC's clients, the regulator and consultees.

Following agreement with the regulator, through the process of the EA, it is considered that any application for a Marine Licence or S36 consent for testing activities or operations, within the parameters of the Project Envelope, at the Billia Croo test site may be regarded as pre-appraised in terms of environmental impacts and HRA. Where projects are deemed to not fit within the Project Envelope, additional appraisal will be required by the applicant (to be determined by Marine Scotland after further consultation).

Within the Project Envelope there are certain incidences where case-by-case or additional consultation or assessment is recommended. Where this applies it is highlighted within each appraisal.

It is expected that developers wishing to utilise the Billia Croo test site will use available guidance, standards and procedures from EMEC including EMEC's Guidance for Developers (EMEC, 2019b) in order to understand their requirements for Marine Licence and S36 applications. Individual appraisals within this EA should be consulted when developers produce a Project Environmental Monitoring Programme (PEMP). All PEMP's will be agreed with Marine Scotland ahead of any works taking place at site. It is expected that the developer will liaise closely with EMEC throughout the consenting process.

SNH and other consultees will be consulted by Marine Scotland during the approval of the PEMP. The process of PEMP development is expected to be iterative and will be amended to reflect changes in requirements and any new information which becomes available. A first draft of the PEMP should be submitted with the Marine Licence application.

Development of the PEMP aims to:

- Identify and support delivery of mitigation necessary for ensuring that residual impacts are reduced to an acceptable level;
- Identify and support delivery of mitigation and monitoring that demonstrate best practice in management of environmental impacts at development sites;
- Increase understanding of environmental impacts and how to monitor and analyse them, to the benefit of individual developers and the wider industry in relation to commercial up-scaling and deployment; and

[2] http://marine.gov.scot/themes/european-marine-energy-centre-wildlife-observation

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- Provide opportunities for developers, with support from EMEC, SNH and Marine Scotland, to seek innovative solutions for mitigating impacts or for understanding the importance of interactions between their developments and the environment.

1.4 Exclusions

The following elements are excluded from the EA process:

- Onshore[3] ancillary developments and infrastructure are not addressed in these appraisals (including the landfall of cables). Any such proposals require consideration under the Town and Country Planning (Scotland) Act 1997;
- This EA process does not consider Navigational safety. A Navigation Risk Assessment (NRA) has been carried out separately and is available alongside the EA;
- This EA does not give consideration to seascape, landscape and visual amenity. A detailed Seascape, Landscape and Visual Impact Assessment (SLVIA) has been carried out separately and is available alongside the EA; and
- All activities outwith the Project Envelope.

1.5 EA project team

The EA has been undertaken by specialist environmental and technical consultants. The EA document has been written by Xodus with specialist input from Atlantic Ecology for the ornithology appraisal presented in Section 10 and Orkney Research Centre for Archaeology (ORCA) for the marine archaeology appraisal presented in Section 13.

1.6 EA structure and document updates

The EA document has the following structure:

- Section 1: Introduction
- Section 2: Project Envelope
- Section 3: EA Methodology
- Section 4: Benthic and intertidal appraisal
- Section 5: Hydrodynamic and physical processes appraisal
- Section 6: Fish and shellfish appraisal
- Section 7: Basking shark appraisal
- Section 8: Cetacean appraisal
- Section 9: Pinniped appraisal, including HRA requirement
- Section 10: Ornithology, including HRA requirement
- Section 11: Otter appraisal
- Section 12: Commercial fisheries appraisal
- Section 13: Archaeology appraisal
- Section 14: Mitigation, monitoring and research

[3] Above Mean Low Water Spring (MLWS) and nonshore infrastructure at Billia Croo already established.

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- Section 15: Development of PEMP
- Section 16: Conclusions

As knowledge of impacts changes it may be necessary to update this EA to better reflect the predicted impacts. Updates may also be required if there are any significant changes to the environmental parameters at the site. It is expected this EA will be subject to periodic review and update as population, protected site and management unit information change over time. The regularity of review will be determined by the availability of new or updated information relevant to the EA. This is particularly important where impacts have been appraised using population level data. Any changes to the EA will be reviewed with Marine Scotland and SNH to understand if any changes to consent are necessary.

1.7 Key data sources and references

References used to inform individual appraisals are detailed at the end of each appraisal. The following key references and data sources has been used to inform the process as a whole and are also considered key references which all developers at Billia Croo should be familiar with:

- Offshore wind, wave and tidal energy applications: consenting and licensing manual (Scottish Government, 2018a).
- Marine Licensing Guide (Marine Scotland, 2018a).
- Marine Scotland Interactive website (Marine Scotland, 2016a).
- Marine Scotland Impact Assessment Tool for Marine Energy Developments (Marine Scotland, 2018b).
- EMEC Billia Croo Environmental Statement, (Carl Bro Group Ltd, 2002).
- EMEC Billia Croo Environnemental Description (EMEC, 2009).
- NRA for Billia Croo (Abbott Risk Consulting Ltd, 2009).
- NRA for Billia Croo (Marine and Risk Consultants Ltd, 2019).
- Guidance for Developers at EMEC grid connected sites: supporting environmental documentation (EMEC, 2019b).
- Guidance on Survey and Monitoring in Relation to Marine Renewables Deployments in Scotland, (SNH, 2011).
- Wave and Tidal Strategic Environmental Assessment, (Scottish Government, 2018b).
- SNH Site Link, (SNH, 2017).
- EMEC Billia Croo Wildlife Observation Data, (EMEC, 2016).
- EMEC downloads, (various dates available from http://www.emec.org.uk/about-us/media-centre/downloads/).

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2 PROJECT ENVELOPE

The Billia Croo test site consists of five cabled test berths and two inshore test berths. Testing at the site typically consists of entire devices with associated moorings or foundation system, but may also include testing of device components, mooring systems, marine operations associated with installation, maintenance and/or decommissioning. The test site was developed as a wave energy test site, and this remains the principle form of testing activity at the site. However, due to similarities in required infrastructure across the offshore renewable energy industry, the test site may be offered for testing components and mooring/foundation systems for other forms of renewable energy.

A detailed Project Envelope has been produced which will accompany this EA with the S36 application (EMEC, 2019a). This Project Envelope has been used as the basis for assessment. The following section serves to provide an overview of the infrastructure and activities included, which each appraisal has considered when appraising potential impacts and importance.

The following activities and deployments are included within the EA and considered throughout this EA:

- Testing activities associated with single devices and arrays deployments, including installation, maintenance and decommissioning works;
- Installation, maintenance, and testing of subsea cables;
- Testing of device components including mooring/foundation systems;
- Buoys and scientific instrument/equipment deployments and surveys;
- Marine works including site preparation and simultaneous operations; and
- Decommissioning of infrastructure.

Any activities not described in the Project Envelope are excluded from this appraisal and would require further consultation and appraisal/assessment to understand the potential positive and negative environmental and navigational impacts directly associated with the activity. This will be determined by the Regulator and EMEC. Of note the following are excluded:

- Onshore works;
- Percussive piling;
- Additional cable (replacement of existing cable is included);
- Beach excavation; and
- Seabed clearance such as kelp clearance and rock grinding/blasting.

Table 2-1 provides an overview of the technologies to be considered throughout this EA and Table 2-2 details the maximum parameters which potential impacts and importance are assessed against throughout the EA.

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Table 2-1 Overview of technologies included in the Project Envelope

WEC categories	Foundation and mooring methods	Likely marine works[4]	Typical vessels	Typical scientific instruments/testing
> Over-topping Device > Oscillating Wave Surge Converter > Submerged Pressure Differential > Oscillating Water Column > Attenuator > Point Absorber > Bulge Wave > Rotating Mass	> Foundation structure fixed into the seabed via piles/pins (non-percussive drilling only) > Foundation structure held on to the seabed by gravity > Gravity-based anchor(s) with mooring line(s) attached > Rock anchor(s) with mooring line(s) attached > Suction anchor(s) with mooring lines attached > Embedment anchor(s) with mooring line(s) attached > Pin(s) (e.g. rock bolts) with mooring line(s) attached > Other mooring structure pinned (non-percussive drilling), or held on, to the seabed by gravity	**Pre-installation:** > ROV/diver surveys > ADCP and waverider deployment/retrieval > Bathymetry surveys > Sub-bottom profiling > Acoustic surveys **Installation:** > Drilling and grouting > Lowering infrastructure > Cable works and connection to device **Testing and maintenance of devices:** > ROV inspection > Diver activities > Repairs below and above sea surface > Biofouling removal > Acoustic surveys **Decommissioning:** > ROV inspection > Cable works and disconnection > Diver activities > Cutting and drilling	> Tug > Workboat with and without dive support capability > Multicat workboat > Dive support vessel > Survey vessel (ROV compatible) > Gantry barge > Crane barge > DP Class II Anchor Handler Tug > Cable laying vessel	> Wave Measurement Buoys > Acoustic Doppler Current Profilers (ADCP) > Acoustic measurement devices > Active acoustic devices > Acoustic communication devices > Marine robotics > Datacentres > Testing of anti-fouling systems, biofouling and corrosion tests > Underwater cameras > Conductivity Temperature Depth (CTD) measurement instruments > Integrated monitoring pod housing an array of the above instrumentation

[4] Active acoustic devices and sub bottom profilers may be subject to additional appraisal, taking account of equipment specifications.

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WEC categories	Foundation and mooring methods	Likely marine works[4]	Typical vessels	Typical scientific instruments/testing
		> Grappling operation > Lifting infrastructure > Forensic/failure analysis		

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Table 2-2 Maximum parameters relevant to appraisals

Project element/activity	Maximum parameter	Relevant appraisal									
		Benthic	Hydrodynamics	Fish and shellfish	Basking sharks	Seals	Cetaceans	Otters	Commercial fisheries	Ornithology	Archaeology
Area of test site	11 km^2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Length of existing subsea cable[5]	11,000 m	✓	✓	✓	×	×	×	×	✓	×	✓
Maximum area of cable which could be replaced (Assuming maximum cable diameter of 0.03m)	3,300 m^2	✓	✓	✓	×	×	×	×	✓	×	✓
Export grid capacity at the site	7 MW	×	×	✓	✓	✓	✓	✓	×	×	×
Maximum number of berths	10 (within the site boundary as per Project Envelope)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Maximum length of a floating device	200 m	×	×	×	×	×	×	×	✓	✓	×
Maximum width of a floating device when length 50 – 200 m	12 m	×	✓	×	×	×	×	×	✓	✓	×
Maximum width of a floating device when length ≤ 50 m	30 m	×	✓	×	×	×	×	×	✓	✓	×
Maximum number of WEC assemblages[6]	20 on site at one time	✓	✓	✓	✓	✓	✓	×	✓	✓	✓

[5] The 11 km cable stated in the Project Envelope is the existing cable length. A Marine Licence and associated assessment will be required for the addition of subsea cables at the site beyond 11km.
[6] Some WECs require numerous converter components to function, therefore an assemblage is considered the device components and individual components necessary to have a fully functioning wave energy converter.

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Project element/activity	Maximum parameter	Relevant appraisal									
		Benthic	Hydrodynamics	Fish and shellfish	Basking sharks	Seals	Cetaceans	Otters	Commercial fisheries	Ornithology	Archaeology
Floating platforms (not including floating devices/components)[7]	Maximum of two on site at any one time	×	✓	✓	×	×	×	×	✓	✓	×
Maximum number of electrical hubs on site at one time (may have surface piercing elements)	10	×	×	✓	×	×	×	×	✓	✓	×
Maximum total area of seabed coverage per electrical hub	400 m^2	✓	✓	✓	×	×	×	×	×	×	✓
Maximum height above sea surface for surface piercing elements	12 m at MLWS or 8 m when floating component is >20 m in length	×	×	×	×	×	×	×	×	✓	×
Maximum number of mooring systems not connected with devices	Three	✓	✓	✓	✓	✓	✓	×	×	×	×
Maximum footprint in total of moorings per device or independent mooring system (including mooring lines)	3,000 m^2	✓	✓	✓	×	×	×	×	×	×	✓
Maximum direct seabed coverage from foundation (area of seabed with which infrastructure has direct contact) per device	750 m^2	✓	✓	✓	×	×	×	×	×	×	✓
Maximum footprint for a single vessel anchor and line, sweeping the seabed along 150 m and in an angle of 45°	10,000 m^2	✓	×	×	×	×	×	×	×	×	×

[7] Floating platforms are included in the maximum number of devices i.e where two floating platforms are deployed a maximum of 18 WECs are able to be deployed.

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Project element/activity	Maximum parameter	Relevant appraisal									
		Benthic	Hydrodynamics	Fish and shellfish	Basking sharks	Seals	Cetaceans	Otters	Commercial fisheries	Ornithology	Archaeology
Maximum footprint (area under infrastructure or mooring spread)[8]. This assumes: 20 devices (including floating platforms), ten electrical hubs, three mooring systems not connected with devices. For maximum footprint it is assumed mooring systems rather than foundations are utilised.	73,000 m^2	✓	✓	✓	✓	✓	✓	×	×	×	✓
Maximum worst case scenario for simultaneous marine works	Noise-generating activities simultaneously taking place at all 10 berths[9]	×	×	✓	✓	✓	✓	✓	×	✓	×
Maximum number of vessels operating simultaneously at the site	12	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

[8] Excludes developer owned electrical cable or pipeline.
[9] Noise-generating activities are defined as drilling for piling installation or pile cutting and do not vessel activity. This maximum worst case scenario is highly unlikely due to practical operational constraints (vessel/crew availability). A more realistic maximum scenario would be noisy activity taking place at a maximum of two berths at the same time, with inspection/maintenance activities happening at a maximum of two other berths simultaneously (although in practice even this scenario would be unlikely due to the constraints mentioned above).

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3 EA METHODOLOGY

3.1 Overview

The appraisals that follow (Sections 4 – 14) assess the environmental impacts during the installation (and decommissioning), operation and maintenance phases of device and infrastructure testing at Billia Croo. The appraisals are carried out based on the detailed Project Envelope. The appraisals account for all installations to date as well as those which may be applied for in the lifetime of the consent (expires 2040). Through this process, it is considered that any application for a Marine Licence or S36 consent for deployment at any of the berths at Billia Croo up to 2040 are regarded as pre-appraised in terms of environmental impacts. This will only be considered true if application details are within the limits set out by the Project Envelope, deviation from this envelope will require additional appraisal and consultation with EMEC and Marine Scotland.

3.2 Methodology

In 2014, EMEC undertook an EA for the Fall of Warness tidal test site (EMEC, 2014). The aim of the EA was to pre-appraise potential deployments within the context of the wider test site.

The three-step process used for the Fall of Warness is the chosen methodology for the appraisals for the Billia Croo test site. This allows for:

- Continuity of appraisal methodology between different EMEC assets;
- Use of a methodology that has previously been accepted by the regulator and their advisors; and
- Clearly distinguishes between the assessment requirements under different legislative regimes.

An overview of the process and a brief description of the steps is provided in Figure 3-1.

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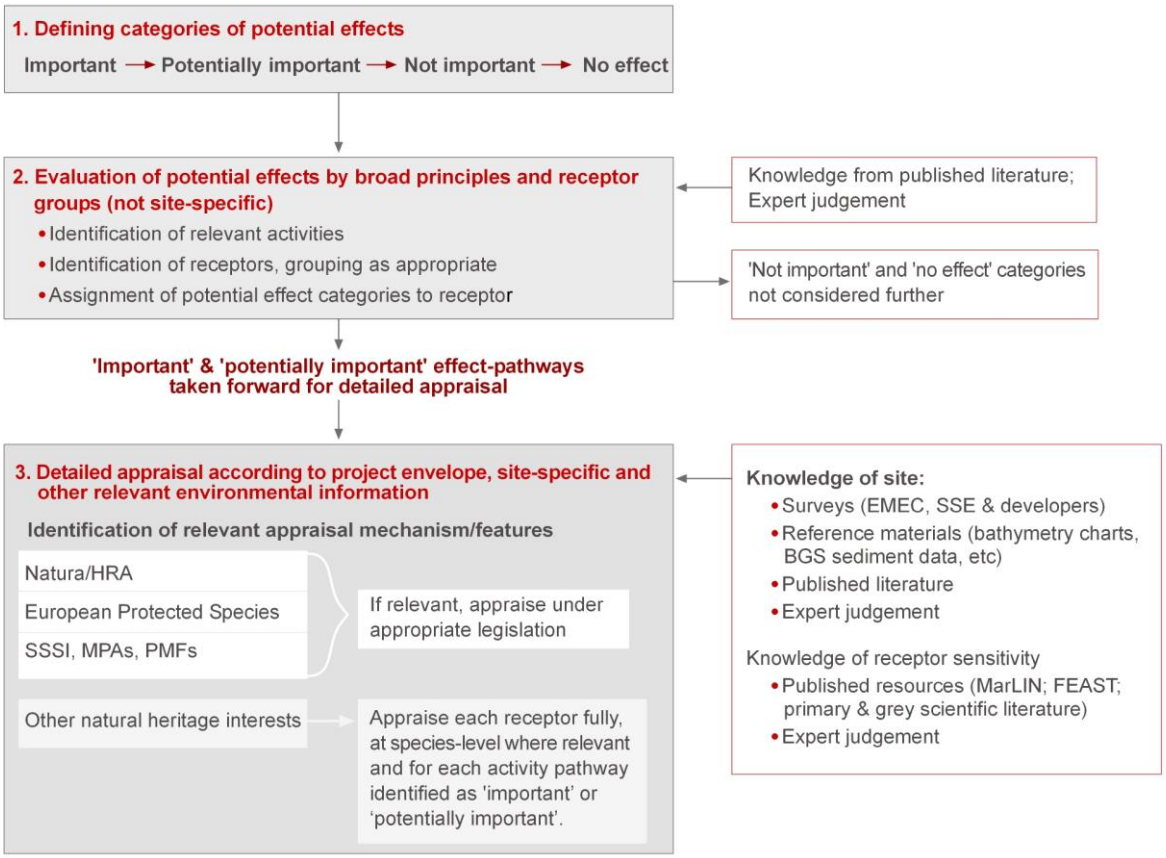
Figure 3-1 Overview of the EA process to be utilised for the Billia Croo test site



Step 1 Identification of activities/effects requiring detailed appraisal

Step 1 sets out the definitions and categories of potential effects to be considered in subsequent steps. These categories are to be applied to all receptor types and be used to identify which activities/effects require detailed appraisal.

Step 2 Identify potential effect-pathways and assign level of 'importance'

Step 2 identifies development activities and potential effect-pathways and assigns a level of importance (as per definitions developed/agreed in Step 1) for each receptor under consideration. Construction, installation and decommissioning effects are considered separately from those during operational and maintenance phases.

Step 3 Detailed appraisal of 'important' or 'potentially important' effects

Step 3 undertakes a full detailed appraisal of potential activities/effect-pathways regarded to be 'important' or 'potentially important'. The detailed appraisal reports on the following outcomes:

- Appraisal conclusion for each receptor/receptor group or impact type, including outcomes for protected sites and species;
- Any species licensing needs; and
- Potential mitigation and monitoring measures.

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3.3 Step 1: Defining categories for potential effects

Step 1 of the appraisal sets out the definitions and importance categories of potential effects to be considered (Table 3-1). The categories are applied to all receptor types and used to identify which activities/effects require detailed appraisal, based on the activities and parameters in Table 2-1 and Table 2-2 and the Project Envelope.

Where impact mechanisms are poorly understood, there is a preference at this stage for precautionary categorisation of 'potentially important'. Consequently, that category not only addresses issues for which the importance is dependent on particular details of the proposal or site, but also those issues for which there is currently insufficient understanding of the potential impact mechanism.

Table 3-1 Definitions and importance categories

Potential importance of effect	Effects (positive and/or negative)	Further assessment required?
Important	> Likely Significant Effect on European site(s); > Impact on European Protected Species (EPS); > Impact on the integrity of a Site of Special Scientific Interest (SSSI) or damage to natural features of a SSSI; > Impact on the protected features of a Marine Protected Area (MPA); > Impact on a Priority Marine Feature (PMF); > Impact on other sensitive natural heritage features at a population/habitat scale of concern; > Impact on commercial fisheries interests; and > Impact on Scheduled Ancient Monument (SAM) or ships and aircraft lost on military service.	Yes
Potentially important	> Potential Likely Significant Effect on European site(s); > Potential impact on EPS; > Potential impact on the integrity of a SSSI or damage to natural features of a SSSI; > Potential impact on the protected features of a MPA; > Potential impact on a PMF; > Potential impact on other sensitive natural heritage features at a population/habitat scale of concern; > Potential impact on commercial fisheries interests and > Potential impact on SAM or ships and aircraft lost on military service.	Yes (further information will assist determination of importance, including consideration of uncertainties)
Not important	Negligible effect on natural heritage, commercial fisheries or archaeological interests.	No
No effect	No effect on natural heritage, commercial fisheries or archaeological interests.	No

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3.4 Step 2: Evaluation of potential effects in broad principles

Step 2 of the appraisal process is used to summarise the potential effects in broad principles. Deployment and installation (and decommissioning[10]) effects are addressed separately to operational and maintenance effects. For each receptor appraisal the results of this broad scale assessment are summarised in tabular format. This stage involves an initial evaluation of effects from wave developments in broad principles only (i.e. no site-specific considerations) and receptors are generally considered in biologically relevant groups as required. This step of the evaluation also addresses potential effects prior to consideration of mitigation and monitoring options.

3.5 Step 3: Detailed appraisal based on site specific information and the Project Envelope

Following identification of the potential effects and their importance, a description of the relevant natural heritage features that could be impacted by, and set the context for, the impact assessment for activities at the Billia Croo test site is provided.

At step 3 a detailed appraisal of potential activities/effect-pathways regarded to be 'important' or 'potentially important' is undertaken. Whereas the earlier steps have evaluated potential effects only in broad principles, at this stage site-specific knowledge of species, habitats and development details at the Billia Croo test site are taken into consideration. This allows the types of device, subsea cabling, and installation and retrieval methods associated with the site (as per the Project Envelope) to be accounted for in the appraisal. Furthermore, whilst receptors have been previously grouped, they are considered individually (i.e. to species-level) where appropriate.

As mentioned previously the appraisal excludes the following:

- Onshore ancillary developments and infrastructure (e.g. substation maintenance);
- Seascape, landscape and visual impact; and
- Navigational safety.

3.6 Approach to Habitats Regulations Appraisal (HRA)

3.6.1 Legal requirements

European sites for the protection of flora and fauna of European importance are designated under the Habitats Directive as Special Areas of Conservation (SACs) (also referred to as Natura 2000 sites or European sites).

The European Union meets its obligations for bird species by means of Directive 2009/147/EC (Birds Directive) The Directive provides a framework for the conservation and management of, and human interactions with, wild birds in Europe. One of the main provisions of the Directive is 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, paying attention to the protection of wetlands of international importance.

The Habitats and Birds Directives are transposed in Scotland by both the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended), known as the Habitats Regulations. These regulations cover European sites occurring in onshore areas and territorial waters (out to 12 nm). In accordance with the Habitats Regulations, the effects of a project on the integrity of a European site are assessed and evaluated as part of the HRA process.

Any plan or project which is not directly connected with, or necessary to the management of, a European site has the potential to significantly impact said site, either individually or in-combination with other plans and projects, and shall, therefore, be subject to an Appropriate Assessment per Article 6(3) of the Habitats Directive (EC Directive 92/43/EEC). The Appropriate Assessment will appraise the potential impacts of plan or project

[10] To save unnecessary repetition, decommissioning impacts are considered alongside installation impacts, highlighting where necessary impacts specific to decommissioning only.

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activities on the European site's conservation objectives. It is for the Competent Authority[11] to determine whether it is necessary to undertake an Appropriate Assessment for plans or projects.

An Appropriate Assessment must include: (1) a scientific appraisal of the LSEs to a European site's qualifying features and conservation objections from the plan or project; and (2) a conclusion about the integrity of the site, in the context of the Natura 2000 site network, based on this appraisal.

The Habitats Regulations apply applies the precautionary principle to the appraisal of impacts to European sites. Permission for plans or projects will be granted only when it is ascertained that there will be no adverse impacts on the integrity of the site(s) in question. Where adverse impacts to a site are identified, a plan or project shall only be permitted if there is an Imperative Reason of Overriding Public Interest (IROPI) and no alternative mechanisms to carry out the plan or project have been identified. During such a situation, Member States are required to take compensatory measures necessary to ensure that the overall coherence of the Natura 2000 network is protected.

3.6.2 How HRA is approached for this EA

For each appraisal, consideration of the protected sites for the applicable receptor will be given. Where it is determined there is no connectivity between a protected site and the Project Envelope, Likely Significant Effect (LSE) to the qualifying features of the site can be ruled out and no further assessment under HRA is required. Where connectivity is identified assessment of the importance of the Project Envelope to a receptor (qualifying feature) is given along with consideration of the importance of potential impact pathways. Expert judgement is then used to ascertain whether LSE is considered likely.

3.7 Cumulative and In-combination impacts

The consideration of cumulative (and in-combination impacts) is an important aspect of the appraisals. Cumulative impacts act together with other impacts (including those from any concurrent or planned future third-party activities) to potentially affect the same receptors as the activities and area as per the Project Envelope.

Cumulative impacts need to be considered throughout the EA process and for all stages of the Project. A list of projects has been identified, which together with the Project Envelope may result in potential cumulative impacts. These are summarised in Table 3-2 and illustrated in Figure 3-2.

Under the Crown Estate Scotland offshore wind leasing round (ScotWind) several sites have been identified for potential fixed and floating wind developments around the coast of Scotland. Currently the leasing process is set to launch in July in 2019. Several sites have been identified around Orkney, although at this stage it is unsure which, if any, will be developed. It is therefore difficult to carry out a detailed cumulative impact in respect of the Billia Croo test site and potential wind farms which may occur as a result of the leasing round. The closest of these proposed areas is titled N1 and is situated in excess of 20 km from Billia Croo. For the purposes of this assessment, it has been assumed that some wind development will occur in the future at this site.

Additionally, a new subsea power cable from Orkney to the Scottish mainland is being planned by SSE. This is still at an early stage of planning and the exact location of the cable is yet to be published, however early review of initial publications suggests the cable would be pass by the Billia Croo test site at less than 1 km, therefore this has been considered for this EA.

[11] A person or organisation that has the legally delegated or invested authority, capacity, or power to perform a designated function.

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Table 3-2 List of projects considered in cumulative assessment

Project	Status	Distance/direction from Project	Figure 3.2 reference
Offshore renewables			
EMEC Nursery Wave Test site - Scapa Flow	Active	23.9 km east	22
EMEC Nursery Tidal Test site – Shapinsay Sound	Active	26.4 km east	21
EMEC Tidal Test site – Fall of Warness	Active	34.6 km north-east	19
EMEC Tidal Test Site - Stronsay	Active	33.7 north-east	20
MeyGen Tidal site – Pentland Firth	Active	34.1 km south-east	25
Dounreay Trì Floating Wind Demonstration	Consented – on hold	43.1 south-west	26
Brough Head Wave Farm	Agreement/Option for Lease	14.3 km north-east	29
Westray South Tidal Array	Scoping	33.8 km north-east	18
Churchill Barriers Tidal Project	Screening	27.4 km south-east	27
Lashy Sound Tidal Array	Scoping	45 km north-east	17
Ness of Duncansby Tidal Array	Agreement/Option for Lease	37.1 km south-east	24
Brims Tidal Array	Application submitted	21.0 km south-east	23
Katanes Floating Energy Park	Screening	48.2 km south-west	28
Ferry routes			
Stromness, Orkney – Scrabster, Scotland mainland	Active 6 crossings a day (maximum in summer)	2 km south	5
Stromness, Orkney – Graemsay, Orkney	Active 6 crossings a day	6 km south-east	6
Stromness, Orkney – North Hoy, Orkney	Active 6 crossings a day	4 km south-east	7
There are other ferry routes in Orkney (inter-islands, Orkney to Shetland and Orkney to Scotland mainland), but all further than 10 km from the Project Envelope			
Aquaculture			
Shellfish farm	Active	7 km east	3
Bring Head – Fish farm	Active	9 km south-east	1
Chalmers Hope – Fish farm	Active	11 km south-east	2
There are 27 other active finfish farms and four active shellfish farms in Orkney, but all are further than 10 km from the Project Envelope.			
Power cables			
Pentland Firth 1	Active	9.5 km south	12
Pentland Firth 2	Active	10 km south	13
Project	**Status**	**Distance/direction from Project**	**Figure 3.2 reference**

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Warebeth, Orkney - Dounreay, Scotland mainland	Planned	7 km north	16
Hoy, Orkney – Orkney mainland	Planned	8 km south-east	15
Graemsay, Orkney - Orkney mainland	Planned	7 km south-east	14
There are other planned power cable routes in Orkney, but all are further than 10 km from the Project Envelope.			
Telecommunication cables			
Northern Lights	Active	5 km north-east	31
Farice	Active	26 km west	30
Harbour works ***There are ongoing and approved harbour works located in excess of 10 km from the Project Envelope, due to the potential for percussive piling these projects have been considered below despite their distance.***			
Planning application 18/354/AMC Kirkwall Pier, Kirkwall, Orkney Siting of a fishing industry building with an air source heat pump (following permission in principle 17/432/PIP) (amendment to 18/317/AMC).	Decided - Decision Issued Date Mon 14 Jan 2019	23 km east	8
Pier repair works – Longhope Pier	Current as of 1 January 2019	Over 20 km south-east	9
Repair Works – Pierowall Pier, Westray	Current as of 1 January 2019	45 km north-east	10
Dredge spoil disposal sites			
Stromness A	Open	2 km south-west	4
MoD grounds			
MOD – Diving and Survey Ops – Royal Oak	Current as of 1 January 2019	19 km south-east	11

The general principle for the cumulative impact assessment is to consider only those projects that are at EIA scoping stage (i.e. for which an EIA Scoping Report and requests for an EIA Scoping Opinion have been submitted or equivalent level of information for projects not required to complete an EIA) and beyond (at the date the assessment is undertaken). Consultation has been undertaken with MS-LOT to identify projects are either close to submitting their EIA Scoping Reports, are directly relevant to the proposed Project and have suitable information available to allow a robust assessment and are therefore advised to be considered within the cumulative impact assessment.

Details of the projects considered within the cumulative impact assessment have been provided within each environmental assessment topic section. Only projects that share a relevant pathway of effect with the Project are considered in the cumulative assessment. The decision on which projects share a pathway of effect is based on the results of the specific impact assessment together with the expert judgement of the specialist consultant undertaking the impact assessment.

The assessment of these projects is dependent upon the level of information available at the time of undertaking the cumulative assessment. Different levels of information are available for different projects, as such the cumulative impact assessment is generally a qualitative assessment.

Each of the appraisals in this document contains a sub-section which provides an assessment of the relevant cumulative impacts of projects considered relevant to the topic section in question.

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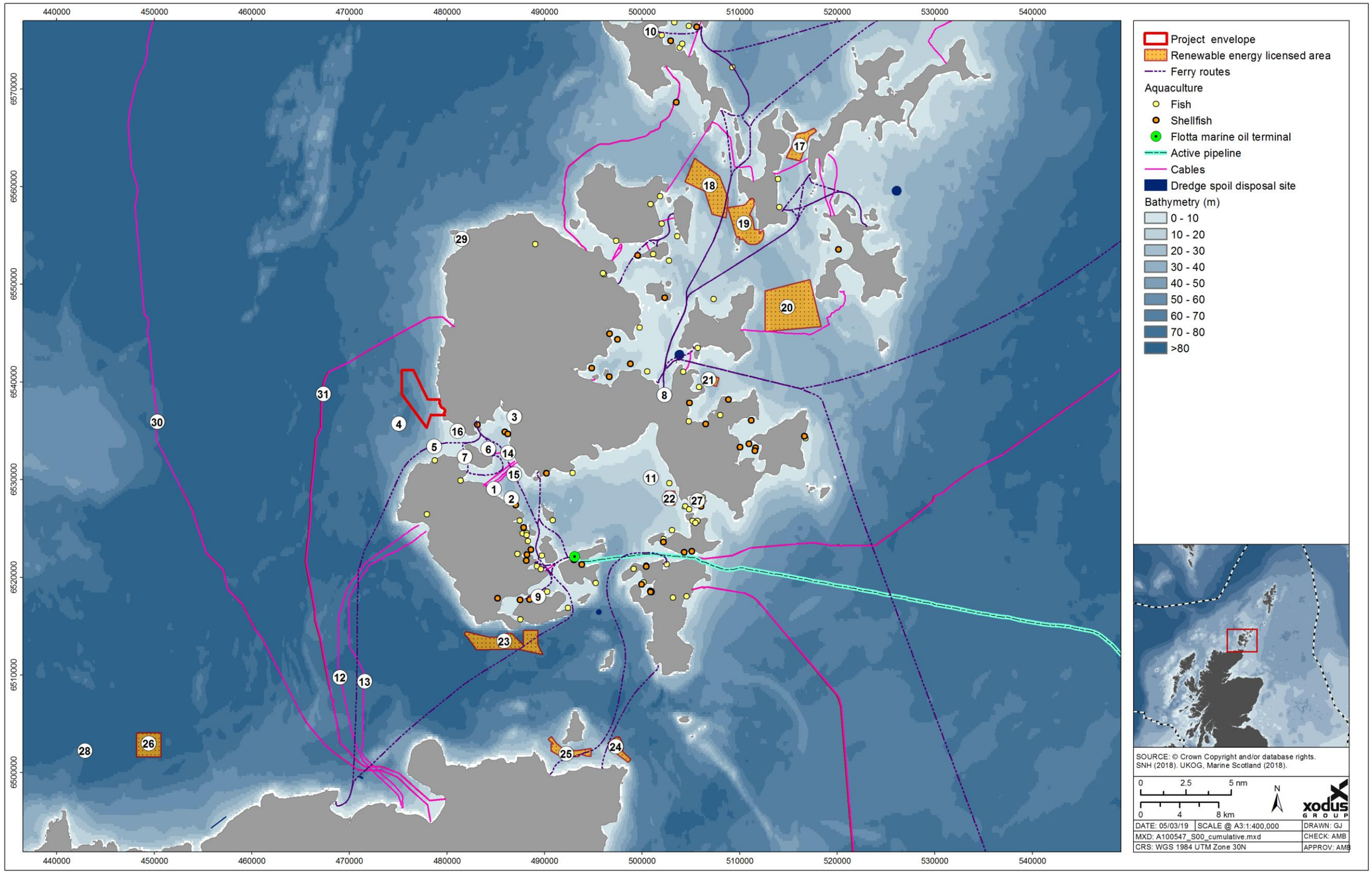
Figure 3-2 Projects considered as part of cumulative assessments illustrated in the wider context of the Project Envelope



4 INTERTIDAL AND SUBTIDAL BENTHIC ECOLOGY

Stage 1 of this appraisal has defined the categories as presented in Table 3-1. The appraisal now picks up at Stage 2 of the methodology where effect pathways and importance are identified as described in Section 3.

4.1 Key data sources

The key data sources that have been used to inform this appraisal:

- Environmental Description for the EMEC Wave Test site Billia Croo, Orkney (EMEC, 2009);
- ROV cable survey footage at Billia Croo (EMEC, 2017);
- Marine Energy Test Centre Environmental Statement (Carl Bro, 2002);
- UKSeaMap 2018, broad-scale seabed habitat map for the UK (JNCC, 2018a); and
- Information on the biology of species and the ecology of habitats found around the coasts and seas of the British Isles (MarLIN, 2018).

4.1 Potential effects

For benthic receptors in the intertidal and subtidal, the defined potential effect categories are applied to activities/effect pathways relevant to wave energy developments as described in the Project Envelope. First, potential effects are considered in broad-principles. Installation and decommissioning effects (Table 4-1) are addressed separately from those during the operational and maintenance phases (Table 4-2).

Note that details specific to Billia Croo, both environmental and relating to project-specifications, are not considered until the detailed appraisal later in this section.

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Table 4-1 Potential effects on intertidal and subtidal benthic receptors during installation and decommissioning of infrastructure

Benthic Environment – Potential generic effects from device installation and decommissioning
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels (e.g. multi cat; workboat; DP vessel; dive-support vessel; crane-barge; gantry barge; tug; specialist cable-laying vessel; survey vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Habitat loss/damage	Benthic species	**Potentially important** - some mooring/foundation designs, cable protection options and installation techniques result in loss/damage to larger areas than others. Sensitivity (including recoverability) of benthic species is often linked to their natural resilience to disturbance events, with species associated with mobile substrates recovering relatively quickly. However, importance will also depend upon the scale of the impact in the context of the local and regional distribution of species, and the conservation value of the species concerned.
	Benthic habitats	**Potentially important** - most biogenic habitats are highly sensitive and slow to recover from loss or damage. Such habitats are also typically of high conservation value, supporting high biodiversity and ecological functionality. Importance will depend upon the extent and quality of biogenic habitats, and upon the scale of loss/damage in the context of the habitat locally/regionally.
Smothering by re-settlement of disturbed sediments or drill cuttings	Benthic species	**Potentially important** – there is potential for smothering impacts on highly sensitive species in sedimentary habitats – importance will depend upon the species present, their abundance and local/regional importance, the hydrodynamic conditions and the volume of suspended material above natural background levels.
	Benthic habitats	**Potentially important** - there is potential for smothering impacts on highly sensitive sedimentary habitats – importance will depend upon the habitats present, their extent, quality and local/regional importance, the hydrodynamic conditions and the volume of suspended material above natural background levels.
Introduction of marine non-native species (MNNS) via	Benthic species	**Potentially important** – the potential effect of a proliferation of a MNNS on benthic species is difficult to predict but has the potential to be important. Importance will depend upon the conservation and ecological value of benthic species and the scale of a MNNS proliferation.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
vessels, devices or other equipment.	Benthic habitats	**Potentially important** – the potential effect of MNNS on biogenic habitats is difficult to predict but has the potential to be important, particular given the typical ecological value of biogenic habitats. Importance will depend upon the conservation and ecological value of the habitats present and the scale of a MNNS proliferation.

Table 4-2 Potential effects on benthic and intertidal receptors during operations and maintenance of infrastructure

Benthic Environment – Potential generic effects from device operation and maintenance
Summary of activity categories – see Project Envelope description for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels (e.g. multi cat; workboat; DP vessel; dive-support vessel; crane-barge; gantry barge; tug; specialist cable-laying vessel; survey vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Habitat creation	Benthic species	**Potentially important** – sessile species may colonise new structures, while mobile species may aggregate around structures that provide some protection or feeding opportunities. Effects of introduction of hard infrastructure may be less noticeable over hard substrates where artificial structures may help offset lost habitat, in comparison to a sedimentary environment. Importance will also depend upon the scale of devices, foundations and infrastructure in the context of the local environment.
	Benthic habitats	**Potentially important** – new structures may form a habitat. Effects may be positive or neutral over hard substrates, where artificial structures may help offset lost habitat. Effects may be more noticeable where hard structures are introduced to a sedimentary environment. Importance will also depend upon the scale of devices, foundations and infrastructure in the context of the local environment.
Introduction/facilitation of MNNS via vessels, devices, other equipment, or by	Benthic species	**Potentially important** – the potential effect of a proliferation of a MNNS on benthic species is difficult to predict but has the potential to be important. Importance will depend upon the conservation and ecological value of the baseline benthic species present and the scale of a MNNS proliferation.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
provision of device and infrastructure as a stepping-stone in MNNS range expansion.	Benthic habitats	**Potentially important** – the potential effect of MNNSs on biogenic habitats is difficult to predict but has the potential to be important, particularly given the typical ecological value of biogenic habitats. Importance will depend upon the conservation and ecological value of the habitats present and the scale of a MNNS proliferation.
Changes to hydrodynamic and sediment regime (including scour around devices and cables).	Benthic species	**Potentially important** – arrays of devices could theoretically alter hydrodynamic and sediment processes that could affect benthic species over a wide area. More obvious, however, is the potential for effects upon benthic species in the immediate vicinity of devices or infrastructure. Importance will depend upon natural hydrodynamic conditions, the conservation value and sensitivity of species and the design and layout of devices, foundations and infrastructure in the context of the distribution of important species.
	Benthic habitats	**Potentially important** – arrays of devices could theoretically alter hydrodynamic and sediment processes that could affect biogenic habitats over a wide area. More obvious, however, is the potential for effects in the immediate vicinity of devices or infrastructure. Importance will depend upon natural hydrodynamic conditions, the conservation value and sensitivity of habitats and the design and layout of devices, foundations and infrastructure in the context of the distribution of important habitats.
Electromagnetic Field (EMF) effects.	Benthic species	**Not important** – although the evidence base is limited, thermal loading from export and intra-array and export cables is expected to be so low and localised as to be almost immeasurable (BERR, 2008; NIRAS, 2015; Taormina *et al*., 2018). Any effects on benthic species will be highly localised.
	Benthic habitats	**Not important** – as above for benthic species.

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4.2 Natural heritage context

4.2.1 Benthic habitats

4.2.1.1 Intertidal area

The inshore lease area encompasses the intertidal area at Billia Croo, the infralittoral zone, and part of the circalittoral zone further offshore as shown on Figure 4-1. The seabed habitats in infralittoral and circalittoral zones within the inshore lease area are described in Section 4.2.2.2 – Subtidal area.

Several seabed surveys have been undertaken in the littoral zone of Billia Croo (Murray *et al*., 1999 and Carl Bro, 2002 in EMEC, 2009). The west coast of Orkney is a high energy coastal environment. The Billia Croo shoreline, where the cables make landfall (cables are buried beneath the seabed prior to landfall), is composed of bedrock and boulders (EMEC, 2009) as illustrated in Figure 4-2, Figure 4-3 and Figure 4-4. The boulder beach is flanked to the south by a rocky promontory, and to the north by shelving bedrock leading to a cliff coastline. The geology of western Mainland, Orkney is dominated by sedimentary rocks of the Middle Devonian Caithness Flagstone Group, which have a thickness of 750 m. Glacial deposits up to 10 m thick compose much of the lower ground in western Mainland, consisting of reddish or grey clay or sandy-clay diamicton (Carl Bro, 2002).

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Figure 4-1 EUNIS broad-scale seabed habitats in the vicinity of the Billia Croo test site (JNCC, 2018a)

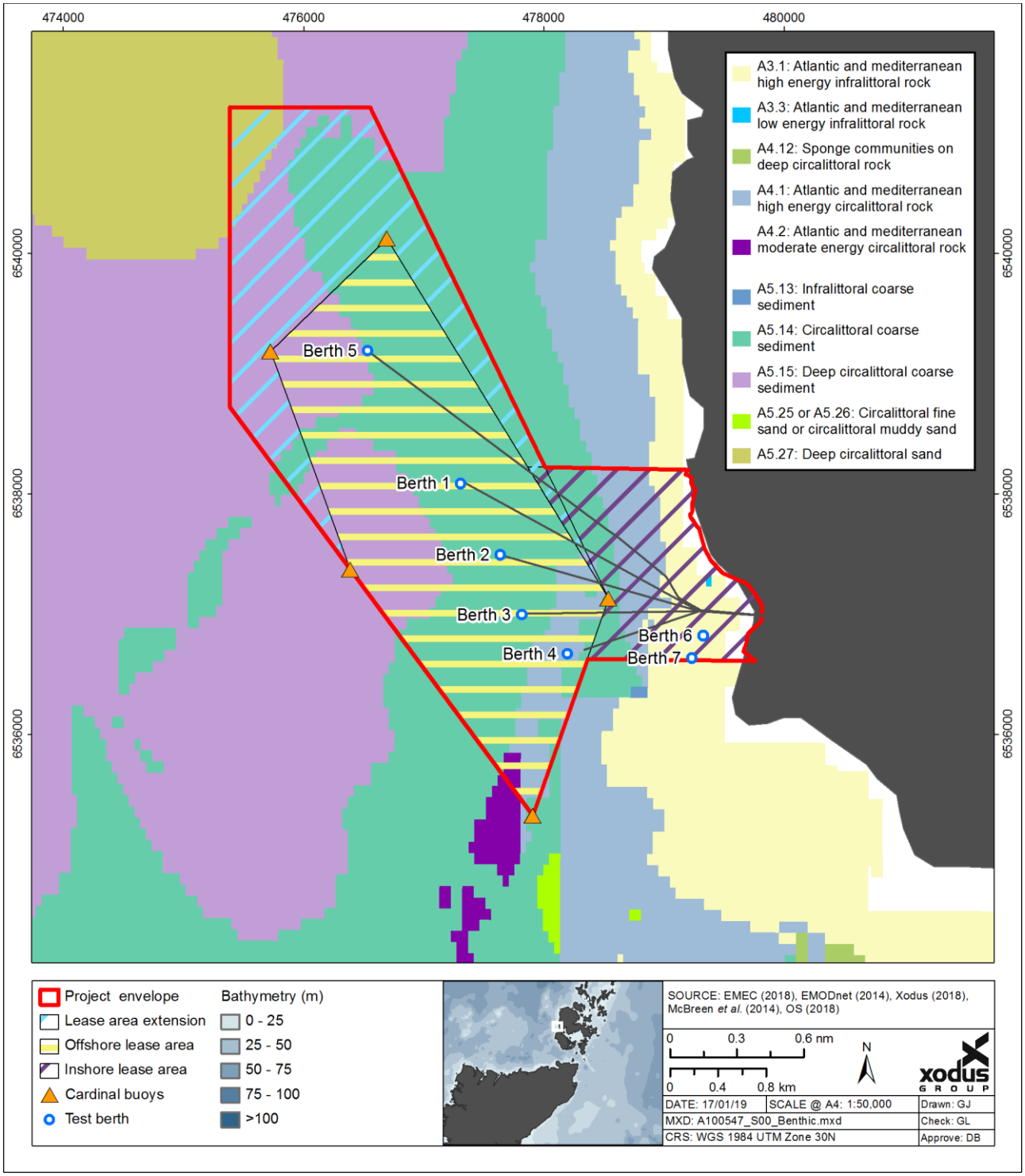

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Figure 4-2 Shoreline at Billia Croo looking north-west (EMEC, 2009)

Figure 4-3 Shoreline at Billia Croo looking south-west (EMEC, 2009)

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Figure 4-4 Low shore at Billia Croo (EMEC, 2009)

4.2.1.2 Subtidal area

The description of seabed habitats within the inshore lease area, existing lease area and proposed extension are described in this section. As mentioned in Section 4.2.1.1, the inshore lease area encompasses the intertidal area and extends to the infralittoral zone and part of the circalittoral zone. The existing offshore lease area and the proposed extension are located in the circalittoral zone, further offshore as shown on Figure 4-1. A cable route survey and a sublittoral survey were conducted by the International Centre for Island Technology (ICIT) in 2002 identified the baseline habitat types and biological communities present sub tidally off Billia Croo (EMEC, 2009). Photographs were taken at seven survey stations (W1 to W7), which are located within the inshore lease area. The location of survey stations and the spatial distribution of seabed habitats identified during this survey are shown in Figure 4-5, example seabed photographs are provided in Figure 4-5 and Figure 4-6 The subtidal habitats are described below from the mean low water mark into deeper waters.

The seabed within infralittoral zone at Billia Croo, from the mean low water spring (MLWS) mark down to 20 m water depth, is dominated by exposed bedrock.

From 20 – 25 m water depth, where the circalittoral zone starts, the seabed is characterised by bedrock with an overlying sediment veneer in many places. The particle size in this veneer varies from sand through to large boulders, as shown on the photographs taken at stations W1, W2 and W7 (Figure 4-5). From 45 – 47 m water depth, the exposed bedrock is replaced by coarse to fine sand. The sand is interspersed with boulders and stones as shown on photographs taken at stations W3, W5, W6 (Figure 4-5). Bedrock outcrops also occur within this area (EMEC, 2009). Vibrocoring was undertaken in the inshore lease area of the Billia Croo test site to determine the geotechnical properties of the seabed sediments. Vibrocore samples were successfully recovered at stations W4, W5 and W6, located in the circalittoral zone (Figure 4-5). Particle size analysis (PSA) was carried out on these samples to identify the main sediment type. Each of the sediment samples taken at W4, W5 and W6 contained less than 1% of very fine sediments, also called 'fines' (<63 µm diameter) with the majority of the sediments being classified as medium to coarse sand (between 212 µm and 600 µm diameter). The sampling sites also contained a small proportion of fine sand (particles between 63 µm and 150 µm), with <2% of fine sand at W4, 5% at W5, and 4% at W6 (unpublished data).

Figure 4-5 Seabed habitats identified during the 2002 subtidal survey at Billia Croo (adapted from EMEC, 2009)

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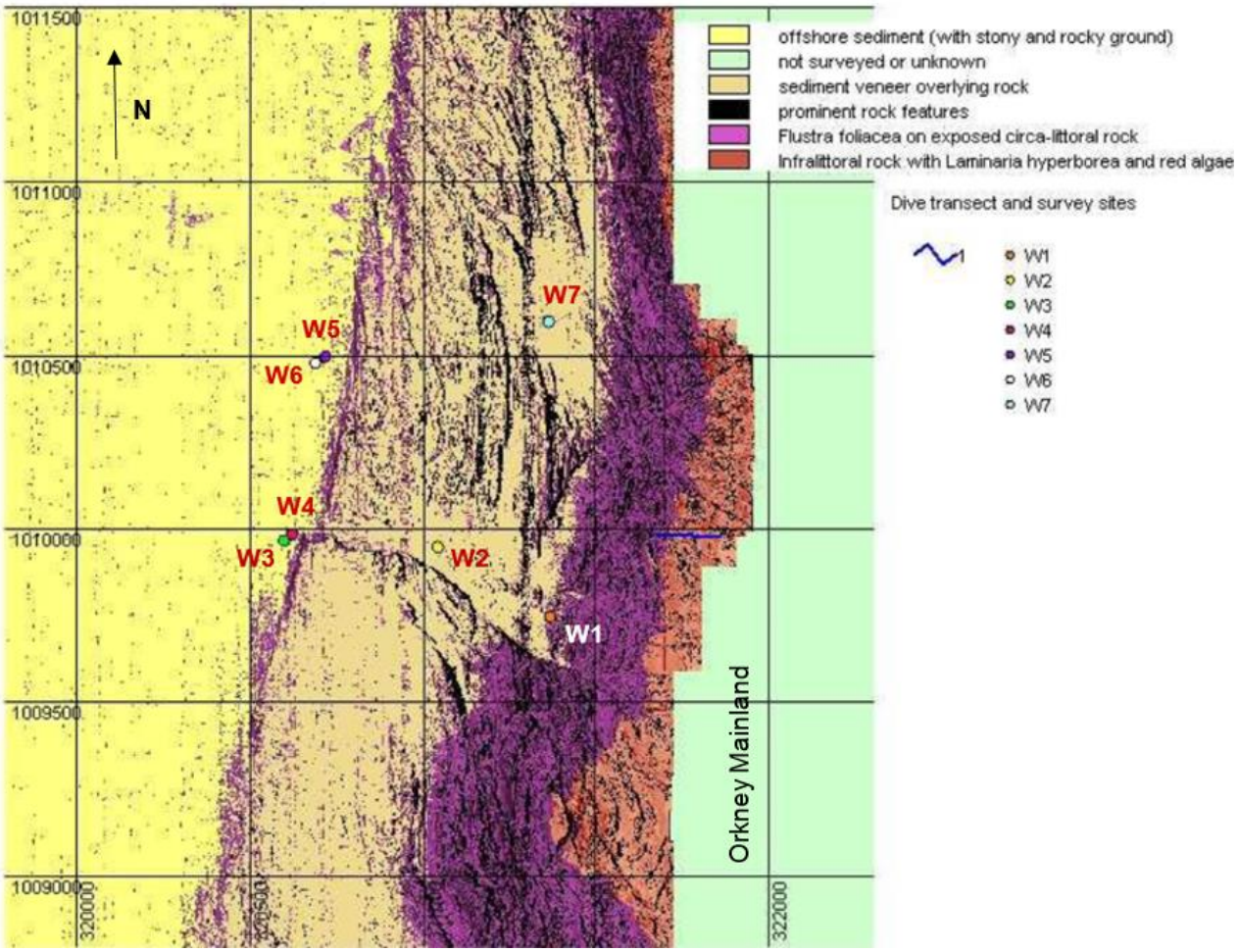

An ROV cable survey was conducted at the Billia Croo test site in 2017 (EMEC, 2017), and revealed various habitat types. Areas of cobbles/stones interspersed with sandy sediments were identified, which changed into a finer sediment type further along the cable routes, with patches of cobbles and boulders (Figure 4-7). Other images revealed exposed bedrock, with very little overlying sediments in some areas. The fauna present on the exposed bedrock included numerous urchins (most likely *E. esculentus*) and dead man's fingers. Closer to shore, sparse kelp was observed on exposed bedrock. Overall, the seabed type observed through the ROV footage corresponded with habitats previously described in surveys in EMEC, 2009.

These results are supported by the broad-scale seabed habitat map for UK waters (JNCC, 2018a) which show that the rocky seabed identified by EMEC in the subtidal area of the Billia Croo test site is classified as high energy infralittoral rock and high energy circalittoral rock (Figure 4-1). The infralittoral and circalittoral rock in this area is also classified as potential bedrock/stony reef habitat, listed in the Annex I of the European Commission (EC) Habitats Directive (Ellwood, 2013). The area of coarse to fine sand identified further offshore in the offshore lease area is classified as coarse sediments on the broad-scale seabed habitat map (Figure 4-1) (JNCC, 2018a).

The seabed within most of the existing offshore lease area and the extension area is classified as circalittoral coarse sediments as seen on the broad-scale seabed habitat map (Figure 4-1).

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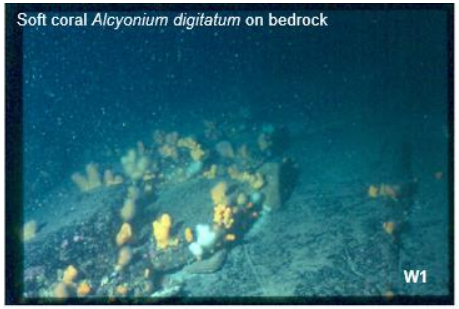
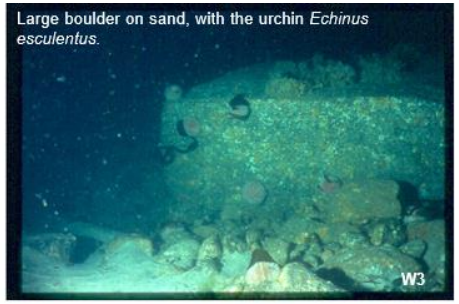
Figure 4-6 Seabed photographs taken during the 2002 subtidal survey at Billia Croo (EMEC, 2009)





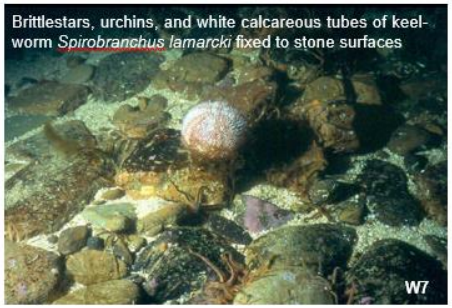


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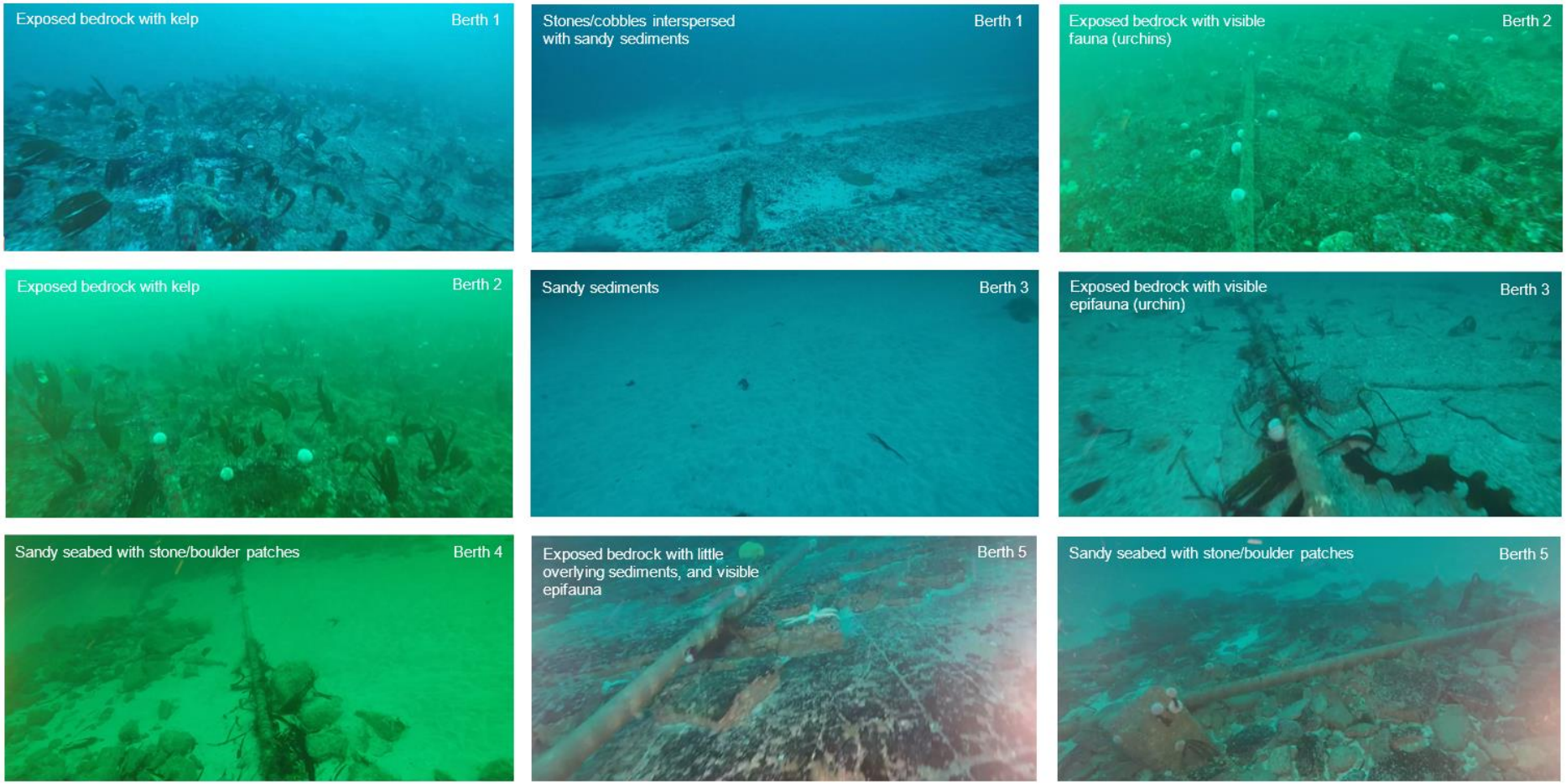
Figure 4-7 ROV images taken during the 2017 cable survey at Billia Croo (EMEC, 2017)



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4.2.2 Benthic species

The succession of benthic communities at Billia Croo in the intertidal area and subtidal area is illustrated in Figure 4-8 and described further in Section 4.4.2. The intertidal area is part of the littoral zone, which extends beyond the intertidal area, whilst the subtidal area comprises the infralittoral, circalittoral and sublittoral zones.

4.2.2.1 Intertidal species

This section describes the benthic flora and fauna known to occur in the intertidal zone of the inshore lease area. Previous surveys suggest that the littoral rock at Billia Croo is inhabited by mussels (*Mytilus edulis*) and barnacles. The brown fucoid algae *Fucus distichus* Subsp *anceps* and *Fucus spiralis* can be found on the extremely exposed rock in the upper mid shore, with the red calcareous alga *Corallina officinalis* on very exposed lower eulittoral rock. The algae *Alaria esculenta*, mussels and coralline crusts can be found on very exposed sublittoral fringe bedrock at the extreme low water springs (ELWS) mark. The algae species *Fucus distichus* Subsp *anceps* found during the littoral survey are rare species whose distribution is restricted to the far north and west coasts of Scotland (EMEC, 2009). A summary of the species found in the intertidal zone is provided in Table 4-3.

Table 4-3 Benthic species identified in the intertidal zones at Billia Croo (EMEC, 2009)

Shore/seabed area	Zone classification	Character of zone	Species present
Top of the shore	Supralittoral	Bedrock promontory and boulder beach	Dominated by the lichen *Verrucaria maura*. Barnacles present.
	Upper littoral	Bedrock promontory and shelf	Rock pools present with dense coralline algal crusts, fucoids and kelp in deeper pools. Green algae in pools higher up the shore including *Enteromorpha* spp.
Middle of shore	Mid littoral	Boulder beach and bedrock promontory	Dominated by barnacles and fucoid algae. *Fucus vesiculosus* and *Fucus serratus.* Mussels *(Mytilus edulis)* form a band mid-way down the shore.
	Eulittoral	Exposed bedrock shelf	Dominated by mussels with barnacles and barnacles with limpets (*Patella* spp.) and *Fucus vesiculosus* f. *linearis.*
	Lower littoral	Boulder beach	Stands of dulse (*Palmaria palmata*) and other red seaweeds where *Osmundea* (*Laurencia*) and/or *Gelidium* always dominate.

4.2.2.2 Subtidal species

Near the low water mark in the shallow sublittoral, *Laminaria digitata* was observed in a narrow band with the algae *Alaria esculenta*. Near shore areas of a transect survey undertaken in 2002 indicated that dense kelp forests formed by *Laminaria hyperborea* (Figure 4-9) thinning to kelp park exist between MLWS and down to 20 – 25 m water depth, where the circalittoral zone begins (EMEC, 2009). *L. hyperborea* on infralittoral rock is designated as a PMF in Scotland as 'kelp beds' (Tyler-Walters *et al*., 2016).

Below 25 m water depth in the inshore lease area, *L. hyperborea* plants were sparse and were not observed at the shallowest dive site at 32 m water depth. Fauna typical of hard substrate and exposure to water movement are common on the bedrock, boulder and stone seabed (e.g. the soft coral *Alcyonium digitatum*, the urchin *Echinus esculentus,* and the hornwrack (*Flustra foliacea*).

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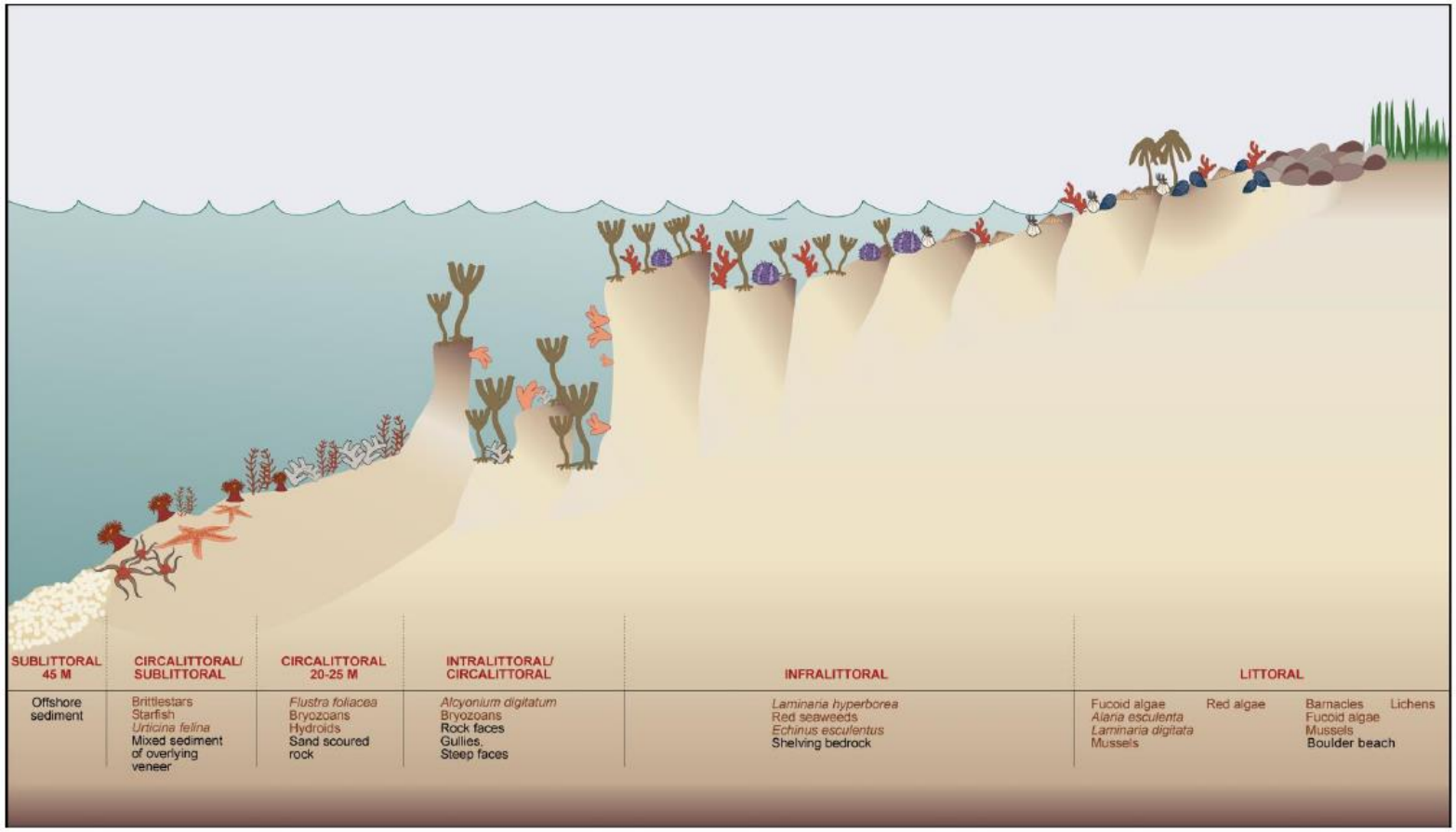
Figure 4-8 Illustration of seabed habitats in the littoral and sublittoral zones (inshore lease area) at Billia Croo[12] (EMEC, 2009)



[12] In reality habitats are more complex than shown and the boundaries between zones less defined.

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A database of benthic species records observed in the nearshore area of the Billia Croo test site, or in its vicinity, is held by EMEC. The data suggest that the five most abundant species are of the phylum Mollusca and include the common limpet (*Patella vulgate)* (79 records), the dog whelk (*Nucella lapillus)* and the sea snail (*Gibbula cineraria)* (both with 72 records), and the blue mussel (*Mytilus edulis)* (72 records). The blue mussel can form beds on sediments or infralittoral rock which are listed as PMF in Scottish waters. However, individual blue mussels are not of particular conservation importance in the UK and there is no evidence of mussel beds in more recent surveys within the Billia Croo test site (EMEC, 2009). The horse mussel (*Modiolus modiolus)* was also recorded in the vicinity of the Billia Croo test site. However, more recent surveys did not provide any evidence of the presence of horse mussel beds, classified as PMF in Scottish waters. There are also few records of annelid worms (*Spirobranchus triqueter*, then *Pomatoceros triqueter*), urchins (*E. esculentus*), crabs (*Cancer pagurus*), starfish (*Asterias rubens*) and king scallops (Pecten maximus) within the Billia Croo test site. The database also contains a few records of the kelps *L. hyperborea*, *L. digitata*, and *A. esculenta*, the soft coral *A. digitatum,* and the wracks *Fucus spiralis, Fucus vesiculosus* and *Fucus serratus*. Overall, similar benthic species were observed in more recent surveys across the intertidal and shallow subtidal areas.

Surveys of the deeper dive sites (48 – 50 m) in the current offshore lease area, were found to lie close to the boundary between the predominantly boulder/stone seabed on the landward side and the sedimentary seabed on the seaward side, as reported by EMEC (2009). Although some hard substrate was available (e.g. scattered boulders), the area predominantly supported sedimentary biotopes and, where hard substrate is available, it is typically scoured by sand. This area was surveyed visually (i.e. video and photography) and by taking core samples. Analysis of the core samples for infauna content indicated that offshore sediments were dominated primarily by polychaetes and nematodes, although in some samples polychaetes accounted for over 80% of sample species composition (EMEC, 2009).

Example photographs taken in the subtidal zone of the inshore lease area are shown in Figure 4-6. A summary of the biotopes identified in the subtidal area at Billia Croo across the inshore lease area, the existing offshore lease area and the proposed extension, is provided in Table 4-4.

Figure 4-9 Image taken in the inshore lease area at Billia Croo, showing *L. hyperborea* kelp forest (EMEC, 2009)

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Table 4-4 Benthic species identified in the subtidal zones at Billia Croo (EMEC, 2009)

Shore/seabed area	Project Envelope area	Area (km^2)	Zone classification	Character of zone	Species present
Below low water	Inshore lease area	0.49	Infralittoral	Bedrock	Dominated by dense *L. hyperborea* forest. Thins to kelp park with depth, with sparse understorey of red seaweeds. Sparse fauna and algal crusts. *E. esculentus* with sparse dead man's fingers (*A. digitatum*) and some grazing tolerant fauna.
			Infralittoral/circalittoral	Rock faces, steep exposed rock features and gullies. High energy, tide and wave swept rock faces.	Dominated by dead man's fingers (*A. digitatum*) and the bryozoan *Securiflustra securifrons*.
Begins 20 – 25 m deep	Inshore lease area	1.1	Circalittoral	Soured rock and rock surfaces	Dominated by the bryozoan *F. foliacea*. Other bryozoans and hydroids present.
	Offshore lease area	0.74	Circalittoral/sublittoral	Mixed sediments of the overlying veneer and at the boundary of sublittoral sediment.	Brittlestar beds dominated by *Ophiothrix fragilis* and *Ophiocomina nigra*. Associated with the starfish *Luidia ciliaris*. *Urticina felina* present.
	Offshore lease area extension	0.062			
From 45 m	Inshore lease area	0.073	Sublittoral	Sand cover of the offshore zone.	Dominated primarily by infaunal polychaete species. Nematodes, amphipods, bivalves and echinoderms also present.
	Offshore lease area	5.4			
	Offshore lease area extension	3.4			

4.2.3 Protected sites

The Stromness Heaths and Coast Site of Special Scientific Interest (SSSI) forms an extensive protected area on the west coast of Orkney (Figure 1-2), crossing the Billia Croo test site. However, the protected features of this site are on the land and therefore do not include any benthic features. The North-West Orkney Nature Conservation Marine Protected Area (NCMPA) is designated for sand banks, sand wave fields and sediment wave fields representative of the Fair Isle Strait Marine Process Bedforms Key Geodiversity Area and sandeels, the site is located over 9 km from Billia Croo. The closest SAC with benthic features as a qualifying feature is the Sanday SAC, designated for the presence of bedrock reefs listed on Annex I of the EC Habitats Directive, and located 50 km north-east. Due to the distance to these conservation sites there is no connectivity with the proposed activities at the Billia Croo test site.

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4.3 Summary of benthic impact appraisal process for Billia Croo

This impact appraisal takes account of a maximum-case scenario based on the Project Envelope where all available berths within the test site are developed and operating at capacity. It addresses the differing consenting and licensing regimes. This appraisal will inform the consenting process for both Marine Licence and S36 applications. However, it should be noted that, if there are key deviations in the device design or in any activity (deployment, installation, decommissioning, operations and maintenance) from that outlined in Project Envelope, further appraisal work may be required. Any additional appraisal work required will be undertaken by the individual developer (further advice should be sought from EMEC in the first instance).

Table 4-5 presents the relevant legislation and the reasons for undertaking an appraisal for several features in the test site area.

Table 4-5 Appraisal mechanism for benthic and intertidal species and habitats

Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
Qualifying features of European sites	The Conservation of Habitats and Species Regulations 2017 (Note: these regulations apply in Scotland in relation to certain specific activities (reserved matters), including consents granted under Sections 36) Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	No	No connectivity with SACs with benthic qualifying features (Figure 1-2).
European Protected Species (EPS)	The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	No	No benthic species are listed as EPS.
Notified features of SSSIs	Nature Conservation (Scotland) Act 2004 (as amended)	No	No SSSIs with benthic features will be impacted.
Protected features of MPAs	Marine (Scotland) Act 2010	No	No MPAs with benthic features will be impacted.
PMFs	Marine (Scotland) Act 2010	Yes	The PMF 'kelp beds' may be present in the nearshore area at Billia Croo, due to the presence of *L. hyperborea* forests.
Other sensitive natural heritage features	Appraisal of other features under: > The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (relevant to projects located 0-12 nm from shore) > The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 > Marine (Scotland) Act 2010. > Wildlife and Countryside Act 1981	Yes	Captures assessment of all other sensitive natural heritage features at a population/habitat scale of concern.

4.4 Appraisal of PMFs and other natural heritage features

An overview of the seabed habitats that may be impacted by the activities described in the Project Envelope, and their associated footprint, is presented in Table 4-6.

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Table 4-6 Overview of habitat typed that may be impacted by the Project Envelope activities and potential worst-case footprint

Project Envelope installations or activities	Worst case seabed area – based on Table 2-2	Likely habitats to be impacted		
		Inshore lease area	Offshore lease area	Offshore lease area extension
Cable laying	**3,300 m²**	> Infralittoral rock with kelp (*L. hyperborea*) forests > Circalittoral rock with soft coral *A. digitatum* > Circalittoral rock dominated by the bryozoan *F. foliacea*	> Mixed sediments of overlying veneer, dominated by brittle stars and starfish. > Fine to coarse sand dominated primarily by infaunal polychaete species.	> Mixed sediments of overlying veneer, dominated by brittle stars and starfish. > Fine to coarse sand dominated primarily by infaunal polychaete species.
Infrastructure moorings (including mooring systems not associated with devices)	3,000 m² per mooring system **Total: 69,000 m²** for 20 devices and three mooring systems not associated with devices.			
Electrical hubs moorings	400 m² per hub Total: **4,000 m²** for 10 hubs			
Total for all infrastructure and associated moorings	**76,300 m²**			
Vessel anchoring system[13]	**10,000 m²** for a single anchor and anchor chain			
Predicted area of seabed impact as a result of anchor deployment from installation and decommissioning vessels	**2,850,000 m²** for ten berths. Assuming 150 m anchor line and 150 work area to include test berth and immediate vicinity.			
Total predicted area of seabed impact:	2,926,300 m² (2.92km²) which equates to approximately 26.5 % of the Project Envelope area			

4.4.1 Benthic habitats

4.4.1.1 Sedimentary substrates

There will be a maximum of 20 WECs within the Billia Croo test site at any one time (including floating platforms). The maximum calculated footprint from these devices assumes all devices will utilise mooring lines rather than foundations[14].

Electrical hubs may be installed, tested, operated and decommissioned. These hubs will be tested for collection of power from WECs and may be seabed mounted or floating. If seabed mounted the total direct footprint (based on mooring system) will be 400 m² per hub. A maximum of 10 electrical hubs may be installed on the site at any one time, which equates to a total footprint of 4,000 m².

[13] Exact vessel specification, durations and ancor requirments will be specified in the supporting documentation submitted to Marine Scotland submitted when seeking approval to install.
[14] Floating platforms would be moored using a temporary gravity-based solution such as clump weights, which would have a much smaller area of impact than the mooring systems associated with WECs.

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There is currently 11 km of subsea cable at the Billia Croo test site. As a worst-case scenario, it is assumed that during the lifetime of the Project Envelope all cable will replaced, this is calculated as a seabed impact of 3,300 m^2.

The worst-case scenario footprint for infrastructure is therefore 76,300 m^2 (0.0763 km^2) which equates to 0.7% of the total Project Envelope area.

In addition to this, the vessels deployed during installation, maintenance or decommissioning of infrastructure within the Billia Croo test site, may have to anchor. It is difficult to quantify the area that will be impacted as a result of vessel anchoring as full vessel specifications and requirements are not known. However, based on past experience and expert judgement it is assumed that for a single anchor with 150 m of anchor line in contact with the seabed, and with the line sweeping the seafloor in a 45° angle, the resulting footprint will be 10,000 m^2 (0.01 $km^{2)}$. Anchoring of vessels is therefore expected to result in a relatively large impact area, to give some context, one vessel deploying six anchors will impact an area of 0.06 km^2. Generally, the majority of seabed disturbance by both infrastructure and vessel mooring will be in the vicinity of the test berths and not throughout the entire Project Envelope area (although activity may occur anywhere within the Project Envelope). Assuming the seabed within a 150 m radius of each test berth (assuming 10) could be disturbed throughout the life of the test site and taking account the 150 m anchor line, this equates to an area of 2,850,000m^2 (2.8km^2) of seabed which could be impacted or approximately 25 % of the Project Envelope area. This impact will be temporary but will be repeated throughout the life of the test centre, however the seabed habitats that will be disturbed are represent a small area of like habitat in the wider environment and the ecological functionality of the area is not predicted to be at risk from this impact. Full vessel details including anchor specifications will be submitted to Marine Scotland in support of seeking approval to install.

The above reflects a highly precautionary analysis as it assumes use of the largest possible seabed footprint, and in reality, this very unlikely to occur. Although the sediments will be disturbed and re-suspended during installation, maintenance and decommissioning, these are expected to resettle quickly and in the immediate vicinity of the area of disturbance due to their size being classified as coarse. Therefore, the total footprint of activities is not expected to increase significantly because of sediments resettlement.

Cabling works within the Project Envelope are limited to cable recovery and replacement of existing cables, plus laying of short lengths of cable connecting berth ends to new devices. Existing cabling amounts to a total cable length of approximately 11 km. Cables are surface-laid, reducing impacts on sedimentary substrates during installation. Although some scouring is likely in the immediate vicinity of any cabling on sedimentary substrates, loss of or damage to sedimentary substrates on this scale, in the context of the development site and its wider availability, is not of ecological concern.

Decommissioning works will include the removal of infrastructure, with potential lifting and/or cutting of infrastructure, drilling, and/or grappling operations which will generate sediment re-suspension. However, sediment conditions are expected to recover relatively quickly following any works or decommissioning, particularly in such a tidally active location. Similarly, while the introduction of cabling infrastructure to sedimentary substrates results in the creation of a hard substrate, the project footprint represents approximately 0.7 % of the whole lease area and for anchor deployments approximately 25 % of the total Billia Croo test site and similar substrates in the immediate area and throughout Orkney are largely available.

Some minor scouring may be anticipated around some mooring chains; however, the footprint represents a small area the total Billia Croo test site, and similar substrates in the immediate area and throughout Orkney are largely available.

Appraisal conclusion for sedimentary substrates: Any potential impacts are not regarded as important at the scale of the development and in the context of the wider environment.

4.4.1.2 Rock, boulder and cobble substrates

Although the Billia Croo test site is not within a SAC, areas of bedrock boulder and cobble reef are regarded as potential Annex I reef habitats. Some impacts on discrete areas of rocky/stony habitat in the subtidal zone may occur.

The total worst-case footprint of developments is calculated as 0.0763 km^2 comprising approximately 0.7 % of the whole lease area and for anchor deployments (2.8 km^2) approximately 25 % of the whole lease area.

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However, only three of the current seven berth sites are located on a seabed dominated by rocky substrate (berth sites 4, 6 and 7) as shown on Figure 4-1. An additional three berth sites may be installed within the Billia Croo test site, and some uncertainty remains on the exact location of these berths. It is likely that only part of the WECs and electrical hubs will be located in rocky substrate, therefore the footprint of these installations on this seabed type is expected to be significantly smaller than the worst-case figure provided above.

In addition to WECs and electrical hubs, the Project Envelope covers cabling works, including cable recovery, replacement of existing cables, and laying of short lengths of cable (such as umbilical cable) to connect berth ends to new devices. Any beach excavation works at the landfall would require additional assessment. Only part of the existing 11 km of export and data cabling from berths and associated cable protection crosses non-sedimentary substrates (Figure 4-1). Any additional laying of cable for connections will be localised and will not increase the footprint significantly. Nevertheless, even when appraised against this worst case, loss of or damage to rocky areas at these scales will not compromise the physical integrity of rocky substrates in the context of Billia Croo or the wider area. Similarly, the introduction of new hard surfaces in the form of the devices or other infrastructure is not of a scale sufficient to have an important effect on the availability of natural substrates. Decommissioning works will include the removal of devices with potential lifting and/or cutting of infrastructure, drilling, and/or grappling operations, which will remove hard substrate from the seabed and the associated marine growth, and potentially cause physical damage to benthic species. This will be limited to the direct footprint of decommissioning activities and will not affect the rocky/cobbles habitat near the works.

Hydrodynamic conditions around rocky substrates may be expected to change in the immediate vicinity of devices and may, in the longer-term, cause some localised scouring. However, these impacts will not be sufficient to have an important effect on the physical integrity of these substrates across Billia Croo.

Appraisal conclusion for rock, boulders and cobbles substrates: Any potential impacts are not regarded as important at the scale of the development and in the context of the wider environment.

4.4.2 Benthic species

The infralittoral zone in the Billia Croo test site is dominated by the kelp *Laminaria hyperborea*. It is also typified by sparse faunal and algal crusts and the urchin *Echinus esculentus*, often with sparse *Alcyonium digitatum.* In the circalittoral zone, the seabed is rocky with a veneer of overlying mixed sediments in some areas. The seabed in the circalittoral zone is predominantly inhabited by sea soft corals (*A. digitatum*), bryozoans (*Securiflustra securifrons*, *Flustra foliacea*) and hydroids, brittlestars (*Ophiothrix fragilis*, *Ophiocomina nigra*), starfish (*Luidia ciliaris*), and anemones (*Urticina felina*). Further offshore the sand habitat is inhabited by infaunal polychaete species primarily, but also nematodes, amphipods, bivalves and echinoderms (EMEC, 2009). None of the above species are specific to the Project Envelope area or of individual conservation importance in UK waters. Due to the small footprint of activities (0.073km^2 for infrastructure and 2.8km^2 for anchor deployment) and the localised nature of the works, no significant impact on these subtidal species are anticipated.

The presence of *L. hyperborea* kelp forests and kelp and red seaweeds in the infralittoral zone suggests the potential presence of the PMFs 'kelp beds' and 'kelp and seaweed communities on sublittoral sediment'. However, kelp is not specific to the Project Envelope area and is widely distributed around Scotland and much of the British Isles. *L. hyperborea* has a moderate tolerance to abrasion/disturbance of the surface of the substratum and removal; however, the recovery rate of kelp is relatively fast, with kelp forests able to recover in 2 – 6 years after removal of all canopy-forming adults as observed in a study area by Christie *et al*. (1998). Any infrastructure placed directly over kelp forests, although unlikely, will result in loss of feature. However, the mooring systems for WECs and electrical hubs are small (3,000 m^2 and 400 m^2, respectively) compared to the area of kelp available in the Billia Croo test site and in the wider Orkney coast. Since cables works will occur over short lengths of cable and include cable lifting or laying, any area of kelp disturbed by the potential cable works will remain small. If kelp cannot be avoided during additional laying of short lengths of cables or during devices or electrical hubs installation, kelp clearance would be required prior to the works, however this would be dealt with on a case-by-case basis and would likely require additional licensing. Kelp is not expected to be sensitive to smothering and siltation rate changes resulting from cable works since the high wave energy at the site will is likely to remove any deposited sediments from the rocky seabed within no more than a few

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tidal cycles, except in the deepest rock pools (MarLIN, 2018). Additionally, the kelp habitat in the infralittoral zone is dominated by rock, therefore the risk of sediment smothering is not considered significant.

Decommissioning works will include the removal of devices and potential lifting and/or cutting of infrastructure, drilling, and/or grappling operations, thus removing hard substrate from the seabed and the associated marine growth, and potentially cause physical damage to benthic species. The project footprint represents a small area of the total Billia Croo test site, therefore any physical disturbance to benthic species will be localised, and hard substrates in the Billia Croo area and throughout Orkney are largely available for the epifauna to attach to. In sedimentary habitats, decommissioning activities will generate sediment re-suspension which can reduce the ability of some benthic species to breathe and feed and can result in species smothering. However, sediment conditions are expected to recover relatively quickly following any works or decommissioning, particularly in such a tidally active location.

There is potential for the introduction of MNNS to the site by a variety of vectors, particularly via the hulls or ballasts of vessels, or through transport of the devices and other infrastructure from harbours. Devices and infrastructure may also provide a novel substrate that serves as a stepping-stone for MNNS introduced by other vectors. MNNS may pose a risk to native benthic species and the widespread proliferation of MNNS could be damaging to the benthic ecology of a large area. The kelp *L. hyperborea* is particularly sensitive to the seaweed species *Undaria pinnatifida* which out-competes the native species (Farrell & Fletcher, 2006; Thompson & Schiel, 2012). *U. pinnatifida* is a highly successful invasive species, native from the north-west Pacific, that can cause changes to community structure and trophic interactions (James, 2016). These risks should be managed accordingly by adoption of a series of protocols that ensures MNNS are not transported on vessels or devices and that biofouling of devices is frequently inspected and cleared accordingly. Ongoing discussion with regulators should inform biofouling management requirements. Appraisal for mobile benthic species is presented in Section 6 – Fish and Shellfish.

Appraisal conclusion for benthic species: Any potential impacts are considered as not of ecological importance, but active management of the risk of introducing MNNS is appropriate under the Wildlife and Countryside Act 1981. Monitoring of the colonisation of devices and infrastructure by benthic flora and fauna may be included in an MNNS management protocol.

4.5 Appraisal of cumulative impacts

Cumulative impacts are those resulting from the combined effects of the Project with other subsea cable projects through space and time, in the context of natural variability. It also includes the combined effects with commercial fisheries and other sea users generating similar effects.

As described in Table 3-2 and Figure 3-2, the nearest activity to the Billia Croo test site which interacts with the seabed is the Stromness A dredge spoil disposal site, located approximately 2 km south-west. There are several planned installations of subsea power cables in Orkney, the nearest being the planned SSE Stromness to Dounreay (Scotland mainland) cable route which will pass the Billia Croo test site approximately 1 km to the south-east. Due to the relatively low water depths in the Project area, the anchor chains that may be used by installation or decommissioning vessels for the Project are not expected to overlap with the footprint of anchors and anchor chains that may be deployed at these sites. Due to these activities taking place at some distance from the Project, no cumulative impacts on the seabed are anticipated.

The main commercial fishing gear deployed in the Project and surrounding area are pots (as described in Section 12), which do not interact with the seabed. Furthermore, all inshore Scottish waters are subject to a restriction for cockle harvesting by any means. There is also a restriction on fishing for sandeel using towed gear with mesh of less than 32 mm all year-round in ICES area IVa (which Billia Croo lies within). Due to the limited use of bottom fishing gear in the Project area, no cumulative benthic impacts with fisheries are anticipated.

Appraisal conclusion for cumulative impacts on benthic species and habitats: No cumulative impacts are determined to be important to benthic and intertidal species and habitats.

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4.6 Receptor conclusion

A summary of the appraisal for each of the receptors is provided in Table 4-7 below. Note that, even where no important impacts on the development site are identified, in some cases there may still be a recommendation for mitigation or monitoring. Under these circumstances, mitigation is regarded as good-practice, while monitoring may serve to improve understanding of the relationships between stressors and receptors. Where mitigation or monitoring is considered to be a likely licence or condition of consent this is highlighted in Table 4-8.

Table 4-7 Summary of benthic appraisal conclusions

Receptor	Appraisal conclusion	Mitigation/monitoring applicable?
Benthic habitats	No important impacts	Yes see Table 4-8
Benthic species	No important impacts	Yes see Table 4-8
Benthic species and habitats	No important cumulative impacts are anticipated	Yes see Table 4-8

Given the uncertainties regarding some potential impacts and the opportunity to learn from test deployments, potential mitigation and monitoring measures are presented in Table 4-8.

Site-wide monitoring and research ideas may be more effectively pursued at a strategic level (by EMEC/Crown Estate Scotland/Marine Scotland/SNH/developer consortium), but opportunities initiated by developers are welcomed.

Project-specific assessments are required for aspects of the following impact pathways and, thus, each developer will need to identify any appropriate mitigation and/or monitoring in response to:

- Kelp clearance and or rock grinding/blasting. For this impact an anchor and device mooring plan as mentioned in Table 4-8 may be useful.

It is concluded that while the development footprint includes some rocky habitat, with potential Annex I stony/rocky reefs, any potential impacts on the physical integrity of sedimentary substrates and of rock, boulder and cobble substrates are not regarded as important at the scale of the development and in the context of the wider environment.

Any potential impacts on benthic habitats and species are considered as not important to the ecological functioning of the area. Good-practice mitigation should be applied to minimise the risk of introducing MNNS. In this regard monitoring of the colonisation of devices and infrastructure by benthic flora and fauna could also form part of a MNNS management protocol.

Further research regarding the potential interaction between WECs and the benthic ecosystem is ongoing through the EU-funded Horizon 2020 CEFOW project and EMFF SEA Wave project. Data is being collected using cameras mounted in a flying towed array and remote operated vehicle that provides wide area spatial coverage on an annual basis. The research compares the spatial and temporal patterns of biodiversity associated with increasing numbers of WECs at the test site.

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Table 4-8 Potential mitigation and monitoring measures relevant to benthic ecology

Impact	Receptor	Impact pathway	Monitoring/mitigation	Licence requirement / Likely condition of consent	Explanation
Change to benthic communities	Benthic species and habitats	Creation of new habitat	Monitor colonisation of selected devices and infrastructure. This may also form part of an invasive MNNS protocol or biofouling management protocol.	No	Monitoring colonisation will provide information on the species (if any) which colonise WECs and other infrastructure at the site. Information in relation to any preferences or timings and seasonality may also be identified.
	Benthic species and habitats	Disturbance/loss of habitat	The use of a vessel anchor and devices anchor/mooring plans.	No	Device and mooring plans will be informed by visual inspection of the seabed to identify and avoid any sensitive habitats/species, which may be carried out as part of maintenance activities.
	Benthic species and habitats	Disturbance/loss of habitat	All infrastructure including moorings will be removed during decommissioning. This will form part of a Decommissioning Plan which is a requirement for all developers.	Yes	Removal of infrastructure and moorings will allow the benthic environment to recover to pre-installation conditions which will be recorded ahead of any installation activities taking place.

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Impact	Receptor	Impact pathway	Monitoring/mitigation	Licence requirement / Likely condition of consent	Explanation
	Benthic species and habitats	Marine non-native invasive species	Adopt good practice: > All devices moorings will be removed during decommissioning; > Marine Biosecurity Planning Guidance (SNH, 2014a); > Marine Biosecurity Planning – Identification of best practice: a review (SNH, 2014b); > Guidelines for the control and management of ships' biofouling to minimise the transfer of invasive aquatic species (IMO, 2011); > Code of practice on non-native species (Scottish Government, 2012); > Good practice for water management (IPIECA, 2010).	Yes	The following wording is generally included in Marine Licences: *The Licensee must ensure that the risk of transmitting MNNS to and from site is kept to a minimum, by ensuring appropriate bio-fouling management practises are implemented during any works*. It is recommended that the suggested guidelines, codes and good practice are followed to limit impacts on the benthic environment as a result of MNNS.

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5 HYDRODYNAMIC AND PHYSICAL PROCESSES

Stage 1 of this appraisal defined the categories of potential effect as presented in Table 3-1. The appraisal now picks up at Stage 2 of the methodology where effect pathways and importance are identified as described in Section 3.

5.1 Key data sources

The key data sources that have been used to inform this appraisal:

- British Geological Survey: Geology of Britain viewer;
- EMEC MetOcean and Geophysical Description: Report number REP152-02-02 20080131 (EMEC, 2008); and
- EMEC Benthic Survey, (ICIT, 2006).

5.2 Potential effects

For hydrodynamic and physical processes receptors, the defined potential effect categories are applied to activities/effect pathways relevant to wave energy developments as described in the Project Envelope. First, potential effects are considered in broad-principles. Installation and decommissioning effects (Table 5-1) are addressed separately from those during the operational and maintenance phases (Table 5-2).

Note that details specific to Billia Croo, both environmental and relating to project-specifications, are not considered until the detailed appraisal later in this section.

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Table 5-1 Generic potential effects during device installation and decommissioning

Hydrodynamic Environment – Potential generic effects from device installation and decommissioning
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels (e.g. multi cat; workboat; DP vessel; dive-support vessel; crane-barge; gantry barge; tug; specialist cable-laying vessel; survey vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Changes to sedimentary processes (suspended sediment, sediment transport pathways and subsequent deposition) from site excavation for seabed mounted and surface-piercing elements, foundations, mooring or cable installations	Seabed	**Potentially important** – changes to sediment processes through disruption to seabed from infrastructure associated with the devices and other infrastructure during installation, and sediment deposition particularly, may alter the seabed, but is likely to be temporary in the near-field. Far-field effects may be longer-lasting but will be limited by the dispersal of material. Importance will be dependent upon the sensitivity of the receiving environment to deposited sediment, local hydrodynamics, the physical characteristics of released sediment and the volume of sediment disturbed.
	Water column	**Not important** – any changes to sedimentary processes in the water column during construction are expected to be within the natural variability of the site in the near-field and negligible in the far-field.
	Coastline	**Potentially important** – increased sediment deposition to the coastal environment may occur as a result of disturbance to seabed. The initial sensitivity and rate of recovery will be greater for some coastal types than others. Importance will also depend on the orientation and proximity of seabed works to sensitive coastal areas, local waves and hydrodynamics and the volume and physical characteristics of released material.

Table 5-2 Potential effects on hydrodynamic receptors during operations and maintenance of infrastructure

Hydrodynamic Environment – Potential generic effects from device installation
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels (e.g. multi cat; workboat; DP vessel; dive-support vessel; crane-barge; gantry barge; tug; specialist cable-laying vessel; survey vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices) >

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Changes to erosive forces/patterns and sedimentary processes (suspended sediment, sediment transport pathways and subsequent deposition) from presence/operation of devices and infrastructure	Seabed	**Potentially important** – altered hydrodynamics in the immediate vicinity of the devices and other infrastructure may result in increased scouring and loss/release of sediment (if present). Far-field effects on the distribution and transport of sediment to and from the seabed may be difficult to predict but may include increased sedimentation if energy has been removed from the system. Importance will depend upon the sensitivity of the surrounding seabed to changes in sediment dynamics, local hydrodynamics, the arrangement/spacing of devices and other infrastructure and the level of energy extraction in the context of local conditions.
	Water column	**Not important** – increases in suspended sediment are expected to be a result of scouring and therefore highly localised and rapidly dispersed in a hydrodynamically active area. The extraction of energy may result in higher rates of deposition/settlement of sediment over a wider area. This is unlikely to be of concern to the pelagic environment in a hydrodynamically active area.
	Coastline	**Potentially important** – a change in the wave climate in the shadow of the array may result in changes to sediment or beach deposition downstream (near and far field effects). Current speed may increase adjacent to devices/arrays, with a resultant increased likelihood of sediment entrainment. The presence of infrastructure may alter patterns of scour and deposition in the near-shore and intertidal environments. Sensitivity will be greater for some coastal habitats than others. Importance will depend upon local hydrodynamic conditions, the availability of sediment, the physical arrangement/spacing of devices and the level of energy extraction in the context of local conditions.

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5.3 Natural heritage context

The Billia Croo test site is located on the south-west coast of the Orkney mainland. The coastline is predominantly rocky, with few beaches, and its westerly location leaves it exposed to harsh wave conditions from the North Atlantic. Although there is little documented detail on the sediment transport patterns of this area, examples of west to east movement of sand deposition within the region have been observed in Scapa Flow to the south of the site (SNH, 2000). Littoral transport is dominated by wave processes, with much of this coastline being exposed to the high energy wave conditions. Long-term coastal edge retreat is occurring at many beaches and cliffs in the area, most notably at the Bay of Skaill (approximately 8.6 km north from the Billia Croo test site) (JNCC, 1997).

The Orkney archipelago comprises of sedimentary rocks, predominantly Old Red Sandstone. The geology of the offshore EMEC test site is undifferentiated sandy gravels underlain by mudstones and siltstones (BGS, 2018). The shores along the western Orkney coastline consist of very wave exposed bedrock, with some areas of extremely large boulders (Murray *et al,* 1999). To the south of the site a rocky promontory whilst to the north of the site is steeply shelved bedrock leading to a high cliff coastline (MS, 2019).

The littoral zone (shore or seabed area) within the Billia Croo area consists of a boulder beach and is characterised by exposed littoral rock (ICIT, 2006). The area off the west coast of Orkney, and in close proximity to the site is a high energy environment. Off the west coast of mainland, Hoy and the south coast of South Ronaldsay, the seabed shelves away relatively quickly, so relatively deep water (>50 m depth) occurs close to the coastline. As such, little dissipation of offshore wave energy is likely to occur prior to the severe offshore wave conditions reaching the coastline (SNH, 2000).

Wind from the west and south-east is one of the most significant features of the Orkney climate, and gales are frequent in occurrence, typically around 30 days in an average year with the winter months being the windiest (JNCC, 1997). The west coast of Orkney is open to the Atlantic Ocean and subject to high energy waves. The dominant swell wave direction is east-north-east, with waves from the east and north-east also contributing. The average significant wave height at the Billia Croo test site is around 1.7 m, with corresponding average wave periods of around 14 seconds (EMEC, 2008). Extreme 100-year return period waves from the dominant wave direction are predicted at the site with significant wave heights of around 14 m (EMEC, 2008).

The tides around Orkney produce a net flow of water from west to east within the Scapa Flow and between the islands, but tidal currents are relatively weak in the north-south direction on the west coast of Orkney, with current speeds rarely exceeding 0.5 m/s on a site-specific survey (EMEC, 2008). The mean spring tidal range at nearby port of Stromness is 2.9 m, while the mean neaps range is 1.3 m, and the 1 in 50-year return period tidal surge can be between 1.25 m and 1.5 m around the Orkney Isles (SNH, 2000).

Warebeth beach is located approximately 960 m south of the Billia Croo test site. The sand component of the beach is 200 m long, backed by a course cobble beach. The fringing beach is situated on top of the backshore abrasion platform and has a very low gradient of less than 1^{o} and a shell content of just over 40%. Due to the shallow gradient, the beach seldom dried out for long periods of time, decreasing the volume of sand blown towards the coastal edge (SNH, 1973).

Along the southern coastline of Stromness there are areas of sand dune vegetation, the closest of which is within 50 m east from the Billia Croo test site on the western flank of Breck Ness, while others are found nestling in the leeward eastern flank of Breck Ness, and backing the beach at Warebeth (Marine Scotland, 2019).

As part of the Dynamic Coast National Change Assessment, baseline descriptions are provided for various areas of the Orkney coastline. Orkney is described as being in Cell 10. The cell has been split into four sub-cells based on the exposure to the wave climate and the grouping together of coastlines with similar characteristics. Billia Croo is within Sub-cell 10a which encompasses much of the high energy outer coastline of The Mainland and Hoy. The coastline of Billia Croo has not undergone a detailed assessment as part of the work, but some of the information supports the high-level baseline for the area. The coast line of Cell 10 (1,024 km) makes up 5% of the Scottish coastline. Of this length, 61% (623 km) has been categorised as hard and mixed, 36% (373 km) as soft and 28.3 km (3%) as artificial. The assessment notes that in recent years

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(from 1970s to present day) erosion rates of soft shoreline has increased in rate and extent whilst accretion has reduced (Rennie *et al*., 2017).

The western coast of Orkney, within the vicinity of the Billia Croo site, is used for leisure and recreational craft at a moderate to high level (Marine Scotland, 2019). There are no listed scuba-diving areas within the vicinity of the Billia Croo test site; the closest scuba diving site is Tarbarka wreck and is approximately 5.6 km south (Marine Scotland, 2019). There are no stated surfing locations within the vicinity of the EMEC site; the closest being the Bay of Skaill (Marine Scotland, 2019); and Skara Brae and Skaill Bay Right which are located approximately 9 km north (Magicseaweed, 2019). There are no stated windsurfing locations within the Orkney Islands (Marine Scotland, 2019). There are no designated bathing waters on the Orkney Islands (SEPA, 2019). There are no general boating areas within the vicinity of the Billia Croo test site; the closest general boating area is located approximately 23 km east. Therefore, the main recreational receptor in which changes to the hydrodynamic regime could impact is leisure and recreational craft.

5.3.1 Protected sites

The North-West Orkney NCMPA is located 9.8 km from the site and shown within Figure 1-2. The NCMPA is a shallow area situated to the north and west of the Orkney Islands on the Scottish continental shelf. This site is designated for the following geomorphological feature; sand banks, sand wave fields and sediment wave fields repetitive of the Fair Isle Strait Marine Process Bedforms Key Geodiversity.

The Stromness Heaths and Coast SSSI which runs along the west coast of Mainland Orkney, overlaps the test site towards the eastern nearshore extent of the site boundary (Figure 1-2). This site is designated for two geological features; coastal geomorphology of Scotland, and the non-marine Devonian stratigraphy. The geomorphological nature of the designated features is sensitive to changes in the sediment regime within the marine environment and as such this receptor is deemed to have high sensitivity to the Project. Further assessment regarding the potential impact of the Project upon this receptor is detailed within Section 5.4

Geological Conservation Review (GCR) sites have been identified as sites of national and international importance regarding British geology. The West Coast of Orkney GCR site could be impacted by the project, as wave arrays may alter the wave field incident on the coastline.

Billia Croo is located within the Breck Ness to Noup Head coastal water body. The condition of this surface water body has been historically high (from 2014), with future predictions of it remaining so (from 2027 onwards) (NMPI, 2019). There are no designated bathing waters on the Orkney Islands (SEPA, 2019). The installation and presence of devices or other infrastructure is considered unlikely to adversely impact upon the water quality of the Breck Ness to Noup Head coastal water body.

5.4 Summary of impact appraisal for Billia Croo

This impact appraisal takes account of a maximum-case scenario based on the Project Envelope discussed in Section 2, where all available berths within the test site are developed and operating at capacity. It addresses the differing consenting and licensing regimes. This appraisal will inform the consenting process for both Marine Licence and S36 applications. However, it should be noted that, if there are key deviations in the device design or in any activity (deployment, installation, decommissioning, operations and maintenance), further appraisal work may be required. Any additional appraisal work required will be undertaken by the individual developer (further advice should be sought from EMEC in the first instance).

Table 5-3 presents the relevant legislation and the reasons for undertaking an appraisal for several features in the test site area.

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Table 5-3 Appraisal mechanism for hydrodynamic and physical processes

Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
Qualifying features of European sites	The Conservation of Habitats and Species Regulations 2017 (Note: these regulations apply in Scotland in relation to certain specific activities (reserved matters), including consents granted under Sections 36) Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) Water Framework Directive (WFD) 2000/60/EC	Yes	WFD River Basin Management Plan Coastal Water Bodies
Notified features of SSSIs	Nature Conservation (Scotland) Act 2004 (as amended)	Yes	Potential connectivity with the Stromness Heaths and Coast SSSI designated for coastal geomorphological features.
Protected features of MPAs	Marine (Scotland) Act 2010	No	Potential connectivity with the North-West Orkney NCMPA designated for marine geomorphology of the Scottish Seabed, however due to intervening distance connectivity is unlikely.
PMFs	Marine (Scotland) Act 2010	Yes	PMFs known to be present and discussed in more detail within Section 4.
Other sensitive natural heritage features	Appraisal of other features under: > The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (relevant to projects located 0-12 nm from shore) > The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 > Marine (Scotland) Act 2010	Yes	Captures assessment of all other sensitive natural heritage features at a population/habitat scale of concern

5.5 Appraisal of protected sites

During the installation and decommissioning phases of WEC and other infrastructure at the Billia Coo test site, installation of seabed mounted infrastructure, seabed piercing infrastructure, mooring lines and anchors will result in localised seabed disturbance and sediment suspension around the infrastructure. Sediment suspension will be limited to the device vicinity whilst seabed change will be small in scale and recover its original state in the medium term of months to years. There may be temporary, highly localised change in seabed character due to buried sediment layers being disrupted through the installation of infrastructure, however this disturbance will also recover over the medium term of months to years.

Venugopal *et al.* (2017) modelled the wave energy extraction at a large-scale wave farm development situated on the western coast of Orkney. This modelled development comprised of both surface water attenuators (198) (deployed in deep water) and Oscillating Wave Surge Converters (120) (deployed in shallow waters). Overall, the study found that an array of that scale would have an impact upon the wave climate, both within the array and neighbouring arrays. Cumulative wave height reduction downstream of the array, and farther down the coastline was observed as being significant. The magnitude of this effect was dependent on the array layout and number of co-located arrays. However, the study observed that although the wave height reduction to the lee side of the array was very high, with increasing distance from the arrays towards the shoreline, a recovery wave in wave heights or energy restore was observed (Venugopal *et al.* 2017). Comparatively, the number of WECs proposed at the Billia Croo test facility (20) is significantly fewer than the modelled wave farm from Venugopal's study, the distances between each device will be much greater, and therefore the predicted impact upon the wave climate will be significantly reduced. As such, during the operational phase of the

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development, although there may be some reduction in wave height within the immediate vicinity of WECs, wave heights and wave energy will recover within a short distance from the devices, and the wave field at the coast will likely return to background levels indistinguishable from the baseline. Given the highly energetic character of the western coast of Orkney, the near-field effects are unlikely to cause any changes to coastal erosion, or sediment transport.

The North-West Orkney Nature Conservation Marine Protected Area (NCMPA) is located 9.8 km from the site and shown within Figure 1-2. The NCMPA is a shallow area situated to the north and west of the Orkney Isles on the Scottish continental shelf. This site is designated for the following geomorphological feature; sand banks, sand wave fields and sediment wave fields repetitive of the Fair Isle Strait Marine Process Bedforms Key Geodiversity. The geomorphological nature of the site is sensitive to changes in the sediment regime within the marine environment and as such this receptor is deemed to have high sensitivity to the activities at the test site. However, increased volumes of suspended sediment within the water column due to the installation of the wave devices is unlikely to be transported to the NCMPA; the NCMPA is situated a significant distance away, 9.8 km north of the Billia Croo test site, and there is very little sediment transport in a north-south direction as a result of low current speeds, incident wave angle and lack of mobile sediments.

The Stromness Heaths and Coast SSSI runs along the west coast of Mainland Orkney, overlaps the test site towards the eastern nearshore extent of the site boundary (Figure 1-2). This site is designated for two geological features; coastal geomorphology of Scotland, and the non-marine Devonian stratigraphy. The geomorphological nature of the designated features is sensitive to changes in the sediment regime within the marine environment and as such this receptor is deemed to have high sensitivity to the test site. The net direction of current flow and sediment deposition (west to east) indicates that there could be connectivity between the test site and the SSSI. However, the potential disturbance to sediment during the installation phase of the wave devices is likely to be very localised and over a short period of time, and unlikely to directly impact upon the SSSI. During the operational phase, the presence of the wave test devices could reduce the wave energy downstream of the array site. This could increase the volume of sediment being deposited within the site but given the small scale of the proposed array site, the extent of sediment deposition is unlikely to have an adverse impact on the sediment regime within the marine environment and as such, it will not adversely impact upon the SSSI.

Billia Croo is located across both the Breck Ness to Noup Head (ID 200237) and Tor Ness to Breck Ness coastal water bodies (ID 200231). The condition of these surface water bodies has been historically high (from 2014), with future predictions of it remaining so (from 2027 onwards) (Marine Scotland, 2019). The installation presence and decommissioning of devices is considered unlikely to adversely impact upon the water quality of these coastal water bodies, due to the temporary nature of installation works, the low volumes of increased suspended sediment, and the high natural variability of the site.

Appraisal conclusion for protected sites: Any potential impacts are not regarded as important at the scale of the development.

5.6 Appraisal of other natural heritage features

The sand dune systems located along the coast of Orkney are sensitive to changes in sources of sediment, so the dune system located to the south of the site is unlikely to be impacted by the installation of wave devices at the Billia Croo test site due to being situated downstream; any potential impacts to the sediment regime within the marine environment will not impact the dune systems situated upstream.

The West Coast of Orkney Geological Conservation Review (GCR) site (May & Hansom, 2003) has the potential to be impacted by the test site, as the wave array could alter the wave field incident on the coastline. However, this GCR is characterised by hard rock and high cliffs, so a slightly altered wave field will have an imperceptible difference to them and will be within the natural variability of the site. Therefore, as discussed for the Stromness Heaths and Coast SSSI (Section 4.2.3), the GCR will not be adversely impacted.

The protruding topography of the coastline to the south of Billia Croo will provide shelter for Warebeth Beach during both the installation (and decommissioning) and operational phases. As such, it is considered that any

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activities as presented in the Project Envelope are unlikely to impact upon beach sediments at Warebeth Beach.

In summary, any changes to the hydrodynamic regime and coastal environment, are regarded as not important to the extent that they will mostly be immeasurable. Consequently, within the specifications of the Project Envelope, no further assessment is required in relation to hydrodynamic and coastal processes.

Generally, it can be considered, the further apart the devices are, the less of a barrier effect will be created to waves, and there will be less wave wake interactions, i.e. the impacts from the wake effects from each device can almost be treated independently. However, depending on the incident wave field, having the devices placed more closely together may cause constructive/destructive wake interference patterns. The spacing of berths at Billia Croo is 0.5 km apart, for context, the devices in the referenced modelling study (Venugopal *et al.* (2017)) were much more closely spaced and registered little to no impact downstream. Therefore, with a maximum of 20 devices at 0.5 km apart, adverse impacts as a result of wave – wake interactions are not anticipated.

Furthermore, given the relatively small number of devices (20 devices and 10 electrical hubs), any measurable alterations to hydrodynamics and physical processes are predicted to be so small as to be of no importance to the local physical environment.

Appraisal conclusion for other natural heritage aspects of hydrodynamic and physical processes: Any potential impacts are not regarded as important at the scale of the development.

5.7 Appraisal of cumulative impacts

In terms of impacts on hydrodynamic and physical processes one of the key concerns for projects acting in a cumulative manner is elevated sediment concentrations. The likely route of this would be through construction and installation activities for any marine and coastal projects near Billia Croo.

The MeyGen Pentland Firth project is located approximately 34.1 km from the Billia Croo test site. As the dominant wave direction at Billia Croo is from the west, there is not considered to be connectivity to the MeyGen site which is to the south and east of Billia Croo and therefore not downstream. The site is also considered to be too far away to act in a cumulative manner in terms of increased suspended sediment in the water column.

The proposed N1 ScotWind wind lease area is located in excess of 20 km from the Billia Croo test site. During construction and installation there may be increased suspended sediment for a limited period time however this will be temporary and given the distance from the Billia Croo test site, cumulative impacts are not predicted.

There are several aquaculture developments around Orkney, the closest shellfish farm is located approximately 7 km away and the closest finfish farm approximately 9 km away at Bring Head (Figure 3-2). Increased sediment in the water column as a result of aquaculture activities is a possibility, but due to mitigation and operational procedures in place at fish farms to minimise this, any increase should be negligible. The possibility for cumulative effects with the Billia Croo test site is therefore considered low.

The proposed SSE cable from Orkney to mainland Scotland is located less than 1 km from the Billia Croo test site at its closest point. During installation activities there is the likelihood that elevated suspended sediment will occur which has the potential to act cumulatively with any suspended sediment generated at Billia Croo as a result of installation activities. However, given the limited nature of any suspended sediment from Billia Croo, it is considered the potential for cumulative impacts is low.

Appraisal conclusion for cumulative impacts on hydrodynamic and physical processes: Any potential impacts are not regarded as important at the scale of the development.

5.8 Receptor conclusion

A summary of the appraisal is provided in Table 5-4. Note that, even where no important impacts are identified, in some cases there may still be a recommendation for some mitigation or monitoring. Under these

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circumstances, mitigation would be regarded as good practice, while monitoring may serve to improve generic understanding of the relationships between stressors and receptors.

Table 5-4 Summary of hydrodynamic and physical processes appraisal conclusions

Receptor	Appraisal conclusion	Mitigation/monitoring applicable?
Hydrodynamic and physical processes	No important impacts	Yes see Table 5-5
Hydrodynamic and physical processes	No important cumulative impacts are anticipated	Yes see Table 5-5

Given the opportunity to learn from test deployments monitoring measures are presented in Table 5-5 (this table should be reviewed as knowledge increases).

Site-wide monitoring and research ideas may be more effectively pursued at a strategic level (by EMEC/Crown Estate Scotland/Marine Scotland/SNH/developer consortium), but developer input or ideas are welcomed.

Project-specific assessments are required for aspects of the following impact pathways and, thus, each developer will need to identify any appropriate mitigation and/or monitoring in response to:

- Kelp clearance and or rock grinding/blasting.

It is concluded that no important impacts of relevance to hydrodynamics or physical processes are expected from the installation operation and decommissioning of WECs and other infrastructure at the Billia Croo test site, based on the parameters of the Project Envelope. Potential mitigation and monitoring proposals have been presented.

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Table 5-5 Potential mitigation and monitoring measures relevant to hydrodynamic and coastal process

Impact	Receptor	Impact pathway	Monitoring/mitigation	Licensing requirement / Likely condition of consent	Explanation
Changes to hydrodynamic regime	Coastal SSSI	WEC changes to hydrodynamic conditions	Measurement of current speeds and wave field in lee of WEC, before and after installation, would quantify downstream impact of WEC on current and wave field Mitigation could include giving careful thought to placement of berths, to try and avoid cumulative wake effects	No	It is unlikely that any mitigation or monitoring in relation to the hydrodynamic regime will be a licensing or consent requirement. Monitoring is suggested as good practice in order to increase the understanding of potential downstream effects.
Changes to seabed morphology	Local seabed	WEC installation causes new deposit on seabed	Collecting bathymetry and side scan sonar data in the test site before, after, and e.g. one year after installation would assess the initial shape, volume and then evolution of any spoil or stirred sediment Mitigation could include using a gravity base foundation which would not require drilling into the seabed and releasing spoil	No	The release of sediment and small rock fragments will likely be negligible above background levels. Unless there are any species or habitats of importance, there will be no requirement to do so.

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Impact	Receptor	Impact pathway	Monitoring/mitigation	Licensing requirement / Likely condition of consent	Explanation
Changes to nearby beach morphology	Warebeth beach	WEC changes to wave and tidal regime causing downstream impacts to beach sediments	Beach monitoring campaign before and after WEC installation. Mitigation could include avoiding placing a WEC directly north-west of Warebeth beach, i.e. in so that Warebeth beach would not be directly leeward of a device	No	Some developments which directly impact a beach may be required to undertake a beach monitoring campaign for the duration of the project, but impacts are unlikely here, and the natural site variability will be so high it would be extremely difficult to prove connectivity between the WEC and the beach, through either monitoring or modelling
Changes to local water quality	Breck Ness to Noup Head coastal water body	Installation activities causing elevated suspended sediment concentration above baseline	Boat-based suspended sediment monitoring before, after and e.g. one year after WEC installation could attempt to quantify the impact of the WEC on water quality Mitigation could include using a gravity base foundation which would not require drilling into the seabed and releasing spoil	No	The highly dispersive nature of the site and natural background variability mean it would be difficult to record any change above background levels, except during installation itself

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6 FISH AND SHELLFISH

Stage 1 of this appraisal defined the categories of potential effect as presented in Table 3-1. The appraisal now picks up at Stage 2 of the methodology where effect pathways and importance are identified as described in Section 3.

6.1 Key data sources

The key data sources that have been used to inform this appraisal:

- Fishery sensitivity maps in British waters (Coull *et al*., 1998);
- Spawning and nursery grounds of selected fish species in UK waters, (Ellis, 2012); and
- Billia Croo Fisheries Project, (EMEC, 2012).

6.2 Potential effects

For fish and shellfish receptors, the defined potential effect categories are applied to activities/effect pathways relevant to wave energy developments as described in the Project Envelope. First, potential effects are considered in broad-principles. Deployment, installation and decommissioning effects (Table 6-1) are addressed separately from those during the operational and maintenance phases (Table 6-2). Note that details specific to Billia Croo, both environmental and relating to project specifications, are not considered until the detailed appraisal later in this section.

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Table 6-1 Potential effects on fish and shellfish receptors during installation and decommissioning of infrastructure

Fish and shellfish – Potential generic effects from device installation and decommissioning
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels (e.g. jack-up barge; multi cat; workboat; DP vessel; dive-support vessel; crane-barge; tug; specialist cable-laying vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Installation vessel transits and manoeuvring leading to disturbance	Diadromous fish	**Not important** – Vehicle transits are not anticipated to be sufficiently noisy to have an important effect. Vehicle transiting activity will also be limited in duration and geography.
	Marine fish	
	Marine shellfish	
Underwater noise from foundation/mooring installation methods and vessels leading to auditory injury, death or disturbance	Diadromous fish	**Potentially important -** different species show varying levels of sensitivity to noise and vibration. Additionally, importance will relate to background noise, the range and frequency of noise sources and the duration and proximity of activities. Distance to relevant rivers will also determine importance (including salmon SACs) and migration routes.
	Marine fish	**Potentially important -** different species exhibit different sensitivity to noise and vibration. Additionally, importance will relate to background noise, the range and frequency of noise sources and the duration and proximity of activities to fish species. Distance to important locations/routes for sensitive species will also influence importance.
	Marine shellfish	**Not important** - detailed species-specific knowledge is lacking in relation to the effects of anthropogenic noise in relation to shellfish (Edmonds *et al*., 2016) and there is considerable debate about the hearing capabilities of aquatic invertebrates, no physical structures have been discovered in aquatic invertebrates that are stimulated by the pressure component of sound. However, vibrations (i.e., mechanical disturbances of the water) are also characteristic of sound waves. Rather than being pressure-sensitive, aquatic invertebrates appear to be most sensitive to the vibrational component of sound (Breithaupt, 2002). There is also evidence that some aquatic invertebrates display a level of sensitivity to underwater noise especially at the larvae recruitment stage (Anguilar de Soto *et al*., 2013). However, any possible effects are expected to be minor, highly localised and unimportant at a population level.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Increased suspended sediment/turbidity (including release of drill cuttings)	Diadromous fish	**Not important –** any increase in suspended sediment is predicted to be dispersed widely and quickly into the wider marine environment and diadromous fish by their nature are highly mobile and accustomed to a range of sedimentary conditions from transiting between various habitats.
	Marine fish	**Potentially important –** some marine species are sensitive to increased suspended sediment in the water column. This is particularly relevant to filter feeding species. The level of importance will be dependent on several factors including the level and nature of increased suspended sediment, the duration of any increase which will in turn be dependent on tidal conditions and the distribution of sensitive species in the vicinity.
	Marine shellfish	**Potentially important -** some marine species are sensitive to increased suspended sediment in the water column. This is particularly relevant to filter feeding species. The level of importance will be dependent on several factors including the level and nature of increased suspended sediment, the duration of any increase which will in turn be dependent on tidal conditions and the distribution of sensitive species in the vicinity.
Smothering because of drill cuttings or re-settlement of sediments	Diadromous fish	**Not important** – diadromous fish are highly mobile and cover large areas when present in the marine environment. They will therefore move away from potential impacts caused by resuspension.
	Marine fish	**Potentially important –** some benthic finfish may be vulnerable to smothering. This is applicable to species of low mobility or those which lay their eggs on the seabed. The level of importance will be dependent on the type of sediment, the volume of sediment, dispersive properties of the locality and the distribution of sensitive species in the vicinity.
	Marine shellfish	**Potentially important –** some shellfish may be vulnerable to smothering. This is applicable to species of low mobility or those which filter feed. The level of importance will be dependent on the type of sediment, the volume of sediment, dispersive properties of the locality and the distribution of sensitive species in the vicinity.
Benthic habitat loss/damage	Diadromous fish	**Not important –** diadromous fish are highly mobile and cover large areas when present in the marine environment.
	Marine fish	**Potentially important –** certain species have a reliance on the benthic environment for feeding and egg laying. Certain operations associated with the Project Envelope have the potential to impact the benthic environment. The level of importance will depend on the extent of the impact, the availability of the same habitat in the wider environment, the duration of the impact and the recoverability of the habitat.
	Marine shellfish	**Potentially important –** the majority of shellfish species have a reliance to some extent on the benthic environment. Certain operations associated with the Project Envelope have the potential to impact the benthic environment. The level of importance will depend on the extent of the impact, the availability of the same habitat in the wider environment, the duration of the impact and the recoverability of the habitat.
Introduction of marine non-native species (MNNS) via	Diadromous fish	**Not important -** diadromous fish move widely throughout the marine environment and therefore non-native species are not likely to pose a significant threat.
	Marine fish	**Potentially important** – certain marine species have a dependence on distinct areas, therefore there is the potential for the introduction of MNNS to impact if introduced into the areas where there is a reliance/exclusivity.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
vessels, devices or other equipment		The importance will depend on the characteristics of the non-native species introduced and the presence of sensitive species in the vicinity.
	Marine shellfish	**Potentially important** – the majority of shellfish have a dependence on distinct areas, therefore there is the potential for the introduction of non-native species to impact if introduced into the areas where there is a reliance/exclusivity. The importance will depend on the characteristics of the non-native species introduced and the presence of sensitive species in the vicinity.
Underwater noise from active acoustic equipment leading to disturbance	Diadromous fish	**Not important –** there is the possibility of the use of active acoustic equipment as part of the Project Envelope, however it is considered that this will not be sufficiently noisy or widespread to have an important effect. Note: Active acoustic devices and sub bottom profilers will be subject to additional appraisal taking account of equipment specifications.
	Marine fish	
	Marine shellfish	

Table 6-2 Potential effects on fish and shellfish receptors during operations and maintenance of infrastructure

Fish and shellfish – Potential generic effects from device installation and decommissioning
Summary of activity categories – see Project Envelope for detail > Physical presence of device(s), foundations, moorings, buoys and other infrastructure on the seabed, in the water column or above the surface > Operation of device(s)/power generation > Repeat removal and redeployment of equipment for maintenance (e.g. device removed from water or floating structure removed from berth; replacement of mooring system) > Other maintenance activities (e.g. biofouling removal; ROV/diver inspection or repairs) > Use of vessels (e.g. DP vessel; jack-up barge; multi cat; workboat; dive-support vessel; crane-barge; tug) > Use of equipment to monitor devices in situ or other environmental parameters (e.g. ROV, cameras or acoustic devices)

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Vessel transits and manoeuvring as part of maintenance activities, leading to disturbance	Diadromous fish	**Not important** – activities will not be sufficiently noisy to cause disturbance. Activities will also be limited in geography and duration; therefore, the activity is not considered potentially important.
	Marine fish	
	Marine shellfish	
Underwater noise from active acoustic equipment leading to disturbance	Diadromous fish	**Not important –** there is the possibility of the use of active acoustic equipment as part of the Project Envelope, however it is considered that this will not be sufficiently noisy or widespread to have an important effect. Any use of such devices will require approval of frequencies with Marine Scotland and SNH ahead of deployment. Active acoustic will also require consideration on a case by case basis to determine the need for an EPS licence. Where active acoustics are to be utilised as part of pre-installation survey, Marine Scotland will be consulted via the Notification of Site Survey process.
	Marine fish	
	Marine shellfish	
Habitat creation and fish aggregation effect	Diadromous fish	**Not important –** diadromous fish are not generally considered to aggregate around structures at sea with any regularity as their time at sea is generally considered to be transitional. Therefore, any aggregation potential is considered not to be important.
	Marine fish	**Potentially important –** there is the potential for some species to be attracted and aggregate around the WECs and other infrastructure. This phenomenon is poorly understood and is likely to be dependent on the benefits which aggregating behaviour will offer (reproductive, predator avoidance etc).
	Marine shellfish	**Potentially important –** some species may utilise the WECs and other infrastructure for feeding and/or habitat. This phenomenon is poorly understood and is likely to be dependent on the benefits which aggregating behaviour will offer (reproductive, predator avoidance etc).
Underwater noise from WEC operation	Diadromous fish	**Potentially important –** although certain species are sensitive to noise, the nature of diadromous fish means that they are unlikely to be in the vicinity of any noise for any extended periods of time. Importance will be dependent on the distance of the WECs to known migration routes, the noise characteristics of the operating WECs and natural and manmade noise in the marine environment.
	Marine fish	**Potentially important –** most marine species are of a highly mobile nature which means they can move away from noisy activities. However, some species do utilise low frequency sound for communication. The implications of the sound generated from WECs on marine species of fish is poorly understood but importance is likely to be dependent on the noise characteristics of the WEC, the life stage of the fish and natural and manmade noise in the marine environment.
	Marine shellfish	**Not important –** it is not considered that shellfish species are sensitive enough to noise for the predicted noise from the WECs to be important.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Changes to sediment and hydrodynamic regime	Diadromous fish	**Not important -** any increase in suspended sediment is predicted to be dispersed widely and quickly in to the wider marine environment and diadromous fish by their nature are highly mobile and accustomed to a range of sedimentary conditions from transiting between various habitats.
	Marine fish	**Potentially important -** certain species have a reliance on the benthic environment for feeding and egg laying. Other species which feed pelagically could also be impacted by changes in hydrodynamic and sediment regimes. Importance will be dependent on the duration of change, the nature and severity of change and the presence of sensitive species in the vicinity.
	Marine shellfish	**Potentially important -** certain species have a reliance on the benthic environment for feeding and egg laying. Other species which feed pelagically could also be impacted by changes in hydrodynamic and sediment regimes. Importance will be dependent on the duration of change, the nature and severity of change and the presence of sensitive species in the vicinity.
Introduction of marine non-native species (MNNS)	Diadromous fish	**Not important -** diadromous fish move widely throughout the marine environment and therefore non-native species are not likely to pose a significant threat.
	Marine fish	**Potentially important** – certain marine species have a dependence on distinct areas, therefore there is the potential for the introduction of MNNS to impact if introduced into the areas where there is a reliance/exclusivity. The importance will depend on the characteristics of the non-native species introduced and the presence of sensitive species in the vicinity.
	Marine shellfish	**Potentially important** – the majority of shellfish have a dependence on distinct areas, therefore there is the potential for the introduction of MNNS to impact if introduced into the areas where there is a reliance/exclusivity. The importance will depend on the characteristics of the non-native species introduced and the presence of sensitive species in the vicinity.
Electromagnetic Field (EMF) effects	Diadromous fish	**Potentially important –** diadromous species utilise magnetism on their migration routes, they are therefore susceptible to EMF. The importance will be dependent on the level of EMF emitted which in turn will be dependent on the cable type and size. Importance will also be dependent on the proximity to migration routes and relevant rivers.
	Marine fish	**Potentially important –** species of shark, skates and rays are sensitive to EMF. The importance will be dependent on the level of EMF emitted which in turn will be dependent on the cable type and size. Importance will also be dependent on the proximity to migration routes and relevant rivers.
	Marine shellfish	**Not important –** shellfish are not considered to be significantly sensitive to EMF.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Entrapment in WECs or other infrastructure with moving parts	Diadromous fish	**Not important –** some of the WECs included in the Project Envelope have moving parts which risk entrapment of fish. However, the risk is considered minimal given the mobile nature of the species.
	Marine fish	**Not important –** some of the WECs included in the Project Envelope have moving parts which risk entrapment of fish. However, the risk is considered minimal given the mobile nature of the species.
	Marine shellfish	**Not important –** given the largely benthic nature of marine shellfish it is not considered they are susceptible to entrapment by WECs.
Presence of WECs and other infrastructure leading to a barrier effect	Diadromous fish	**Potentially important –** migratory diadromous fish may rely on narrow migration routes when moving between fresh and marine water. The potential importance will be dependent on the location of the test site in relation to any migratory routes and the spatial extent of the Project in relation to any such routes.
	Marine fish	**Not important –** marine finfish are unlikely to be exclusively dependant on the area of the test site and therefore barrier effects are not considered to be important.
	Marine shellfish	**Not important –** given the limited mobility of the majority of shellfish species, barrier effects are not considered to be important.

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6.3 Natural heritage context

6.3.1 Diadromous fish

Several diadromous fish occur in Orkney waters, this includes species of salmon, trout and eels. It is possible that some diadromous fish from Orkney waters utilise rivers on mainland Scotland, however the level of connectivity is thought to be relatively low (Malcolm *et al*., 2010) and is discussed further in Sections 6.5 and 6.6.

6.3.2 Marine fish

A variety of marine fish will be encountered at Billia Croo, some of which will be included in the PMF list and some of which will have commercial value. Gadoid species such as cod and saithe are predicted to be encountered, as are pelagic species such as clupeids. Elasmobranch species including tope and spurdog are also expected to be encountered. There is also the potential that sandeel will be encountered at the Billia Croo test site in areas where fine sand is present. Different species will utilise the site in different ways, with some species utilising the site for feeding and reproduction, whilst others may only transit through the area. Orkney is located within spawning and nursery areas for a number of fish species, the Billia Croo test site overlaps with areas recognised as having the potential for spawning for herring (*Clupea harengus*), lemon sole (*Microstomus kitt*), sandeel (*Ammodytes marinus*) and sprat (*Sprattus sprattus*) (see Figure 6-2). The site is also within a wider area recognised as a nursery area for angler fish (*Lophius piscatorius),* blue whiting (*Micromesistius potassou*), cod (*Gadus morhua*), hake (*Merluccius angustimanus*), ling (*Molva molva*), saithe (*Pollachius virens*), lemon sole, whiting (*Merlangius merlangus*), herring, mackerel (*Scomber scombrus*), common skate (*Dipturus batis*), sandeel, spotted ray (*Aetobatus narinari*), spurdog (*Squalus Acanthiai*) and tope shark (*Galeorhinus galeus*). (see Figure 6-1). The extent of spawning and nursery within the Project Envelope is presented in Table 6-3.

Table 6-3 Summary of nursery and spawning in the vicinity of Billia Croo as presented in Figure 6-1 and Figure 6-2 (Coull *et al*., 1999; Ellis *et al*., 2014)

Species	Spawning	Intensity	Nursery	Intensity
Herring	Y	Undetermined	Y	Low
Lemon sole	Y	Undetermined	Y	Undetermined
Sandeel	Y	Low	Y	Undetermined
Sprat	Y	Undetermined	N	-
Angler fish	N	-	Y	High
Blue whiting	N	-	Y	High
Cod	N	-	Y	Low
Hake	N	-	Y	Low
Herring	N	-	Y	Low
Mackerel	N	-	Y	High
Whiting	N	-	Y	Low
Spurdog	N	-	Y	Low
Lemon sole	N	-	Y	Undetermined
Sandeel	N	-	Y	Undetermined
Common skate	N	-	Y	Low
Ling	N	-	Y	Low
Saithe	N	-	Y	Undetermined
Spotted ray	N	-	Y	Low
Tope shark	N	-	Y	High

6.3.3 Marine shellfish

The nature of the seabed in the vicinity of Billia Croo is ideal habitat for a number of shellfish species including lobster (*Homarus gammarus*), brown crab (*Cancer pagurus*), velvet crab (*Necora puber*) and shrimp (*Nephrops norvegicus*). Other species of crustaceans and molluscs are likely to be present, but none are expected to be unique to Billia Croo. European spiny lobster (*Palinurus elephas*), may also occur in the vicinity of Billia Croo and is classed as a PMF.

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Figure 6-1 Nursery grounds in the vicinity of Billia Croo test site

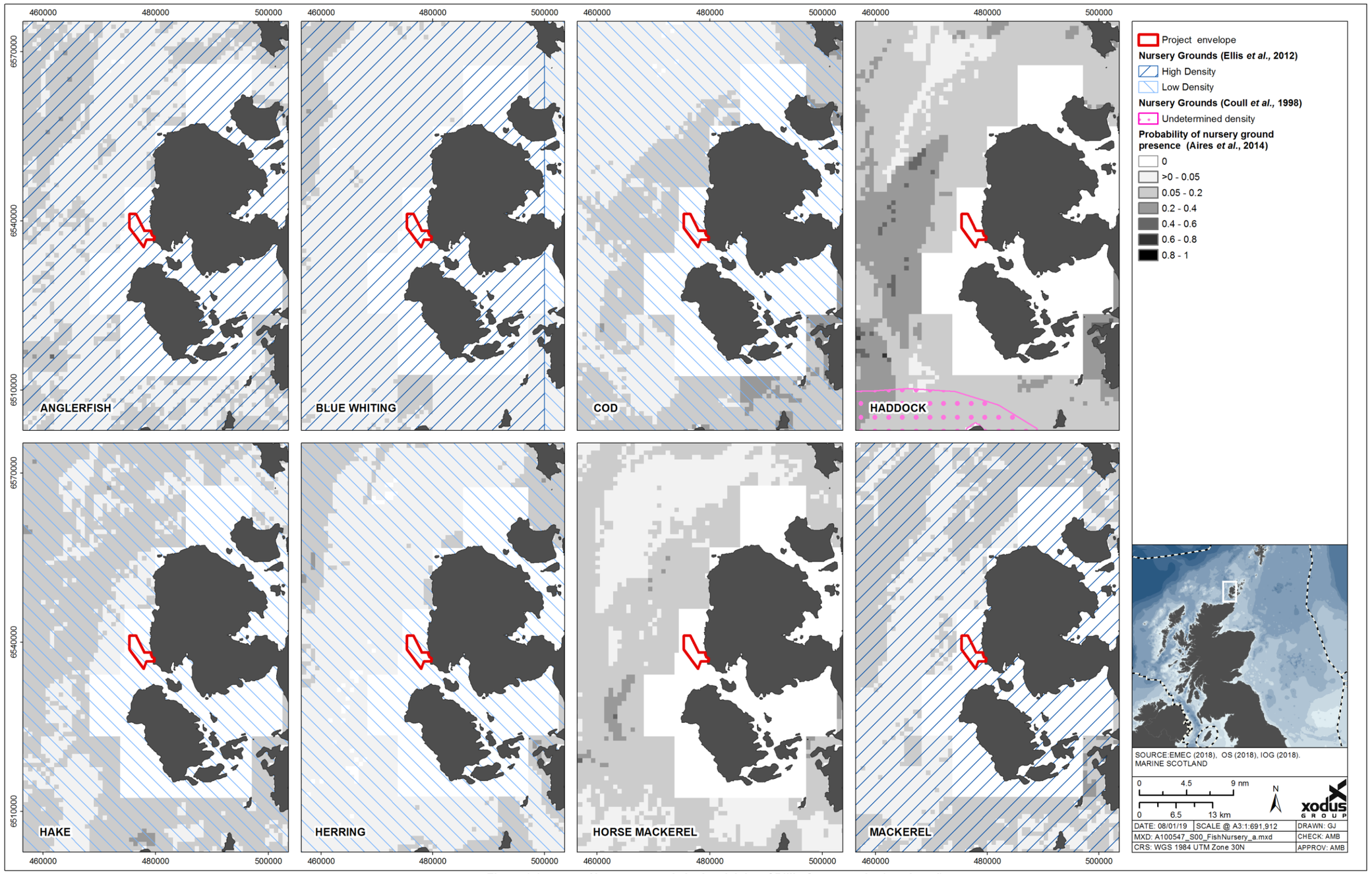

Figure 6.1 Nursery grounds in the vicinity of Billia Croo test site (continued)

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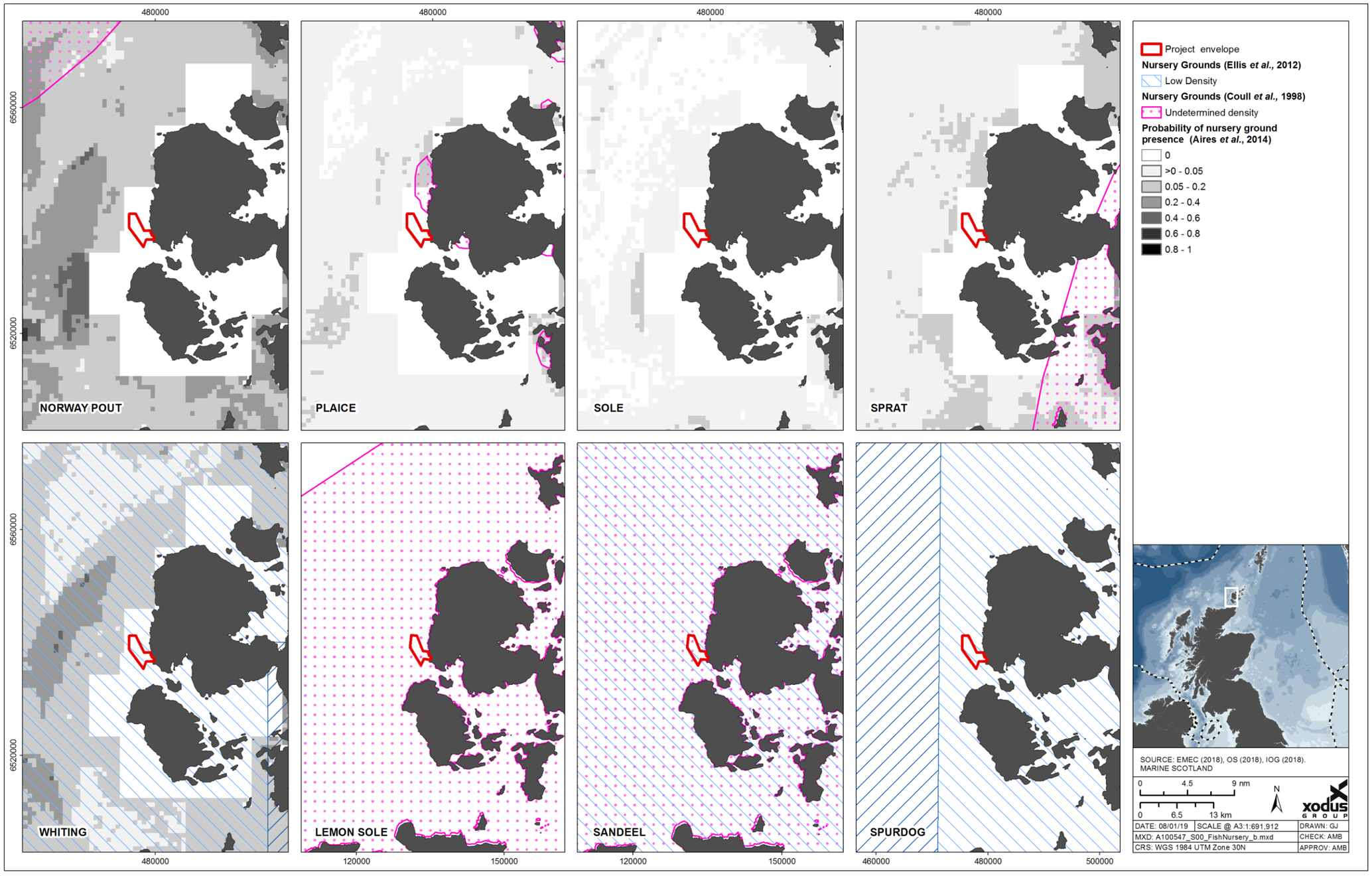

Figure 6.1 Nursery grounds in the vicinity of Billia Croo test site (continued)

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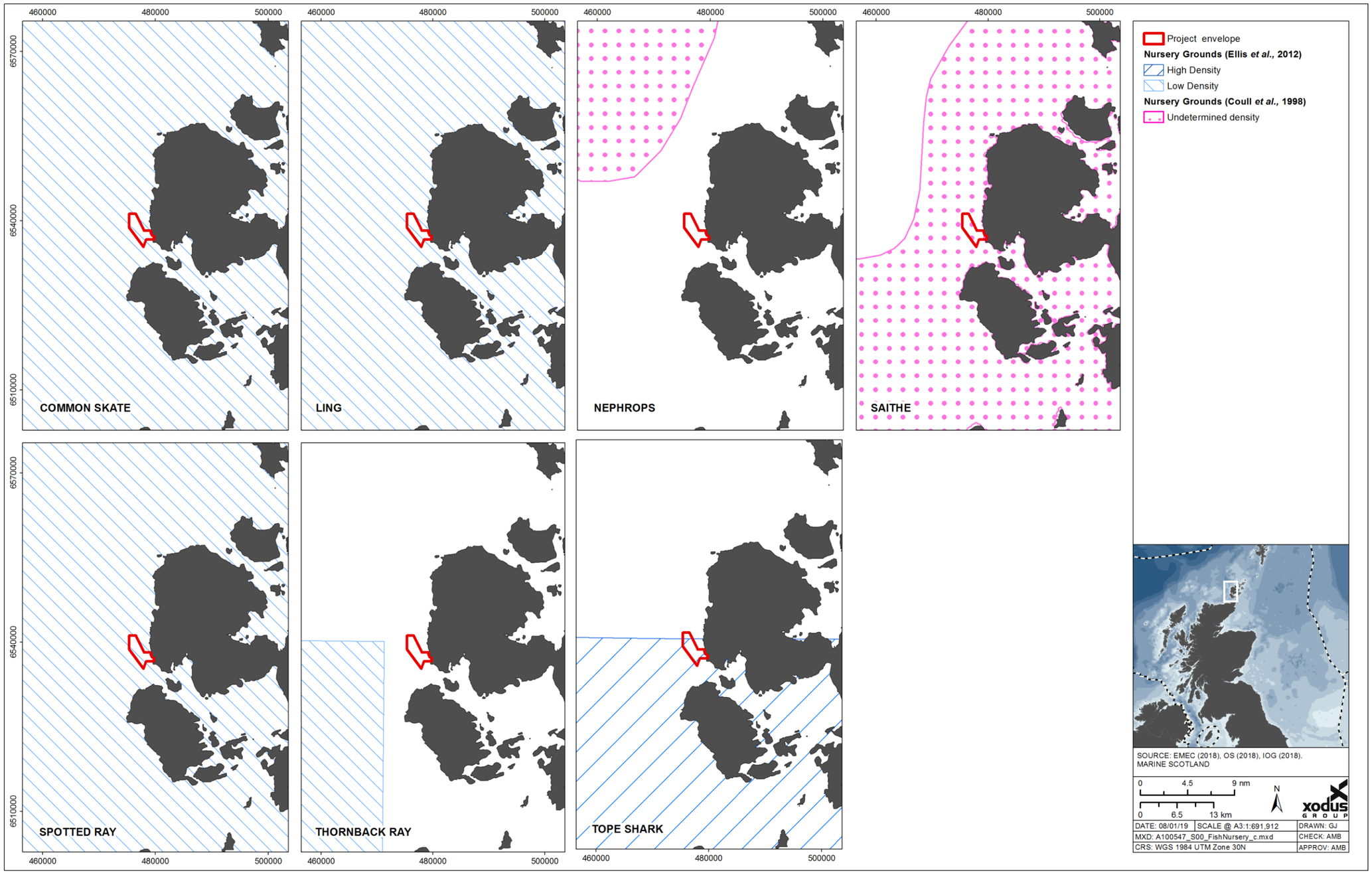

Figure 6-2 Spawning grounds in the vicinity of the Billia Croo test site

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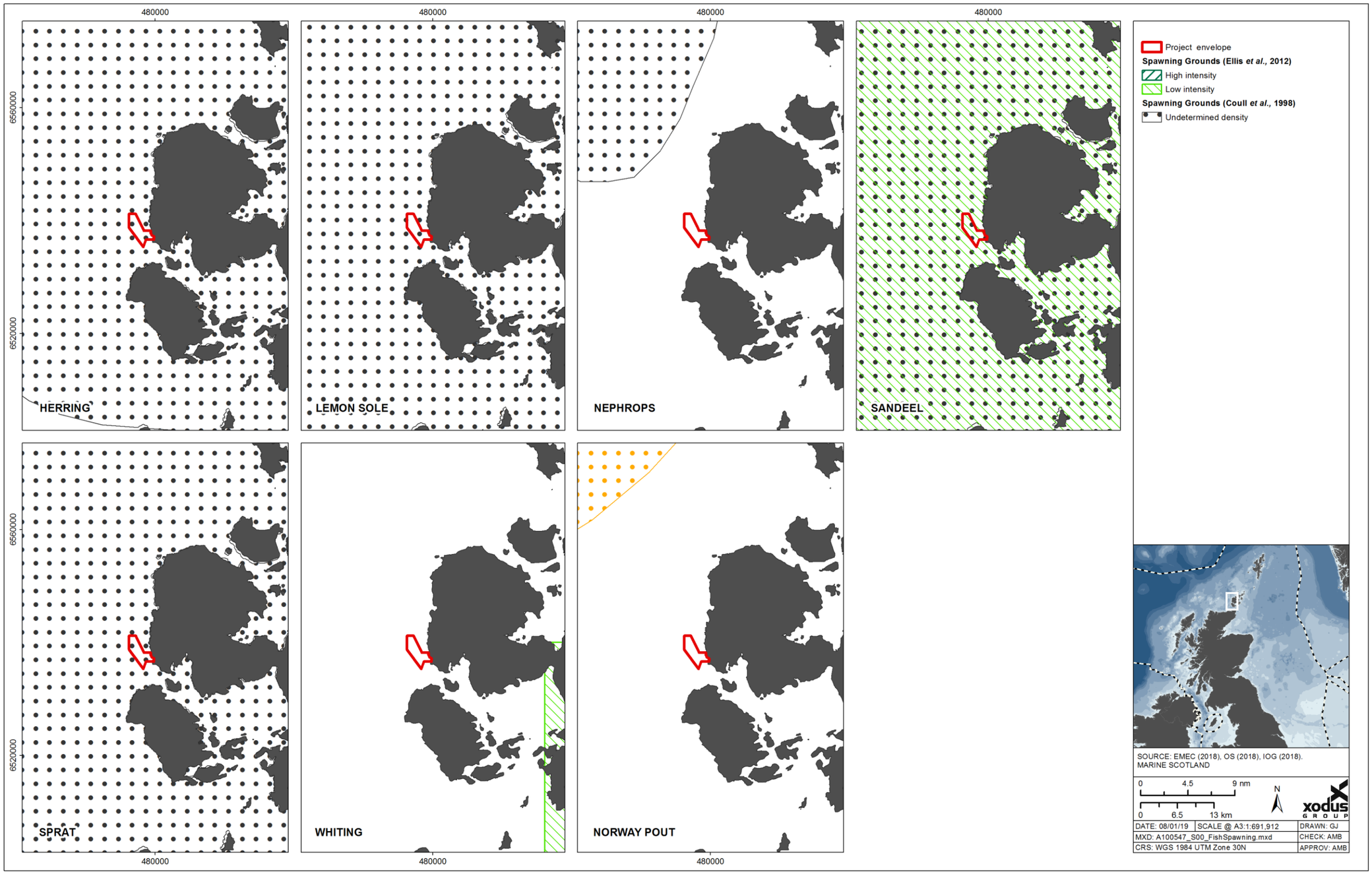
480000
6560000
6520000
HERRING
LEMON SOLE
NEPHROPS
SANDEEL
SPRAT
WHITING
NORWAY POUT
Project envelope
Spawning Grounds (Ellis et al., 2012)
High intensity
Low intensity
Spawning Grounds (Coull et al., 1998)
Undetermined density
SOURCE: EMEC (2018), OS (2018), IOG (2018).
MARINE SCOTLAND
0 4.5 9 nm
0 6.5 13 km
N
xodus GROUP
DATE: 08/01/19
SCALE @ A3:1:691,912
DRAWN: GJ
MXD: A100547_S00_FishSpawning.mxd
CHECK: AMB
CRS: WGS 1984 UTM Zone 30N
APPROV: AMB

6.3.4 Protected sites

The nearest protected sites which feature fish and shellfish as a qualifying feature are the Thurso SAC and the NW Orkney NCMPA (Figure 1-2). Atlantic salmon (*Salmo salar*) is the primary qualifying feature of the Thurso SAC located approximately 41 km away. The NW Orkney NCMPA is located approximately 10 km from Billia Croo and has sandeel as a protected feature.

6.3.5 Summary of impact appraisal for Billia Croo

This impact appraisal takes account of a maximum-case scenario based on the Project Envelope where all available berths within the test site are developed and operating at capacity. It addresses the differing consenting and licensing regimes. This appraisal will inform the consenting process for both Marine Licence and S36 applications. However, it should be noted that, if there are key deviations in the device design or in any activity (deployment, installation, decommissioning, operations and maintenance), further appraisal work may be required. Any additional appraisal work required will be undertaken by the individual developer (further advice should be sought from EMEC in the first instance).

Table 6-4 presents the relevant legislation and the reasons for undertaking an appraisal for several features in the test site area.

Table 6-4 Appraisal mechanism for fish and shellfish

Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
Qualifying features of European sites	The Conservation of Habitats and Species Regulations 2017 (Note: these regulations apply in Scotland in relation to certain specific activities (reserved matters), including consents granted under Sections 36) Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	Yes	Potential connectivity with Thurso SAC which has Atlantic salmon as a qualifying feature.
European Protected Species	The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	No	The only fish species listed as EPS is sturgeon (*Acipenser sturio*). Billia Croo is outwith the distribution range of this species.
Notified features of SSSIs	Nature Conservation (Scotland) Act 2004 (as amended)	No	No marine fish are notified features of SSSIs.
Protected features of MPAs	Marine (Scotland) Act 2010	Yes	Sandeels are a protected feature of the NW Orkney NCMPA.
PMFs	Marine (Scotland) Act 2010	Yes	Fish PMFs are likely to be present at Billia Croo.
Other sensitive natural heritage features	> The Wildlife and Countryside Act 1981 > The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (relevant to projects located 0-12 nm from shore) > The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 > Marine (Scotland) Act 2010	Yes	Captures assessment of all other sensitive natural heritage features at a population/habitat scale of concern.

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6.4 Appraisal of qualifying features of European sites

Several rivers along the north coast of Scotland are known to be important for Atlantic salmon, this importance has led to the designation of several rivers as SACs including the Thurso SAC, which is located approximately 41.3 km from the Project Envelope (Figure 1-2). The River Thurso drains a moderately large catchment in Caithness and flows north before entering the Pentland Firth at the town of Thurso. The river supports a higher proportion of multi sea-winter salmon than is found in many rivers further south in the species' range and the river is known to support the full range of salmon life-history types (JNCC, 2017). It is possible that Atlantic salmon from the Thurso SAC will pass through Billia Croo, but it is not anticipated this is with any frequency and connectivity is difficult to establish due to the distances involved and current lack of knowledge regarding migratory routes.

Appraisal conclusion for Atlantic salmon as qualifying species of European sites: SNH advise that no assessment under HRA is required as there is a current lack of knowledge regarding migration routes for the species which means it is difficult to attribute connectivity to SACs unless a project is within or very close to the SAC (not the case for Billia Croo and the Thurso SAC which is located 41 km away).

6.5 Appraisal of protected features of MPAs

The NW Orkney NCMPA is located approximately 9.8 km from Billia Croo (Figure 1-2). One of the protected features of the NW Orkney NCMPA is sandeel. The MPA plays an important role in supporting wider populations of sandeel, specifically newly hatched sandeel larvae from this region are exported by currents to sandeel grounds around Shetland and the Moray Firth (JNCC, 2018b). Billia Croo is recorded as a nursery and spawning ground for the species (Figure 6-1 and

Figure 6-2). However, this is true of the wider environment in general and the Billia Croo site is not recognised to be any more significant for sandeel than the surrounding area.

Appraisal conclusion for sandeels as a protected feature of an NCMPA: Given the localised nature and small scale of predicted seabed disturbance the potential for significant impacts to sandeel from the NCMPA is unlikely. Therefore, it is concluded there is no significant risk of hindering the achievement of the conservation objectives of the NCMPA and no further assessment is required.

6.6 Appraisal of PMF and other natural heritage features

6.6.1 Diadromous fish

Atlantic salmon, sea trout and European eel (*Anguilla anguilla*) are all encountered in Orkney waters, these species are all included on the PMF list. There are few salmon rivers recorded in Orkney and none on the west coast of Orkney near Billia Croo (NMPi, 2018). In 2010, Malcom *et al.* produced a report focused on migration of diadromous species in Scotland and the implications for renewable energy (Malcolm *et al*., 2010). One salmon tagging study from Orkney is mentioned in the report and concludes that all recaptures occurred within 2 – 3 miles of tagging, however these data may be attributable to the limited available data. The routes by which salmon depart and return to rivers in the north of Scotland, including the River Thurso are not known, but it is assumed that on return they swim along the coast seeking olfactory[15] cues that help them identify the correct river (Lockwood, 2005). In 2014, a report looking into depth use and migratory behaviour of homing Atlantic salmon was produced (Godfrey *et al*., 2014). The report focused on a study which involved tagging 50 adult salmon on the northern coast of Scotland and recording their depths. The median number of records occurred at 0 – 5 m and the mean maximum dive depth was 64 m. The results suggest the potential for salmon to interact with man-made obstacles throughout the water column, but most likely in the surface waters (Godfrey, *et al.*, 2014). Given the lack of clear understanding on the migratory routes and behaviour of Atlantic salmon it is considered possible they could be encountered in the Billia Croo area.

[15] Relating to the sense of smell.

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Sea trout also have a relatively poorly understood distribution and migratory behaviour; however, they are considered widespread in Scottish waters and are infrequently reported outwith the coastal zone (Tylers-Walters, 2016). They are therefore likely to be encountered at Billia Croo, but not with great frequency.

European eel has a complex life history that is poorly understood, involving migration of mature adults from European rivers and estuaries to the Sargasso Sea in the west Atlantic for spawning, and the subsequent return of juveniles (Avant, 2007). In Scotland the species is known to be widely distributed through all types of fresh water with a connection to the sea (Tyler-Walters, 2016). Malcolm *et al*. (2010) report that Orkney waters may contain migratory eels from northern Europe and the UK, however the same report states that it is also possible that European eels bypass Scottish coastal waters and take a route which tracks the Scandinavian coast. It is therefore considered the presence of European eels at Billia Croo is possible, but it is not considered they will be encountered with any frequency or that Billia Croo is a particularly important site for the species.

The potential impacts identified as important for diadromous fish in Table 6-1and Table 6-2 were underwater noise, EMF and barrier effects.

During installation and decommissioning underwater noise will be limited to vessel activity and installation of WECs and other infrastructure. Percussive pile driving is explicitly excluded from the Project Envelope, any developments wishing to utilise this technique will be subject to further and separate assessment. Further assessment would also be required for active acoustic devices and sub bottom profilers taking into account equipment specifications. During operations and maintenance noise will occur because of operation of the WECs and vessels on site for maintenance. These activities will be limited in duration and geography. The maximum number of vessels to operate simultaneously on site is 12, this is considered a worst-case maximum rather than a standard and will be maintained through EMEC's Control of Work Standard Operating Procedure (SOP). The Billia Croo area already has vessel use and is considered naturally noisy due to the hydrodynamic regime. Hearing varies across fish species and Atlantic European eels are considered to have medium sensitivity (Nedwell *et al*., 2004). Atlantic Salmon are thought to have poor to medium hearing sensitivity, as their swim bladder is disconnected from skull/hearing system (Nedwell *et al*., 2004; Faber Maunsell, 2007). Given the limited nature of noisy activities, it is not considered that underwater noise will be important to diadromous fish species present at Billia Croo.

Current knowledge suggests that EMFs from subsea cables may interact with migrating diadromous fish if their movement routes take them over the cables, particularly in shallow water (Gill *et al*., 2012). A report from the Bureau of Ocean Energy Management (BOEM) (Hutchinson *et al.,* 2018) assesses the impacts of submerged power cables on fish and invertebrates. Some of the key findings indicate that there were no significant differences in the fish communities living around energized and unenergized cables and natural habitats and there is no compelling evidence that the EMF in the cables were either attracting or repelling fish and that EMF strength dissipated quickly with distance and reached background levels at about one metre from the cable (Hutchinson *et al*., 2018). The recent NorthConnect ES included a literature review of EMF data sources, it reported that literature indicates that species have different levels of sensitivity to EMFs and elevated sediment temperatures, and the thresholds of effects will be different for different species. There is also limited unequivocal evidence of adverse behavioural or physiological effects caused by either EMFs or elevated sediment temperatures, at an individual or population level from any existing projects (NorthConnect, 2018). However, a level of uncertainty remains on the exact mechanisms and consequence. Given the relatively small scale of the Project Envelope and the limited number of subsea cables, it is not considered a population effect will occur.

Barrier impacts are also considered unlikely to impact diadromous fish at a population level given the small scale of the Project Envelope.

Appraisal conclusion for diadromous fish: Any potential impacts to diadromous fish species are not considered important at a population level.

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6.6.2 Marine fish

The potential impacts identified as important for marine fish in Table 6-1and Table 6-2 were underwater noise from WEC operation; changes to the sedimentary regime, smothering, benthic habitat loss, introduction of MNNS, EMF and habitat creation. Some of these potential impacts will be of more relevance to certain species than others and are discussed accordingly in the following sections.

6.6.2.1 Gadoids

Gadoid species are known for both their commercial and conservation interests. Species such as cod (*Gadus morhua*) and whiting (*Merlangius merlangius*) are known to have an important economic value and several gadoid species are included on the PMF list including cod, ling (*Molva molva*), saithe (*Pollachius virens*) and Norway pout (*Trisopterus esmarkii*). Billia Croo is a known nursery ground for a number of gadoid species including anglerfish (*Lophius piscatorius)*, blue whiting (*Micromesistius potassou*), cod, hake (*Merluccius angustimanus*), ling, saithe, lemon sole (*Microstomus kitt*) and whiting. The area does not support spawning for any gadoid species (Coull *et al*., 1999, Ellis *et al*., 2012). It is therefore expected that these species will be encountered at Billia Croo, but that the site does not represent a high-density nursery area or spawning area.

Gadoids are classed as having intermediate hearing ability, with some species being sensitive to loud noises. Cod in particular has been identified as having high sensitivity to marine noise and has been identified as using vocalisations for communication (Faber Maunsell, 2007). It is therefore possible that installation and decommissioning activities and operational noise may interfere with this behaviour. However, given the limited Project Envelope and the lack percussive piling and the intermittent nature of deployments at Billia Croo it is considered unlikely that any impacts would have an impact on any gadoid species including cod at a population level. However, there is a level of uncertainty on the sensitivity to noisy activities and further research may be useful in informing this.

Many of the gadoid species likely to be encountered at Billia Croo are classed as benthopelagic, with generally a low sensitivity to suspended sediment (Barnes, 2008; Heard, 2004). Many species are accustomed to experiencing a range of turbidity conditions in the water column and given their mobile nature can move away from conditions which are less than favourable. It is also likely that any suspended sediment as a result of activities at Billia Croo (installation, operation and decommissioning) will be limited spatially and temporally and rapidly dispersed.

Some gadoid species are known to aggregate around manmade infrastructure structures such as marine fin fish cages (Skilbrei, 2016) and oil and gas platforms (Soldal *et al*., 2002). The Project Envelope contains a maximum of 20 WECS, 10 electrical hubs and two floating platforms, it is considered that this only represents a small opportunity for aggregations and there will be no population level effect.

As benthopelagic species gadoids do associate with the seabed, however they don't interact exclusively with it. Therefore, the small area of seabed which will be utilised within the Project Envelope will not impact any species at population level because of habitat loss or disturbance. Additionally, any small-scale changes to the hydrodynamic and sediment processes at Billia Croo will not impact gadoid species at a population level.

It is not considered that gadoid species will be impacted by any MNNS that may enter the test site as gadoids don't tend to have exclusive interactions with specific areas of habitat and are therefore free to move away from any potential negative impacts as a result of MNNS.

Appraisal conclusion for gadoid species: Impacts determined to be potentially important will not have any population level effects on gadoid species. It is noted that certain pathways such as underwater noise are not fully understood, and further monitoring and research may be beneficial.

6.6.2.2 Clupeids

Clupeid species which may be encountered at Billia Croo include herring (*Clupea harrangus*) and sprat (*Sprattus sprattus*). Outwith spawning time herring are thought to stay away from the immediate coastal area (Barnes, 2008) so may not be seen with great regularity. Both herring and sprat have some commercial value and Billia Croo is recorded as overlapping with the spawning area for both (Figure 6-2). Herring is also

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recorded as a PMF and both species are recognised as having ecological value as a food source for other fish, bird and mammal species.

As discussed in Section 4.4.1.1, PSA of substrates from Billia Croo identified were mainly medium to coarse sand and therefore considered potentially suitable for herring spawning.

Clupeid species are considered sensitive to sound, species such as herring, have elaborate specialisations of their auditory apparatus, characterised by the presence of an optic bulla, a gas-filled sphere, connected to the swim bladder, which enhances hearing ability (Nedwell, 2004). Despite this sensitivity, the localised nature of underwater described as included within the Project Envelope (explicitly excluding percussive piling) and the relatively noisy natural environment means that no impacts because of noisy activities at any stage of activities is predicted. Additionally, clupeid species are not known to make vocalisations (Popper, 1993), so masking of vocalisations by Project Envelope noise is not an issue.

Clupeids are pelagic species and therefore do not have a heavy reliance on the seabed for most of their existence. Herring are however demersal spawners and limit spawning to areas of clean gravelly substrate. The near shore area of the Project Envelope does not contain suitable substrate for herring spawning, but the offshore area has a mixture of coarser substrate which may present some opportunity for spawning. Considering this and given the limited nature of seabed disturbance because of activities and devices as per the Project Envelope, there is not considered to be a threat to clupeid species.

Herring and sprat feed pelagically and could therefore be at risk to changes in the water column as a result of suspended sediment and changes to hydrodynamic regime. However, given the scale of the Project Envelope, neither are predicted to cause an issue.

WECs with large floating elements offer the greatest potential for Fish Aggregation Device (FAD) potential to pelagic clupeids (ABP Marine Environmental Research Ltd, 2010). However, given the limited number of WECs on site at any one time and the intermittent and non-permanent nature of deployment at Billia Croo the potential for any long-term impacts as a result of FAD is low and no population level impacts are predicted. Further research regarding this effect is ongoing at the test site.

It is not considered that MNNS will enter the test site at a level which has the potential to impact on clupeid species. Additionally, the test site is not recognised as a particularly important or exclusive area for clupeid species.

Appraisal conclusion for clupeids: No impacts are regarded as important at a population level.

6.6.2.3 Sandeels

Sandeels provide an important food source for a variety of bird and fish species, with many bird species feeding chicks exclusively on the species. This importance has led to the inclusion of the species on the PMF list. The Billia Croo site is identified as overlapping with areas determined to be sandeel nursery and spawning (low intensity) grounds Figure 6-1 and

Figure 6-2. It is possible that the species would be encountered at the site and indeed utilise the site to some extent for nursery and spawning. However, sandeel are known to have a strong preference for sandy substrates (Marine Scotland, 2017a). As discussed in Section 4.4.1.1, PSA of substrates from Billia Croo identified were mainly medium to coarse sand with an estimated < 5% classed as fine sands. This coupled with the occurrence of bedrock conditions at Billia Croo indicates the area is not a favourable habitat for the species and it is considered sandeels will not rely heavily on this area for habitat.

Appraisal conclusion for sandeels: Given the limited suitability of habitat for the species and therefore low encounter rate, no impacts are regarded as important at a population level.

6.6.2.4 Elasmobranchs

Please note potential impacts on basking sharks are covered separately in Section 7.

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Elasmobranch species with the potential to be encountered at Billia Croo include common skate (*Dipturis batis complex*), and spurdog (*Squalus acanthias*), both species are included on the PMF list. As shown in Figure 6-1, Billia Croo overlaps with the nursery grounds of a number of elasmobranch species – spurdog, common skate, spotted ray (*Raja montagui*), tope and thornback ray (*Raja clavata*).

Understanding of elasmobranch hearing is limited, but general understanding is that they of low sensitivity with a narrow range of hearing (Casper, 2010). Elasmobranch species are also not considered to be particularly sensitive to changes in sedimentary and hydrodynamic regime given their mobile and wide-ranging nature.

Of all fish species elasmobranchs are potentially the most sensitive to EMF, but the effects are poorly understood (Faber Maunsell, 2007). The species possess specialised electroreceptor pores in their skin from which they detect bioelectric emissions from prey, these pores are also susceptible to EMF in the marine environment. Given the small scale of the development and the relatively small number of cables involved, it is not considered that EMF will have a significant effect on elasmobranch species at Billia Croo.

Certain species of elasmobranch lay eggs in cases on the seabed, changes in sedimentary regime and smothering during installation would be of potential concern to these species. However, Billia Croo is not known to overlap with key spawning habitat of any elasmobranch species as indicated in Figure 6-2 any spawning which does occur will not be impacted by smothering as the dynamic conditions at the site will rapidly disperse sediment in the water column.

It is not considered that elasmobranch species will be impacted by any MNNS that may enter the test site. As mentioned, elasmobranchs aren't thought to rely on the area for nursery and spawning and therefore despite utilising discrete areas for spawning and nursery, the level this will happen at Billia Croo is considered low. Therefore, any MNNS which enter the test site are not considered to have the potential to impact elasmobranch species in the area at any discernible level.

Appraisal conclusion for elasmobranchs: No potentially important impacts are considered important at a population level.

6.6.2.5 Other marine fin fish

Other species which may be encountered at Billia Croo which have not been mentioned in previous sections may have ecological or commercial value. Notably anglerfish, Norway pout, whiting, ling, saithe and mackerel all occur on the PMF list. Mackerel and Norway pout are both fish of commercial importance likely to be encountered to some extent at Billia Croo. These species are highly mobile and not considered to have a high sensitivity to any of the potential impacts presented in Table 6-1 and Table 6-2.

Appraisal conclusion for other marine fin fish: No population level impacts are predicted as a result of any of the potentially important impacts.

6.6.3 Marine shellfish

The potential impacts identified as important for marine shellfish in Table 6-1 and Table 6-2 were changes to the sedimentary regime, smothering, benthic habitat loss, introduction of MNNS and habitat creation. Some of these potential impacts will be of more relevance to certain species than others and are discussed accordingly in the following sections.

6.6.3.1 Crustaceans

A variety of crustacean species are encountered at Billia Croo. Several commercially important species such as brown crab (*Cancer pagurus*), velvet crab (*Necora puber)* and lobster (*Homarus gammarus*). European spiny lobster (*Palinurus elephas*) may also be found at Billia Croo and is featured on the PMF list. In 2012, a fisheries study was undertaken at Billia Croo which concluded that the site provides suitable feeding and refuge habitat for lobster and has the potential to act as a nursery area to both the local fishery and Orkney as a whole (EMEC, 2012).

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Installation activities will lead to the loss of some habitat for some crustacean species. However, the small scale of loss and the availability of suitable habitat in the wider area means this impact is not considered to be important. There is the potential that the introduced infrastructure will act as new habitat for crustacean species. This could be viewed as a positive impact, albeit it will be temporary in nature limited to the period of deployment.

Crustacean species likely to be encountered at Billia Croo are considered to have relatively low sensitivity to increases in suspended sediment and smothering (Neal and Wilson, 2008). When considered with the dynamic conditions at Billia Croo which will rapidly disperse sediments, these impacts are not considered to be important.

The effects on EMF on crustaceans is poorly understood. Research does indicate that EMF has the potential to influence crustacean behaviour (Scott, *et al*., 2018). However, given the small scale of development at Billia Croo and the limited amount of subsea cables, this impact is not considered important to crustaceans, however further research into this area would be useful to inform this topic.

There is the potential for non-native species to be introduced because of introduction of WECs and other infrastructure to Billia Croo. By following good practice in relation to biosecurity this risk will be kept to a minimum and given the small scale of development is not considered important.

Appraisal conclusion for crustaceans: No population level impacts are predicted as a result of any of the potentially important impacts.

6.6.3.2 Molluscs

It is expected that a range of mollusc species will be encountered at Billia Croo. This may include PMF species such as heart cockle (*Glossus humanus*) and fan mussel (*Atrina fragilis*). It is inevitable that some habitat loss will occur, however given the availability of similar habitat in the wider environment and the small scale of loss this is not thought to be important.

By virtue of their mobility molluscs are generally considered of low tolerance to suspended sediment and smothering. However, given the small scale of activities and predicted impacts this is not considered important at a population level.

EMF impacts are poorly understood in molluscs, it is generally considered species are of low sensitivity. In combination with the small scale of development and the limited numbers of subsea cables, this is not considered to be an important impact for molluscs.

Appraisal conclusion for molluscs: No potentially important impacts will cause a population impact for mollusc species.

6.7 Appraisal of cumulative impacts

As detailed in Table 3-2 and Figure 3-2, a number of projects are active or planned in the vicinity of the Billia Croo test site. As concluded in Sections 4.5 there are no cumulative impacts predicted as a result of any projects on the benthic or hydrodynamic characteristics at Billia Croo. Therefore, it can be considered that there will be no cumulative impacts to fish and shellfish as a result of benthic or hydrodynamic changes. Other cumulative impacts may arise as a result of disturbance and noise as a result of simultaneous installation operations for example associated with the proposed SSE power cable or the N1 offshore wind potential lease area (Section 3.7). Installation activities at Billia Croo will be limited temporally and to the Project Envelope. Although activities at the Billia Croo test site may take place at the same time as activities associated with adjacent projects any simultaneous activities will only take place over a limited period of time and therefore it is considered that the potential for activities within Billia Croo to act cumulatively with disturbance and noise from other projects is limited.

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6.8 Receptor conclusion

A summary of the appraisal for each of the receptors is provided in Table 6-5 below. Note that, even where no important impacts on the development site are identified, in some cases there may still be a recommendation for mitigation or monitoring. Under these circumstances, mitigation is regarded as good-practice, while monitoring may serve to improve generic understanding of the relationships between stressors and receptors. Where mitigation or monitoring is considered to be a likely licence or condition of consent this is highlighted in Table 6-6.

Table 6-5 Summary of fish and shellfish appraisal conclusions

Receptor	Appraisal mechanism/relevant legislation	Mitigation/Monitoring recommended?
Diadromous fish	No important impacts	Yes see Table 5-5
Marine fish	No important impacts	Yes see Table 5-5
Marine shellfish	No important impacts	Yes see Table 5-5
All fish receptors	No important cumulative impacts are anticipated	Yes see Table 5-5

There is some uncertainty regarding certain impacts and the opportunity to learn from deployments at the site is recognised. Potential mitigation and monitoring measures are presented in Table 4-8.

Site-wide monitoring and research ideas may be more effectively pursued at a strategic level (by EMEC/Crown Estate Scotland/Marine Scotland/SNH/developer consortium), but developer input or ideas are welcomed.

It is concluded that no important impacts of relevance to fish and shellfish are expected from the installation, operation and decommissioning of WECs and other infrastructure at the Billia Croo test site, based on the parameters outlined in the Project Envelope. No mitigation proposals are being made at present, but device-specific monitoring may be useful.

Research is ongoing at the test site under the EU funded Horizon 2020 project CEFOW and EMFF SEA Wave project, to assess fish distribution, biomass and behaviour directly around WECs. Data is being collected using static underwater camera systems lowered to the seabed for short periods of time. Data regarding the species composition and behaviour relative to the WECs is also being collected.

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Table 6-6 Suggested mitigation and monitoring

Impact	Receptor	Impact pathway	Mitigation/Monitoring	Licensing requirement / Likely condition of consent	Explanation
Behavioural change	All species, of particular concern in relation to elasmobranchs	EMF	Measurements of strength and range of EMF at the site.	No	It would be useful for a variety of energy generation situations to be monitored i.e. various levels of occupancy etc.
Community composition and changes in behaviour	Diadromous fish, marine fish and crustaceans	Habitat creation and FAD	Monitoring of all introduced infrastructure including WECs and mooring structures.	No	Monitoring the variety of infrastructure deployed at the site would provide a useful of understanding of when and if FAD occurs and what preferences in terms of infrastructure, seasonality etc there might be.

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Impact	Receptor	Impact pathway	Mitigation/Monitoring	Licensing requirement / Likely condition of consent	Explanation
Change to benthic communities	Mostly low mobility shellfish and benthic species	Introduction of MNNS	Adopt good practice: > All devices moorings will be removed during decommissioning; > Marine Biosecurity Planning Guidance (SNH, 2014a); > Marine Biosecurity Planning – Identification of best practice: a review (SNH, 2014b); > Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (IMO, 2011); > Code of practice on non-native species (Scottish Government, 2012); > Good practice for water management (IPIECA, 2010).	Yes	The following wording is generally included in Marine Licences: *The Licensee must ensure that the risk of transmitting MNNS to and from site is kept to a minimum, by ensuring appropriate bio-fouling management practises are implemented during any works*. It is recommended that the suggested guidelines, codes and good practice are followed to limit impacts on the benthic environment as a result of MNNS. It is recommended that the suggested guidelines, codes and good practice are followed to limit impacts on the benthic environment as a result of MNNS.

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7 BASKING SHARKS

Stage 1 of this appraisal defined the categories of potential effects as presented in Table 3-1. The appraisal now picks up at Stage 2 of the methodology where effect pathways and importance are identified as described in Section 3.

7.1 Key data sources

The key data sources that have been used to inform this appraisal:

- EMEC wildlife observation data from 2009 to 2015, (EMEC, 2016);
- The Marine Conservation Society Basking Shark Watch Project (Bloomfield and Solandt, 2008); and
- Long-term satellite tracking reveals variable seasonal migration strategies of basking sharks in the north-east Atlantic (Doherty *et al*., 2008).

7.2 Potential effects

For basking shark receptors, the defined potential effect categories are applied to activities/effect pathways relevant to wave energy developments as described in the Project Envelope. First, potential effects are considered in broad-principles. Installation and decommissioning effects (Table 6-1) are addressed separately from those during the operational and maintenance phases (Table 6-2).

Note, that details specific to Billia Croo, both environmental and relating to project-specifications, are not considered until the detailed appraisal later in this section.

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Table 7-1 Potential effects on basking shark receptors during deployment, installation and decommissioning of infrastructure

Potential effects from device installation and deployment
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels (e.g. jack-up barge; multi cat; workboat; DP vessel; dive-support vessel; crane-barge; tug; specialist cable-laying vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Installation and decommissioning vessel(s) presence, transiting and manoeuvring leading to disturbance	Basking sharks	**Potentially important** – basking sharks may be sensitive to vessel presence and associated activities. The importance of this potential effect pathway will depend upon the duration and intensity of vessel activity, the distribution of basking sharks across the Project Envelope area, the opportunity for sharks to avoid areas of disturbance and the distribution of planktonic prey species (i.e. the presence of feeding opportunities). The need for a licence to disturb basking sharks should be considered.
Underwater noise from foundation/mooring installation methods leading to disturbance	Basking sharks	**Potentially important** – whilst the hearing physiology of basking sharks is poorly understood, this species may be sensitive to low frequency vibrational noise from foundation installation activities, such as drilling, which may fall within their anticipated range of audibility based on knowledge of other shark species (i.e. 0.1 – 1.5 kHz) (Koper and Plön, 1999). The non-percussive installation methods to be used, coupled with the relatively poor hearing capabilities of elasmobranchs, make injury or mortality from this impact pathway unlikely. However, the importance of underwater noise disturbance effects will depend upon the range and frequency of noise sources, ambient noise levels, the durations and intensity of activities, the opportunity for sharks to avoid areas of disturbance, the distribution of basking sharks across the test site area and the distribution of planktonic prey species (i.e. the presence of feeding opportunities). The need for a licence to disturb basking shark should be considered.
Underwater noise from active acoustic equipment leading to disturbance	Basking sharks	**Not important** – although the hearing physiology of basking sharks is poorly understood, elasmobranchs are generally considered to have low sensitivity to high frequency sounds, such as those emitted by acoustic monitoring equipment. Whilst elasmobranchs can generally hear sounds between 0.1-1.5 kHz (Francis and Lyon, 2013), studies of elasmobranch sensory systems have shown they are receptive to very low frequency pulsed sounds (i.e. 0.1 – 10 Hz) but only over a very limited spatial scale (i.e. in their immediate surroundings) (Montgomery and Bodznick, 1999; Koper and Plön, 2012). As echosounders utilise high frequency sounds which are likely to be on the order of 27 – 120 kHz (Scalabrin and Massé, 1993; Tušer *et al.*, 2009), noise emissions from active acoustic monitoring equipment will be outwith the audibility range for basking sharks and is therefore not an impact pathway which will result in disturbance to this species.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Entanglement in mooring lines or cabling leading to injury or death	Basking sharks	**Potentially important** – basking sharks may be exposed to potential interactions with cables and/or lines which may or may not be under tension (e.g. disconnected from the device, connected to the device before it is at station or in operation, or of a mooring configuration which is slack, such as a Lazy-S Mooring Configuration). Devices may not be moored during the installation and decommissioning phases or moored without the lines under tension, which would pose a risk of entanglement. Lines in the water have the potential to entangle basking sharks, although interactions between individuals and wave device cables or lines remain poorly characterised, such interactions function as potential sources of injury or mortality from entanglement events. Importance will depend upon the likelihood of basking sharks occurring in the test site area, the location and spacing of devices, and mooring and cabling configuration design.
Entrapment[16] in devices, multiple mooring lines or cabling leading to injury or death	Basking sharks	**Not important** - the potential for entrapment of marine species, including basking sharks, in WECs is poorly understood. However, it is considered unlikely that large animals, such as basking sharks, would swim into device cavities or between multiple mooring lines or cables, thereby becoming trapped. Potential impacts from this effect pathway will be highly influenced by device-design, with the size and structure of the WECs dictating likelihood of basking sharks interacting with devices in a manner which would result in entrapment. As this impact pathway is considered to be project-specific, developers should consider this impact pathway further on a case-by-case basis.
Presence of WEC(s) leading to barrier effects	Basking sharks	**Potentially important** – basking sharks are understood to be migratory species which utilise specific areas for important biological and life-history events. Any obstruction or restriction to free movement along migratory pathways that could result from installation and decommissioning activities relating to WEC arrays, may impact upon the reproductive success of this species. Importance will depend upon the relative importance of the test site area to the migration of basking sharks and the likelihood of disturbance from installation and decommissioning activities (e.g. from noise or vessel presence) that might deter basking sharks from transiting through an area. This impact pathway will need to be reviewed to ensure that it does not impact upon the conservation status of this species.
Increased suspended sediment/turbidity leading to disturbance	Basking sharks	**Not important** – basking sharks are not considered sensitive to increased turbidity within the water column caused by disturbance of the seabed (e.g. Skomal *et al*., 2009). Moreover, suspended material disperses rapidly in an energetic coastal environment. For these reasons, this impact mechanism is not considered important to basking sharks.

[16] Entanglement is limited to becoming physically ensnared or tangled in an object, typically a line or cable, whereas entrapment consists of an animal becoming caught in an object. Entangled animals may continue to drag the entangling object if it is mobile, whereas entrapped animals are generally unable to exit and therefore mobility is restricted to the confines of the entrapping object.

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Table 7-2 Potential effects on basking sharks during operations and maintenance of infrastructure

Potential effects from device operation and maintenance
Summary of activity categories – see Project Envelope for detail > Physical presence of device(s), foundations, moorings, buoys and other infrastructure on the seabed, in the water column or above the surface > Operation of device(s)/power generation > Repeat removal and redeployment of equipment for maintenance (e.g. device removed from water or floating structure removed from berth; replacement of mooring system) > Other maintenance activities (e.g. biofouling removal; ROV/diver inspection or repairs) > Use of vessels (e.g. DP vessel; jack-up barge; multi cat; workboat; dive-support vessel; crane-barge; tug) > Use of equipment to monitor devices in situ or other environmental parameters (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Maintenance vessel(s) presence, transiting and manoeuvring leading to disturbance	Basking sharks	**Potentially important** – basking sharks may be sensitive to vessel presence and associated activities. The importance of this potential effect pathway will depend upon the duration and intensity of vessel activity, the distribution of basking sharks across the test site area, the opportunity for sharks to avoid areas of disturbance and the distribution of patchy planktonic prey species (e.g. the presence of feeding opportunities). The need for a licence to disturb basking sharks should be considered.
Underwater noise from device operation leading to disturbance	Basking sharks	**Not important** – elasmobranchs (including basking sharks) are considered to have relatively poor hearing capabilities and noise emissions from device operations are unlikely to be sufficiently loud or at a high enough frequency to fall within the auditory range of this species.
Underwater noise from active acoustic equipment leading to disturbance	Basking sharks	**Not important** – although the hearing physiology of basking sharks is poorly understood, elasmobranches are generally considered to have low sensitivity to high frequency sounds, such as those emitted by acoustic monitoring equipment. Moreover, this impact pathway is considered to be project-specific. Therefore, developers should consider this impact pathway further on a case-by-case basis.
Entanglement in mooring lines or cabling leading to injury or death	Basking sharks	**Potentially important** – basking sharks may be exposed to potential interactions with cables and/or lines which may or may not be under tension (e.g. disconnected from the device, connected to the device before it is at station or in operation, or of a mooring configuration which is slack, such as a Lazy-S Mooring Configuration). Lines in the water have the potential to entangle basking sharks, although interactions between individuals and wave device cables or lines remain poorly characterised, such interactions function as potential sources of injury or mortality from entanglement events. Importance will depend upon the likelihood of basking sharks occurring in the test site area, the location and spacing of devices, and mooring and cabling configuration design.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Entrapment in devices, multiple mooring lines or cabling leading to injury or death	Basking sharks	**Not important** - the potential for entrapment of marine species, including basking sharks, in WECs is poorly understood. However, it is considered unlikely that large animals, such as basking sharks, would swim into device cavities or between multiple mooring lines or cables, thereby becoming trapped. Potential impacts from this effect pathway will be highly influenced by device design, with the size and structure of the WECs dictating likelihood of basking sharks interacting with devices in a manner which would result in entrapment. As this impact pathway is considered to be project-specific, developers should consider this impact pathway further on a case-by-case basis.
Other maintenance activities (i.e. non vessel-based) leading to disturbance	Basking sharks	**Not important** – maintenance activities include inspection (e.g. divers, ROV, etc.), repairs or temporary retrieval and replacement of device infrastructure as needed. In all cases, it is the presence of the accompanying vessel which presents the primary disturbance risk; this is appraised separately.
Presence of WEC(s) and other infrastructure leading to barrier effects	Basking sharks	**Potentially important** – basking sharks are understood to be migratory species which utilise specific areas for important biological and life-history events. Any obstruction or restriction to free movement along migratory pathways that could result from the long-term placement of WEC arrays may impact upon the reproductive success of this species. Importance will depend upon the relative importance of the test site area to the migration of basking sharks, as well as the scale and nature of any long-term occupancy of the test site area by wave devices. This impact pathway will need to be reviewed to ensure that it does not impact upon the conservation status of this species.
Increased suspended sediment/turbidity leading to disturbance	Basking sharks	**Not important** – basking sharks are not considered sensitive to increased turbidity within the water column caused by disturbance of the seabed (e.g. Skomal *et al*., 2009). Moreover, suspended material disperses rapidly in an energetic coastal environment. For these reasons, this impact mechanism is not considered important to basking sharks.

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7.3 Natural heritage context

Basking sharks (*Cetorhinus maximus*) are the largest fish to occur in UK waters. Having been hunted until the mid-1990s, this species is now protected by a suite of national and international legislation. This species is listed in Appendix II of the Berne Convention, Appendix I/II of the Convention on Migratory Species (Bonn Convention), Annex V of the OSPAR Convention, and are protected in the UK by the Wildlife and Countryside Act 1981 (as amended). The last of these pieces of legislation provides protection against harm to this species through defined offenses, whilst the Wildlife and Natural Environment (Scotland) Act 2011 provides a mechanism for licensing anticipated offences in Scottish waters. Basking sharks are also listed in several conservation policy documents for their importance as a UK species, including their designation as a Scottish Priority Marine Feature (PMF) (Tyler-Walters *et al*., 2016); and their inclusion in the Scottish Biodiversity List.

As cosmopolitan filter-feeders with a circumglobal distribution (Doherty *et al.*, 2017), basking sharks solitarily traverse the open ocean opportunistically foraging for planktonic prey (Bloomfield & Solandt, 2008; Gore *et al*., 2008). When not occupying deep-ocean waters, basking sharks appear to target coastal fronts for feeding and reproductive activities (Priede and Miller, 2008; Sims *et al*., 2000). Foraging activity appears to increase in the summer months in response to increases in zooplankton abundance (Sims *et al*., 2005). Socialisation appears to increase during the summer season as well, and aggregations of basking sharks can be seen engaging in courtship behaviours along thermal fronts which support rich planktonic communities (Sims *et al*., 2000). There is also some evidence of seasonal migrations by this species, which appears to occur on both the transatlantic and transequatorial scales (Skomal *et al*., 2009; Gore *et al*., 2008). Whilst several movement pathways have been identified in the northeast Atlantic, tagging data indicates that there is much plasticity in individual movement strategies and the use of specific migration routes is unlikely (Doherty *et al.*, 2017).

In the UK, basking sharks may be seen throughout the North and Northeast Atlantic, the Irish Sea and Hebridean Sea (Southall *et al*., 2005; Witt *et al*., 2012). Around Orkney, basking sharks form casual visitors along the coastline, maintaining a greater distribution offshore (Evans *et al*., 2011).

Eighteen basking sharks were recorded during the EMEC wildlife observations collected between 2009 and 2015, of which six occurred within the existing lease area (Figure 1.1). Two-thirds of the animals described in these observations were identified as feeding (EMEC wildlife observation data 2009 - 2015). Consequently, the area comprising the Project Envelope area appears to provide some foraging habitat to this species.

7.3.1 Protected sites with basking shark features

The only site designated for the protection of basking sharks in Scotland is the Sea of Hebrides proposed Marine Protected Area (pMPA) located over 250 km southwest of Billia Croo (SNH, 2014c). This proposed site covers the seas between the eastern coastline of the Outer Hebrides and the west coast of the Inner Hebrides, including Skye, Mull and the Ardnamurchan Peninsula. This region forms key habitat for basking sharks in the UK and therefore requires protection to conserve and support this pelagic species. An appraisal against protected sites with basking shark features is provided in Section 7.5.

7.4 Summary of impact appraisal for Billia Croo

This impact appraisal takes account of a maximum-case scenario based on the Project Envelope where all available berths within the test site are developed and operating at capacity. It addresses the differing consenting and licensing regimes. This appraisal will inform the consenting process for both Marine Licence and S36 applications. However, it should be noted that, if there are key deviations in the device design or in any activity (deployment, installation, decommissioning, operations and maintenance), further appraisal work may be required. Any additional appraisal work required will be undertaken by the individual developer (further advice should be sought from EMEC in the first instance).

Table 7-3 presents the relevant legislation and the reasons for undertaking an appraisal for several features in the test site area.

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Table 7-3 Appraisal mechanism for basking shark species and habitat

Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
Qualifying features of European sites	The Conservation of Habitats and Species Regulations 2017 (Note: these regulations apply in Scotland in relation to certain specific activities (reserved matters), including consents granted under Sections 36) Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	No	No European sites with basking sharks in Scotland.
European Protected Species	The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	No	Basking sharks are not listed as EPS. However, they are subject to licensing requirements under the Wildlife and Natural Environment (Scotland) Act 2011, which are similar to those for EPS.
Notified features of SSSIs	Nature Conservation (Scotland) Act 2004 (as amended)	No	No SSSIs within the region have basking shark features.
Protected features of MPAs	Marine (Scotland) Act 2010	Yes	Basking sharks are qualifying features of the Sea of Hebrides pMPA.
PMFs	Marine (Scotland) Act 2010	Yes	Basking sharks are a PMF.
Other sensitive natural heritage features	Appraisal of other features under: > The Wildlife and Countryside Act 1981 > The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (relevant to projects located 0-12 nm from shore) > The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 > Marine (Scotland) Act 2010	Yes	Captures assessment of all other sensitive natural heritage features at a population/habitat scale of concern.

7.5 Appraisal of qualifying features of protected sites

The Sea of Hebrides pMPA is the only protected site in Scotland which includes basking sharks as a qualifying feature (SNH, 2014c). This proposed site covers the Hebridean Sea, from the middle of Skye, to the east coast of the Outer Hebrides, through Mull and the Ardnamurchan Peninsula. This region is seasonally frequented by basking sharks and considered to form primary habitat for the northeast Atlantic biogeographic population (Doherty *et al.*, 2017). The Sea of Hebrides pMPA is located over 250 km south-southwest from the Billia Croo test site and, thus, it is outwith the range for significant connectivity with the features of this site. Whilst some basking sharks from this site may travel to the Orkney Islands as casual visitors, the predominant movements of basking sharks within the UK appear to be: (1) movement between the shelf waters and deeper slope waters of Hebridean and Irish Seas; and (2) some individual movement between the Celtic Seas and Faroe Islands (Doherty *et al.*, 2017). Consequently, activities at the Billia Croo test site will not impact upon the integrity of this proposed site or its conservation objectives.

Appraisal conclusion for qualifying features of protected sites: It is concluded that there is no connectivity and no impact pathway to negatively impact basking shark features of the Sea of Hebrides pMPA or at any other protected sites with this species listed as a qualifying feature.

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7.6 Appraisal under The Wildlife and Countryside Act 1981

The following Section outlines the appraisal undertaken in relation to The Wildlife and Countryside Act 1981. A summary of the legal requirements of this legislation are defined below.

7.6.1 Summary of the legal requirements

(1) Under Section 9 - Protection of certain wild animals, the following is an offence:

(a) intentional killing, injuring or taking of any wild animal included in Schedule 5, including basking shark (Cetorhinus maximus);

(b) intentionally or reckless disturbance or harassment of any wild animal included in Schedule 5 as a:

(i) dolphin, whale or porpoise (Cetacea); or

(ii) basking shark (Cetorhinus maximus);

(2) Subject to the provisions of this Part, a licence may be required to ensure an offense under this legislation is not committed.

7.6.1.1 Licence conditions

A Basking Shark Licence will be required from the Scottish Government for any activities which will disturb, injure or kill basking sharks. Licence applications are assessed against the location and types of activities to take place, relative to basking shark habitat use and in consideration of sites designated for the protection of this species.

The following appraisal first considers impacts in relation to whether an offence is likely under the protection afforded to basking sharks under The Wildlife and Countryside Act 1981. It then considers whether a licence to injure, take, disturb or harass basking sharks is required to address this.

7.6.2 Mortality and injury impacts

Activities described in the Project Envelope which have been identified as potentially important to the conservation and management of basking shark populations in Scotland are presented in Section 7.2. Of the activities which have been identified for further assessment, there is the potential for entanglement with mooring lines or cabling to generate instances of mortality or injury to basking sharks. The likelihood of such an event will be limited by mooring design and configuration and habitat use by basking sharks, and, as such, this impact pathway has been assessed in detail in the Section below.

SOPs including implementation of a Vessel Management Plan (VMP) and training shipboard personnel in the Scottish Marine Wildlife Watching Code (SMWWC), will limit the number of vessel users and the flow of marine traffic throughout test site area and enable identification of basking sharks to effectively mitigate against collision risks to this species. For this reason, this impact pathway is not assessed further.

7.6.2.1 Entanglement in mooring lines or cabling leading to injury or death

There are no published records of basking shark entanglements with WECs (e.g., Benjamins *et al*., 2014). The closest equivalent entanglement records come from interactions between other marine megafauna, cetaceans, with moored or derelict, unmoored fishing gears (IWC, 2009; Benjamins, 2014). These records indicate that the likelihood of an entanglement event occurring depends upon both the size of the animal making contact with the device and the tension of the mooring lines or cables connecting the device to the seabed (Sparling *et al*., 2013). Entanglement data from moored gears have illustrated that slack lines and cables are more likely to entangle animals than taut ones (Sparling *et al*., 2013). As well, filter feeding animals, such as basking sharks, are more likely to interact with mooring lines due to how they move through the marine environment with mouth agape, coupled with detection failure, potentially resulting from their being predisposed with feeding at the time of interaction (Benjamins *et al.*, 2014). For these reasons, basking sharks are most likely to become entangled across the mouth (McFarlane *et al.*, 2009).

Around the world, basking sharks are regularly entangled in large-mesh, drift-gillnets and in aquaculture nets, such as salmon pens (McFarlane *et al.*, 2009). It was estimated that entanglement in salmon pens counted for roughly half the basking shark deaths in Canadian waters between 1945-1970 (McFarlane *et al.*, 2009). Thin monofilament is used to create driftnets, while synthetic rope with lead lines is most often used for the

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construction of salmon pens. In both instances, basking sharks are likely to become entangled around the mouth whilst filter feeding. However, there is potential for individuals to break portions of drifting monofilament netting and continue swimming with the net wrapped around the mouth. Conversely, a netting structure which is fasted to the seabed with multiple moorings, similar to a salmon pen, would more likely restrict the shark's movement, suffocating the animal. Furthermore, catenary mooring configurations, including Lazy-S configurations, as opposed to taut mooring systems pose the greatest potential risk of entanglement to basking sharks (Benjamins *et al.*, 2014).

Currently, there are five grid-connected subsea export cables (11 kV) which transfer energy generated at the test berths back to shore. Although the majority of WECs onsite will connect to export cables, not all of the WECs will utilise mooring lines to maintain station or to connect to power cables. Some of the device types anticipated to occupy the 10 berth Billia Croo test site will utilise foundations with pins or piles or gravity-based foundation. Those devices with moorings will be expected to use a minimum four-point mooring system. Additionally, there may be a maximum of three mooring systems which are not directly linked to the devices which may be installed at each test berth (i.e. for mooring project vessels, other infrastructure etc.). The likelihood of an entanglement occurring increases as the number of devices with moorings and the number of moorings across an array increases. The use of synthetic mooring materials, which pose the greatest threat of entanglement, are restricted to 100 tons per device. The mooring system maximum footprint is estimated to be 0.073 km^2 (of the total 11 km^2 site).

Wildlife recordings of basking sharks across the test site are low, with only 18 individuals recorded in the area between 2009 and 2015, 12 of which were recorded as 'feeding' (EMEC wildlife observation data 2009 - 2015). While entanglement events are not likely to occur, given the small footprint of the mooring systems and low density of basking sharks in the area, there remains some uncertainty about the potential for an entanglement event given the variety of mooring configurations which could be used at the site. As such, developers are urged to develop emergency shut-down procedures, should an entanglement event occur, for moored or cabled devices with high risk of entanglement. Devices which utilise synthetic mooring materials or with a minimum five-point mooring system which would potentially hinder the forward movement of the animal should consider the development of such procedures. In the event of entanglement, Marine Scotland and SNH will be consulted. These and other mitigation methods to reduce the potential risk of injury or mortality from entanglement are outlined in Table 7-5 below.

Appraisal Conclusion for mortality and injury impacts to basking sharks: EMEC's SOPs, including implementation of the VMP and training vessel crew in the SMWWC, are considered to successfully mitigate against vessel collision as an impact pathway for basking sharks.

Entanglement in mooring lines or cabling forms the sole residual impact pathway with potential to generate mortality or injury impacts to basking sharks; however, given the low density of basking sharks and small footprint of the devices, the potential for such an event occurring is considered low. Developers with mooring configurations which are deemed of higher risk (i.e. those utilising synthetic mooring materials or with a minimum five-point mooring system, as this would potentially hinder the forward movement of the animal) to develop emergency shut-down procedures for any potential entanglement events.

Based on knowledge of basking shark movements, coupled with the implementation of the proposed mitigation measures, it is recommended that a Basking Shark Licence be considered on a case by case basis, in consultation with Marine Scotland and SNH. Those devices which are deemed a higher risk of entanglement should consider application for a Basking Shark Licence.

7.6.3 Disturbance and/or harassment impacts

7.6.3.1 Installation, decommissioning and maintenance vessel(s) presence, transiting and manoeuvring leading to disturbance

Basking sharks may be sensitive to vessel presence and associated activities, including the transiting and manoeuvring of vessels. Reports suggest that basking sharks are not sensitive to visual disturbance from vessels (Speedie and Johnson, 2008). However, this species has also been known to vacate areas where vessels are present by either diving or swimming away (Bloomfield and Solandt, 2008) and it is as yet unknown

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whether this is caused by the physical obstruction of feeding habitat or vessel noise. The behaviours taking place prior to disturbance also appears to have an impact on the magnitude of basking shark disturbance responses to vessels. Anecdotal evidence from the Isle of Man has indicated changes in basking shark courtship behaviour due to approaching motorised vessels can occur over 1 km, whereas other wildlife observers report no change in basking shark movement patterns until vessels are within 10 m of the animal (Bloomfield and Solandt, 2008).

Disturbance reactions have the potential to impact upon the health of individuals if feeding is halted, or lower reproductive fitness if the disturbance halts courtship or mating behaviours. Unfortunately, the reasoning behind such reactions is not clear, and it is difficult to determine whether basking sharks are responding to visual obstruction or to noise or other cues from vessels at close range. Still, the potential remains for vessels to disturb basking shark behaviour with potential repercussions for population fitness.

For these reasons, vessel presence forms a potential source of disturbance and application for a Basking Shark Licence to disturb basking sharks is recommended. The requirement for a Marine Mammal Observer (MMO) for installation activities will be considered on a case by case basis. For activities included in the Project Envelope, the only likely requirement for an MMO will be for pin piling. Any form of percussive piling which would require an MMO is out with the scope of this appraisal. If an MMO is required for installation activities, the EMEC MMO protocol will be utilised (SOP074). The MMO procedures will include the deployment of a dedicated MMO with protected species observation skills (as per standard MMO training) prior to and during device installation. This will include a soft-start ramp up of piling noise to give animals time to move away from the noise source.

Other SOPs including implementation of a VMP and training shipboard personnel in the SMWWC, will limit the number of vessel users and the flow of marine traffic throughout test site area and enable identification of basking sharks to effectively mitigate against collision risks to this species. For this reason, this impact pathway is not assessed further.

7.6.3.2 Underwater noise from foundation/mooring installation and decommissioning methods leading to disturbance

Due to the limitations of studying basking sharks in captivity, the hearing physiology and auditory abilities of this species are, as yet, uncharacterised. Conclusions on basking shark hearing are generally drawn from knowledge of auditory capabilities in other elasmobranchs (e.g. sharks, rays, skates); however, such reports cannot be viewed as concrete evidence of basking shark hearing sensitivities.

Elasmobranchs are generally sensitive to vibrational noise, or the kinetic component of sound, rather than sound pressure (the component most mammalian species hear) (Corwin, 1981). Other large sharks, such as the lemon shark (*Negaprion brevirostris*) and the scalloped hammerhead (*Sphyrna lewini*), have demonstrated increased sensitivity to low frequency sounds and can discriminate between sound emissions occurring on the lower end of the spectrum (e.g. 40 – 800 Hz) (Corwin, 1981). For the sharpnosed shark (*Rhisoprionodon terranovae*), the greatest hearing sensitivity, as identified through Auditory Evoked Potentials (AEP), occurred at 20 Hz (Casper and Mann, 2010).

Drilling noise is reported to have the majority of its energy below 500 Hz - 1kHz (Kongsberg, 2012; Nedwell *et al*., 2003; 2010), which falls within the hearing sensitivity range for many shark species. It can be considered that basking sharks may hear and respond to the noises generated during the installation of foundations and moorings from non-percussive drilling. Such responses have the potential to impact upon the relative fitness of individuals and populations if they halt feeding behaviours or impinge upon courtship or mating. For this reason, there remains the potential to cause disturbance to basking sharks occurring within the vicinity of the Billia Croo test site during installation activities, and developers may need to apply for a Basking Shark Licence.

Appraisal Conclusion for disturbance and/or harassment impacts to basking sharks: EMEC's SOPs will work to minimise the potential to cause a disturbance from installation and decommissioning or maintenance vessel presence. However, as a precautionary measure, developers are recommended to apply for a Basking Shark Licence for activities within the Billia Croo test site.

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Installation and decommissioning activities, particularly drilling noise, have been identified to emit low frequency sounds which have the potential to disturb basking sharks. In such cases, a Basking Shark Licence will be required.

7.7 Appraisal of other natural heritage features

This section addresses impacts which haven't been covered under the legal requirements of The Wildlife and Countryside Act 1981; it includes the assessment of barrier effects at the Billia Croo test site.

7.7.1 Presence of WEC(s) and other infrastructure leading to barrier effects

Basking sharks are known to utilise different regions for life-history events, such as feeding and breeding, at different times of the year (Gore *et al.*, 2008). Oceanic and tidal fronts are targeted by basking sharks as they may provide foraging opportunities for this planktivore[17] (Priede and Miller, 2009) and, as a result, lend themselves as sites of social activity, including breeding events (Sims *et al.*, 2000; Speedie *et al*., 2009). Tagging data on individuals in the Northeast Atlantic have shown evidence of seasonal transatlantic migration (Gore *et al.*, 2008), with the Irish Sea and the Firth of Clyde serving as key movement corridors between the UK and Atlantic waters (Sims *et al.*, 2003; Solandt and Chassin, 2013). However, recent tagging data indicates high inter-individual variability in basking shark movement patterns, with several different broad-scale migratory pathways existing for sharks originating in the northeast Atlantic (Doherty *et al.*, 2017). This ability to alter patterns in movement and site fidelity is particularly beneficial to species which target patchy prey, such as plankton, which may vary in location and abundance between seasons and years (Doherty *et al.*, 2017).

Strictly migratory species reliant on utilisation of specific routes or habitats are especially vulnerable to barrier effects. Whilst basking sharks may be impacted by obstructions in coastal seas from large-scale engineering projects, such as wind or wave energy arrays, evidence of inter-population variability in site fidelity may enable individuals to utilise alternate migration routes and avoid such obstructions. Whilst a potentially important movement corridor along the continental shelf off western Ireland has been identified, and which should be considered in development projects, consideration of basking shark habitat use in the vicinity of the Billia Croo area suggests that this region is not of particular importance to this species (Doherty *et al.*, 2017).

Most basking sharks recorded near Billia Croo during the 2009 – 2015 wildlife surveys showed the animals as being stationary (e.g. resting) or moving very slowly. Two individuals were recorded as feeding at the surface in late July 2014 and early August 2015 (the others were recorded out with the summer months) a likely indication of feeding on a temporary prey patch during a summer peak in plankton biomass (Sims *et al.,* 2005). Given knowledge of basking shark distribution across their wider geographic range (Witt *et al.*, 2012), and the fact that the Billia Croo test site does not appear to form critical foraging habitat for this species (EMEC wildlife observations data 2009 - 2015; Evans *et al*., 2011), it is considered that any obstruction or restriction to free movement due to the presence of wave devices and other infrastructure in the Project Envelope area is likely to be negligible. Individuals are expected to readily swim around devices and other infrastructure within the test site area and will also be able to utilise the surrounding similar habitat. In this regard, it is not anticipated that there will be any barrier effects to basking shark movements which will have important repercussions to individuals or populations.

Appraisal conclusion for basking sharks impacts on other natural heritage features: The appraisal considers the potential for barrier effects on basking sharks to be not important and will not generate any population-level impacts.

7.8 Appraisal of cumulative impacts

For impacts to basking sharks, the relevant cumulative impact pathways include other sea users which have the potential to increase vessel presence or introduce entanglement risks to basking sharks occurring across

[17] A planktivore is an aquatic organism that feeds on planktonic food, including zooplankton and phytoplankton.

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the test site. Relevant impact mechanisms may include recreational or commercial vessels (e.g. maintenance vessels, ferries, etc.), fishing and aquaculture sites.

Vessel activity by other sea users will be limited within the Billia Croo test site area. The region is not targeted by recreational sea users, for example for fishing or wildlife watching activities. The 2019 NRA reports that most recreational crafts encountered in the vicinity of the Project Envelope tend to be on passage past Billia Croo and that most choose to pass either inshore or offshore of the test site (Marine Risk Consultants Ltd, 2019). Boating intensity for recreational crafts in the Project Envelope is classed as low, with less than 400 recreational boats passing within 500 m of the Project Envelope annually (Marine Risk Consultants Ltd, 2019).

There is some commercial vessel activity which has the potential to introduce cumulative impacts with Project vessel activities. This includes ferry vessels and vessels used for operations and maintenance at nearby aquaculture sites. The nearest ferry vessel transit lanes are those of the Stromness-Scrabster, Stromness-Graemsay, and Stromness-North Hoy ferry routes, located 2 km south, 6 km south-east, and 4 km south-east of the test site, respectively (Table 3-2). Although ferry vessels may be large and introduce a greater disturbance than some of the vessels described in the Project Envelope, these vessels are not anticipated to dramatically deviate from their set routes. Moreover, vessels which pass more closely to the test site, such as those along the Stromness-Scrabster route, will form a temporary disturbance mechanism which is unlikely to compound potential impacts from vessel presence at Billia Croo to such an extent as to generate significant disturbance to basking sharks. Neither the test site nor transiting ferry vessels will generate barrier effects, so individuals can avoid any temporary disturbance by utilising the surrounding habitat. For this reason, potential disturbance impacts from temporal overlap between vessel activities at the test site and transiting ferry vessels will be highly constrained and are not anticipated to generate cumulative disturbance impacts to cetaceans across the Test Site area or the surrounding waters.

Whilst maintenance vessels servicing nearby commercial infrastructure, such as aquaculture sites or submarine cables, have the potential to compound vessel presence at the test site, all other commercial infrastructure is located too far away from the test site to introduce compound effects from vessel presence (Table 3-2).

There is potential for entanglement with gillnet fisheries and local fish pens, such as that occurring at the Bring Head Fish Farm approximately 9 km south-east of the test site (Table 3-2). However, there have been no published reports of basking shark entanglement in fish pens in Orkney, despite ample aquaculture taking place along the island coastlines. Derelict fishing gears may wrap around the mooring lines of the WECs, which have the potential to increase the risk of entanglement. However, this unlikely situation would hinder the operation of the WEC and would be rapidly remediated by developers to ensure devices are not damaged. Furthermore, the low density of individuals occurring in the nearshore environment drastically reduce the likelihood of entanglement from either fishing gears, aquaculture or the installation, operation or decommissioning of WECs, and mitigation measures will further reduce the risk of entanglement to basking sharks. This includes the continued monitoring of basking shark habitat use in the test site, and implementation of emergency shut down procedures for moored or cabled devices with high risk of entanglement, in consultation with SNH and Marine Scotland. These and other mitigation methods to reduce the potential risk of injury from entanglement are outlined in Section 7.9 below.

SOPs including implementation of a VMP and training shipboard personnel in the SMWWC, will limit the number of vessel users and the flow of marine traffic throughout test site area and enable identification of basking sharks to effectively mitigate against collision risks to this species. For this reason, this impact pathway is not assessed further.

Appraisal conclusion for cumulative impacts on basking sharks: In review of activities undertaken by other sea users, it is considered that cumulative disturbance impacts from commercial or recreational vessel presence in the test site and surrounding waters are minimal and will not be detrimental to the maintenance of the population of the species concerned at Favourable Conservation Status across their natural range.

Mitigation measures to monitor the occurrence of basking sharks throughout the test site will help minimise the potential for entanglement impacts to individual animals from test site activities and their potential overlap with the activities of aquaculture sites nearby.

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7.9 Receptor conclusion

A summary of the appraisal for each of the receptors is provided in Table 7-4. Note that, even where no important impacts on the development site are identified, in some cases there may still be a recommendation for mitigation or monitoring. Under these circumstances, mitigation is regarded as good-practice, while monitoring may serve to improve generic understanding of the relationships between stressors and receptors. Where mitigation or monitoring is considered to be a likely licence or condition of consent this is highlighted.

Table 7-4 Summary of basking shark appraisal conclusions

Receptor	Appraisal conclusion	Mitigation/Monitoring recommended?
Basking sharks	There is potential for a disturbance offence to be committed under The Wildlife and Countryside Act 1981. No important impacts predicted for other natural heritage features.	Yes see Table 7-5
	No important cumulative impacts are anticipated.	Yes see Table 7-5

No important impacts are predicted as a result of the proposed activities at Billia Croo. Potential disturbance impacts from vessel presence are not anticipated to be detrimental to the maintenance of basking shark populations or their use of this area. Given uncertainties regarding some potential impacts and the opportunity to learn from test deployments, potential mitigation and monitoring measures are presented in Table 7-5 below. These measures can be seen as appropriate to be conditions on a Basking Shark Licence.

Project-specific assessments are required for aspects of the following impact pathways and, thus, each developer will need to identify any appropriate mitigation and/or monitoring in response to:

- Use of active acoustic equipment;
- Requirement for a Basking Shark Licence in relation to noise generating activities and infrastructure with a high risk of entanglement; and
- Employment of percussive piling methods.

It is concluded that no important impacts of relevance to basking sharks are expected from the installation, operation and decommissioning of WECs and other infrastructure at the Billia Croo test site, based on the parameters outlined in the Project Envelope. Mitigation and monitoring has been recommended which may form a licence requirement and/or consent condition.

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Table 7-5 Suggested mitigation and monitoring

Impact	Receptor	Impact pathway	Mitigation/Monitoring	Licensing requirement / Likely condition of consent	Explanation
Injury or mortality	Basking sharks	Entanglement in mooring lines or cabling leading to injury or death	Continued monitoring of habitat use by basking sharks, particularly large whales.	No	This impact pathway is considered unlikely, due to the low frequency of basking sharks utilising the test site. However, this monitoring measure is recommended to gain further information about the likelihood of entanglement occurring at Billia Croo.
			Training of shipboard personnel on the SMWWC will enable identification of basking sharks from at-sea vantage points. In the event of entanglement, Marine Scotland and SNH will be consulted. Developers are urged to develop emergency shut-down procedures for moored or cabled devices with high risk of entanglement, should an entanglement event occur.	Possible	As there is still uncertainty regarding the potential for basking sharks to become entangled in WEC moorings and cables, monitoring and emergency shut down procedures will enable developers to rapidly respond to any potential entanglements, with guidance from Marine Scotland and SNH.
			Basking Shark Licensing.	Possible	it is recommended that a Basking Shark Licence be considered on a case by case basis, in consultation with Marine Scotland and SNH. Where devices and infrastructure are deemed to have a higher risk of entanglement developers should consider application for a Basking Shark Licence.
Disturbance	Basking sharks	Installation, decommissioning and maintenance vessel	A VMP which includes a traffic management scheme, will be included as a part of the PEMP.	Yes	This mitigation measure should reduce the potential impacts of disturbance from vessel presence and activity onsite. A VMP is required as part of the PEMP.

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Impact	Receptor	Impact pathway	Mitigation/Monitoring	Licensing requirement / Likely condition of consent	Explanation
		presence, transiting and manoeuvring	Training of all shipboard personnel in the SMWWC will enable identification of basking sharks from all vessels on-site.	No	Accurate identification of basking sharks will be useful in gaining an insight into basking shark usage of the area and will also allow appropriate action to be taken where basking sharks are identified.
			Vessel movements and occupancy within the Billia Croo test site will be managed through EMEC's SOPs.	No	The SOPs limit the number and size of vessels which can utilise the test site simultaneously.
		Underwater noise from foundation/mooring installation methods leading to disturbance	The requirement for a Marine Mammal Observer (MMO) for installation and decommissioning activities will be considered on a case by case basis. For activities included in the Project Envelope, the only likely requirement for an MMO will be for pin piling. If an MMO is required for installation activities, the EMEC MMO protocol will be utilised (SOP074). The MMO procedures will include the deployment of a dedicated MMO with protected species observation skills (as per standard MMO training) prior to and during device installation. This will include a soft-start ramp up of piling noise to give animals time to move away from the noise source. For basking sharks, it is noted this may require additional time over cetaceans. The latest version of the EMEC MMO protocol will accompany this EA with the S36 application.	Yes, but likely only for pin piling	The use of the EMEC MMO protocol should reduce the potential impacts of cumulative noise from installation and decommissioning activities in the test site.
			Basking Shark Licensing.	Possible	As there is potential to disturb basking sharks, consideration of an application for

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Impact	Receptor	Impact pathway	Mitigation/Monitoring	Licensing requirement / Likely condition of consent	Explanation
					a Basking Shark Licence is recommended. This should be treated on a case by case basis and it is not considered a likely requirement apart from where particularly noisy activities are planned.

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8 CETACEANS

Stage 1 of this appraisal defined the categories of potential effect as presented in Table 3-1. The appraisal now picks up at Stage 2 of the methodology where effect pathways and importance are identified as described in Section 3.

8.1 Key data sources

The key data sources that have been used to inform this appraisal:

- EMEC wildlife observations data from 2009 to 2015, (EMEC, 2016);
- Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys, (Hammond *et al*., 2017);
- Management Units for cetaceans in UK waters (January 2015), (IAMMWG, 2015); and
- Cetaceans of the Atlantic Frontier, north and west of Scotland, (Pollock *et al*., 2001).

8.2 Potential effects

For cetacean (i.e. whale, dolphin, and porpoise) receptors, the defined potential effect categories are applied to activities/effect pathways relevant to wave energy developments as described in the Project Envelope. First, potential effects are considered in broad-principles. Deployment, installation and decommissioning effects (Table8-1) are addressed separately from those during the operational and maintenance phases (Table 8-2).

Note that details specific to Billia Croo, both environmental and relating to project-specifications, are not considered until the detailed appraisal later in this section.

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Table 8-1 Potential effects on cetacean receptors during deployment, installation and decommissioning of infrastructure

Potential effects from device installation and decommissioning
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels (e.g. jack-up barge; multi cat; workboat; DP vessel; dive-support vessel; crane-barge; tug; specialist cable-laying vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Underwater noise and presence of installation and decommissioning vessel(s), including transiting and manoeuvring, leading to disturbance	Cetacean species	**Potentially important** – cetaceans can be sensitive to noise emissions from vessels and their physical presence in the marine environment. Importance will depend upon ambient noise levels, the duration and intensity of vessel activity, the likelihood and fidelity of cetaceans in the area and the opportunity for animals to avoid areas of disturbance. Whilst noise generated by even very small vessels (< 5 m) would be audible to cetaceans, noise propagation modelling (Xodus, 2015) and source level data (Richardson *et al.*, 1995) from vessels likely to be employed indicate that vessel noise (i.e. small to large vessels; not supertankers) is not an impact pathway for injury to marine mammals and is therefore not considered further. The need for a licence to disturb EPS should be considered.
Underwater noise from foundation/mooring installation methods leading to disturbance or auditory injury	Cetacean species	**Potentially important** – although underwater noise from installation methods is unlikely to occur on a spatial scale which would have an important effect on cetaceans, case-by-case consideration should consider the potential impacts of installation methods, including all behavioural responses with biological consequences, and the need for a licence to disturb EPS. Importance will depend upon the duration and intensity of noise emissions, the frequency of source levels, the likelihood and fidelity of cetaceans in the area and the opportunity for animals to avoid areas of disturbance. Given the Project Envelope is limited to non-percussive installation methods, fatal injury is not expected to result from noise emissions from foundation and mooring installations and has thus been scoped out from further appraisal. The need for a licence to disturb EPS should be considered.
Underwater noise from active acoustic equipment leading to disturbance	Cetacean species	**Potentially important** – although unlikely to be sufficiently widespread to have an important effect on cetaceans, case-by-case consideration should consider the potential impacts of active acoustic equipment, including all behavioural responses with biological consequences, and the need for a licence to disturb EPS. Importance will depend upon the duration and intensity of acoustic activity, the frequency of source levels, the likelihood and fidelity of cetaceans in the area and the opportunity for animals to avoid areas of disturbance.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
		The need for an EPS licence should be considered.
Entanglement in mooring lines or cabling leading to injury or death	Cetacean species	**Potentially important** – cetaceans may be exposed to potential interactions with cables and/or lines which may or may not be under tension (e.g. disconnected from the device, connected to the device before it is at station or in operation, or of a mooring configuration which is slack, such as a Lazy-S Mooring Configuration). Lines in the water form a major source of entanglement for marine mammal species, particularly large whales (Benjamins *et al.*, 2014). Although potential for interactions between cetaceans and wave device cables or lines remain poorly characterised, such interactions function as potential sources of injury or mortality from entanglement events. Importance will depend upon the likelihood and fidelity of cetaceans occurring in the test site area, the location and spacing of devices, and mooring and cabling configuration design.
Entrapment[18] in devices, multiple mooring lines or cabling leading to injury or death	Cetacean species	**Potentially important** - the potential for entrapment of cetacean species in wave energy devices and other infrastructure is poorly understood; however, it is possible that cetaceans may become trapped between multiple mooring lines or cables. Mooring lines and cabling are likely to be installed before deployment of devices, so require assessment during the installation phase. Importance will depend upon the likelihood and fidelity of cetaceans occurring in the vicinity of the test site area, the location and spacing of devices, and mooring and cabling configuration design.
Increased suspended sediment/turbidity leading to disturbance	Cetacean species	**Not important** – although cetaceans may be negatively impacted by increased turbidity within the water column caused by disturbance of the seabed, WECs are generally situated in the upper water column or at the water's surface and will therefore have limited potential to agitate sediments. Installation of other infrastructure including foundations may generate some sediment suspension; however, this will be over a very limited spatial scale and for a short duration, and suspended material will disperse rapidly.

[18] Entanglement is limited to becoming physically ensnared or tangled in an object, typically a line or cable, whereas entrapment consists of an animal becoming caught in an object. Entangled animals may continue to drag the entangling object if it is mobile, whereas entrapped animals are generally unable to exit and therefore mobility is restricted to the confines of the entrapping object.

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Table 8-2 Potential effects on cetacean receptors during operations and maintenance of infrastructure

Potential effects from device operation and maintenance
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Physical presence of device(s), foundations, moorings, buoys and other infrastructure on the seabed, in the water column or above the surface > Operation of device(s)/power generation > Repeat removal and redeployment of equipment for maintenance (e.g. device removed from water or floating structure removed from berth; replacement of mooring system) > Other maintenance activities (e.g. biofouling removal; ROV/diver inspection or repairs) > Use of vessels (e.g. DP vessel; jack-up barge; multi cat; workboat; dive-support vessel; crane-barge; tug) > Use of equipment to monitor devices in situ or other environmental parameters (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Underwater noise and presence of maintenance vessel(s), including transiting and manoeuvring, leading to disturbance	Cetacean species	**Potentially important** – cetaceans can be sensitive to noise emissions from vessels and their physical presence in the marine environment. Importance will depend upon ambient noise levels, the duration and intensity of vessel activity, the likelihood and fidelity of cetaceans in the area and the opportunity for animals to avoid areas of disturbance. The need for a licence to disturb EPS should be considered.
Underwater noise from device operation leading to disturbance.	Cetacean species	**Potentially important** – cetaceans may be sensitive to noise emissions from operational WECs. Importance will depend upon the frequency, intensity and duration of noise production by devices and the likelihood and fidelity of cetaceans in the area and the opportunity for animals to avoid areas of disturbance. The need for a licence to disturb EPS should be considered.
Underwater noise from active acoustic equipment leading to disturbance	Cetacean species	**Potentially important** – although most unlikely to be sufficiently widespread to have an important effect on cetaceans, case-by-case consideration should consider the potential impacts and the need for a licence to disturb EPS. Importance will depend upon the duration and intensity of acoustic activity, the frequency of source levels, the likelihood and fidelity of cetaceans in the area, and the opportunity for animals to avoid areas of disturbance. The need for a licence to disturb EPS should be considered.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Entanglement in mooring lines or cabling leading to injury or death	Cetacean species	**Potentially important** - cetaceans may be exposed to potential interactions with cables and/or lines which may or may not be under tension. Lines in the water form a major source of entanglement for marine mammal species, particularly large whales (Benjamins *et al.*, 2014). Although potential for interactions between cetaceans and wave device cables or lines remain poorly characterised, such interactions function as potential sources of injury or mortality from entanglement events. Importance will depend upon the likelihood and fidelity of cetaceans occurring in the test site area, the location and spacing of devices, and mooring and cabling configuration design.
Entrapment[19] in devices, multiple mooring lines or cabling leading to injury or death	Cetacean species	**Potentially important** - the potential for entrapment of cetacean species in WECs and other infrastructure is poorly understood; however, it is possible that cetaceans may become trapped between multiple mooring lines or cables. Mooring lines and cabling are likely to be installed before deployment of devices, so require assessment during the installation phase. Importance will depend upon the likelihood and fidelity of cetaceans occurring in the vicinity of the Project Envelope, the location and spacing of devices, and mooring and cabling configuration design.
Other maintenance activities (i.e. non-vessel-based) leading to disturbance	Cetacean species	**Not important** – maintenance activities include inspection (e.g. divers, ROV, etc.), repairs or temporary retrieval and replacement of device infrastructure as needed. In all cases, it is the presence of the accompanying vessel which presents the primary disturbance risk; this is appraised separately.
Presence of WEC(s) and other infrastructure leading to barrier effects	Cetacean species	**Potentially important** – cetaceans may utilise or move through areas identified for wave energy development. Importance will depend upon the spatial occupancy of the test site area by wave devices (in three-dimensional space) and other infrastructure, physical characteristics of the devices, the importance of the surrounding region for transit by cetaceans, and the likelihood of disturbance from installation activities (e.g. from noise or vessel presence). This impact pathway will need to be reviewed to ensure that it does not impact upon the conservation status of these species.
Increased suspended sediment/turbidity leading to disturbance	Cetacean species	**Not important** – although cetaceans may be negatively impacted by increased turbidity within the water column caused by disturbance of the seabed, WECs are generally situated with the majority of moving parts located in in the upper water column or at the water's surface. Consequently, operation of WECs has limited potential to agitate sediments and are not anticipated to generate increased turbidity within the water column.

[19] Entanglement is limited to becoming physically ensnared or tangled in an object, typically a line or cable, whereas entrapment consists of an animal becoming caught in an object. Entangled animals may continue to drag the entangling object if it is mobile, whereas entrapped animals are generally unable to exit and therefore mobility is restricted to the confines of the entrapping object.

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8.3 Natural heritage context

All species of cetaceans are listed as species of European Community interest in Appendix II of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Appendix II of the Bern Convention, and in Annex IV of the European Commission (EC) Habitats Directive, the Bonn Convention as ratified through the Wildlife and Countryside Act 1981, and therefore requiring strict protection in UK territorial waters. Those species which are listed in Annex IV are termed 'European Protected Species' (EPS). The harbour porpoise (*Phocoena phocoena*) is additionally protected under the terms outlined in the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS). The Nature Conservation (Scotland) Act 2004 extends the protection afforded by the Wildlife and Countryside Act 1981, by making reckless disturbance of marine mammals an offence in Scottish waters.

There are also non-statutory protections for cetaceans afforded by Scottish and UK-wide policy instruments. Several cetacean species regularly occurring within the test site are protected in the Scottish territorial seas as 'Priority Marine Features' (PMFs) under a list developed jointly by SNH and the JNCC (Tyler-Walters *et al.*, 2016); these include: harbour porpoise; killer whale (*Orcinus orca*); minke whale (*Balaenoptera acutostrata*); Risso's dolphin (*Grampus griseus*); and white-beaked dolphin (*Lagenorhynchus albirostris*). Additionally, there are UK Biodiversity Action Plans (BAPs) in place to protect cetacean species across the UK, including species found in the vicinity of Billia Croo, such as: minke whale; Risso's dolphin; white-beaked dolphin; killer whale; white-sided dolphin (*Lagenorhynchus acutus*); and pilot whale (*Globicephala melas*).

The waters of the Northern Isles form important habitat for a variety of whales, dolphins, and porpoise, and regularly supports the greatest densities and abundances of cetacean species in the United Kingdom Continental Shelf (UKCS) (Hammond *et al.*, 2002). The most frequently encountered cetacean species in the Project Envelope area are (in descending order): harbour porpoise, Risso's dolphin, white-sided dolphin, killer whale, white-beaked dolphin, long-finned pilot whale, and minke whale (EMEC wildlife observations data 2009 - 2015; Evans *et al.*, 2011). Several species also form infrequent visitors; these include: pilot whale, sperm whale (*Physeter macrocephalus*), bottlenose dolphin, common dolphin (*Delphinus delphis*) and humpback whale (*Balaenoptera novaengliae*) (EMEC wildlife observations data 2009 – 2015; Evans *et al.*, 2011). Due to the high occurrence of the former listed species, they have been used as proxies for less prevalent cetaceans in the Project Envelope area. Details on species distribution and abundance in the vicinity of Billia Croo and across the UK Exclusive Economic Zone (EEZ) are provided in Table 8-3.

Table 8-3 Demographics of cetaceans most likely to occur in the region comprising Billia Croo (Hammond *et al.*, 2017; IAMMWG, 2015)

Species	Density (animals/km²)[20]	Abundance (individuals)[21]	Management Unit (individuals)	Abundance in UK EEZ (individuals)
	SCANS- III (Block S)		IAMMWG	
Harbour porpoise	0.152	6,147	227,298	110,433
Risso's dolphin	0.014[22]	440[13]	No data (UK & Irish waters)	No data
Minke whale	0.010	383	23,528 (UK & Irish waters)	12,295
Atlantic white-sided dolphin	0.021[13]	1,366[13]	69,293 (UK & Irish waters)	46,249
Killer whale	No data	No data	No data (suggested association with Iceland and Faroe Islands)	No data

[20] Represents average density across Block S which represents an area from NE Scotland to Orkney and which Billia Croo is part of.
[21] This is a comprehensive estimation of the absolute abundance of a species within a given region. These values have been extrapolated from sightings data which included estimations of re-sighting rates to identify the total number of individuals within the survey area.
[22] Due to data limitations, this data has been taken from Block K, located west of Orkney.

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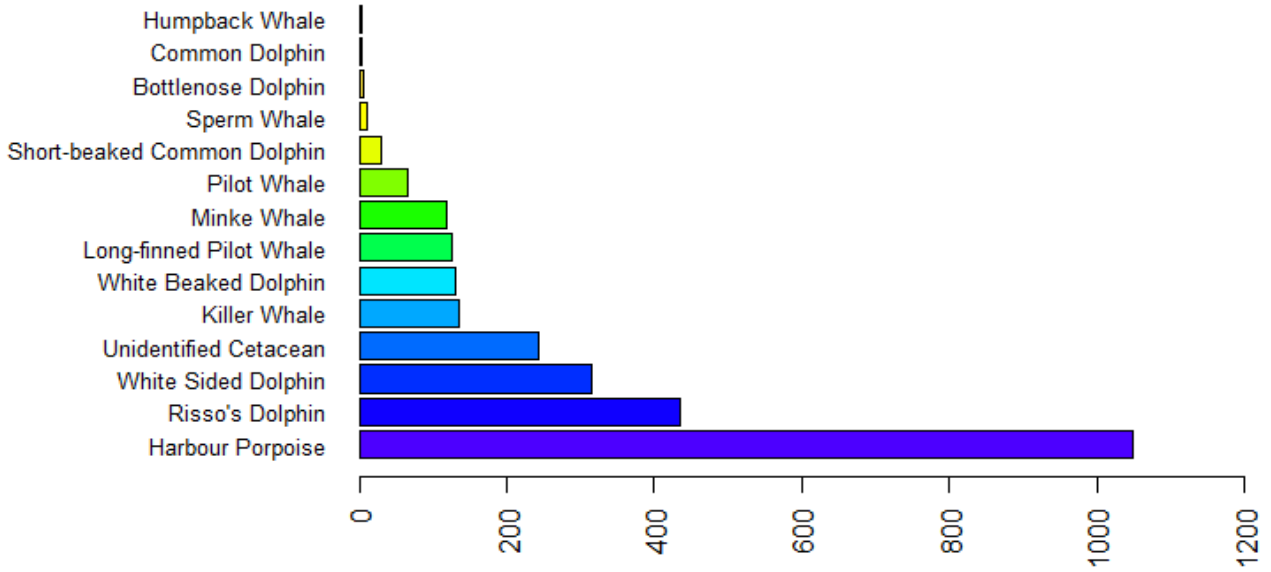
Species	Density (animals/km²)[20]	Abundance (individuals)[21]	Management Unit (individuals)	Abundance in UK EEZ (individuals)
	SCANS- III (Block S)		IAMMWG	
White-beaked dolphin	0.021	868	15,895 (UK & Irish waters)	11,694
Long-finned pilot whale	No data	No data	No data	No data
Bottlenose dolphin	0.004	151	195	195

EMEC wildlife observations collected between 2009 and 2015 show 14 species of cetacean occur within the existing lease areas (Figure 1-1; Figure 8-1). Analysis of these observations data indicate that over 63% (n=659) of observations (n=1,038) contained harbour porpoise, whilst Risso's dolphin (11%; n=113) and minke whale (10%; n=108) formed the second and third most sighted species (EMEC wildlife observations data 2009 - 2015). All other species were observed on 78 or less separate occasions, respectively. Sightings numbers peaked in the summer (38%) and autumn (28%), with the greatest number of sighting events occurring in the month of August across all survey years (n=175) (EMEC wildlife observations data 2009 - 2015).

Sightings data show that harbour porpoise are the most abundant species to occur in the Billia Croo area (Figure 8-1). The observations data show harbour porpoise comprised nearly 39% (n=1,049) of cetacean observations (n=2,664), whilst Risso's dolphin (16%; n=434) and Atlantic white-sided dolphin (12%; n=314) formed the second and third most abundant species. All other species had total counts of 78 or less animals across the seven survey years (EMEC wildlife observations data 2009 - 2015).

Figure 8-1 Total abundance by species of cetaceans sighted within the vicinity of Billia Croo (EMEC wildlife observations data 2009 - 2015)



The distribution of cetaceans observed around Billia Croo varied dramatically between species. Species-specific sightings data are depicted in Figure 8-2.

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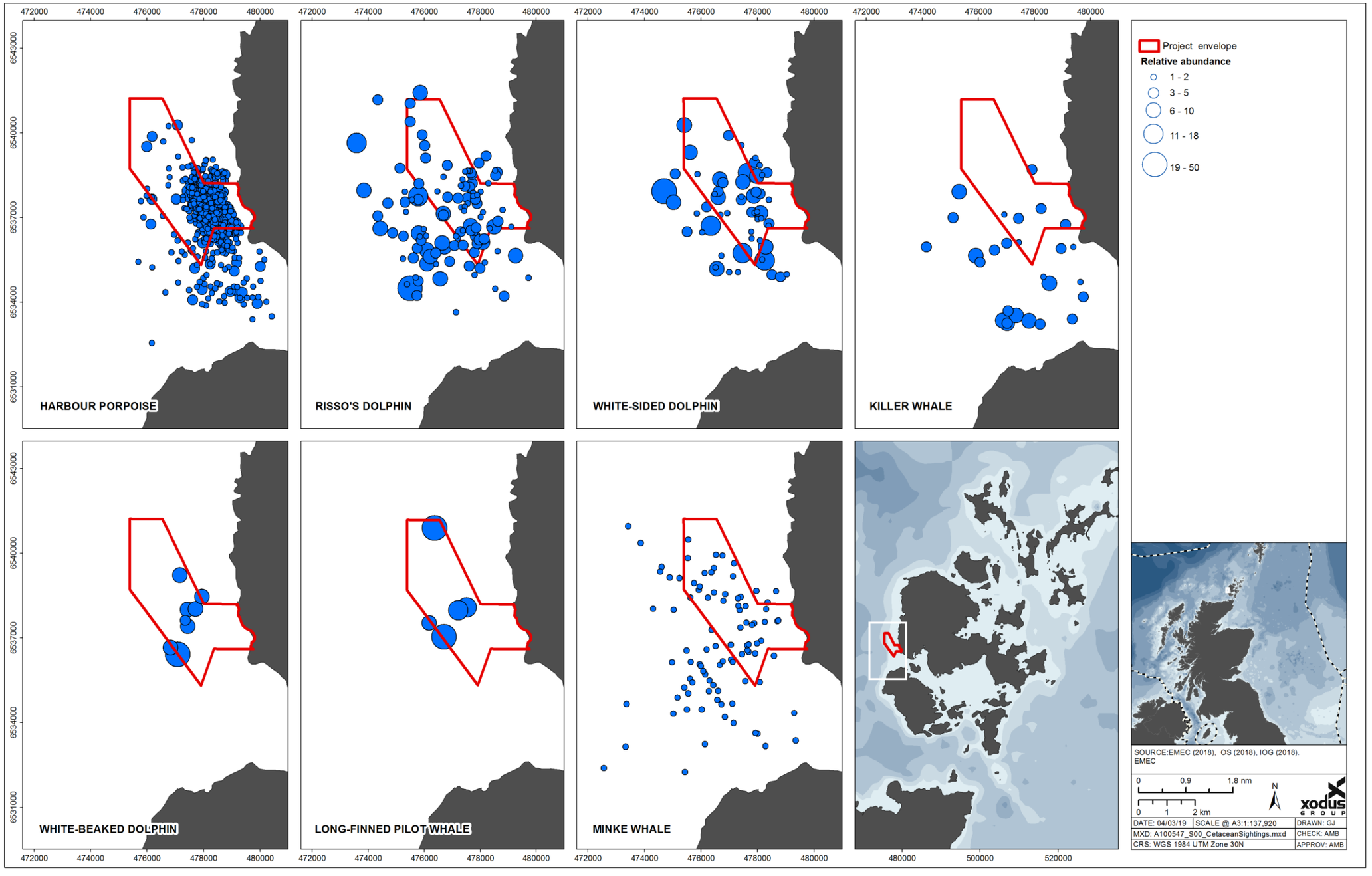
Figure 8-2 Distribution of cetacean sightings around the Billia Croo test site from surveys conducted between 2009-2015 (EMEC, 2016)



8.3.1 Protected sites

There are few protected sites in Scotland designated for the conservation of cetacean features which are relevant to Billia Croo, given its location. Those which are situated with proximity to the Billia Croo area include three pMPAs and three SACs (NMPi, 2018).

NCMPAs in Scottish waters with cetacean features include: the Southern Trench pMPA (approximately 125 km south-southeast) and Sea of Hebrides pMPA, both proposed for the protection of minke whales (158 km southwest); and the North East Lewis pMPA (254 km southwest), proposed for the protection of Risso's dolphins (SNH, 2014c-e). The Southern Trench pMPA is situated along the south-eastern extent of the Moray Firth and the Sea of Hebrides pMPA both contain fronts which support feeding minke whales (SNH, 2014c-e). Of these, the Sea of Hebrides pMPA also appears as key habitat which is utilised as a migratory pathway by this species (Macleod, *et al.*, 2004; SNH, 2014c). Around the North East Lewis pMPA, Risso's dolphins, including elusive juveniles, occur in increased abundance around headlands and peninsulas (SNH, 2014d).

Scottish SACs with cetacean features include: the Moray Firth SAC (95 km south-southwest), designated to protect the inshore bottlenose dolphins of the area; and the Inner Hebrides and the Minches SCI (140 km west-southwest) and the Skerries and Causeway SAC (450 km south-southwest), both designated for the protection of harbour porpoise.

8.4 Summary of impact appraisal for Billia Croo

This impact appraisal takes account of a maximum-case scenario based on the Project Envelope where all ten available berths within the test site are developed and operating at capacity. It addresses impacts to cetaceans in terms of the relevant consenting and licensing regimes for those species. This appraisal will inform the consenting process for both Marine Licence and S36 applications. However, it should be noted that, if there are key deviations in the device design or in any activity (deployment, installation, decommissioning, operations and maintenance), further appraisal work may be required. Any additional appraisal work required will be undertaken by the individual developer (further advice should be sought from EMEC in the first instance).

Table 8-4 presents the relevant legislation and the reasons for undertaking an appraisal for several features in the test site area.

Table 8-4 Appraisal mechanism for cetacean species and habitats

Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
Qualifying features of European sites	The Conservation of Habitats and Species Regulations 2017 (Note: these regulations apply in Scotland in relation to certain specific activities (reserved matters), including consents granted under Sections 36) Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	Yes	Potential connectivity with SACs with cetacean qualifying features, including: Moray Firth SAC (designated for bottlenose dolphin); the Inner Hebrides and the Minches SCI and the Skerries and Causeway SAC (both designated for harbour porpoise).
European Protected Species	The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	Yes	All cetacean species are collectively listed as EPS, 'cetacea'. Harbour porpoise and bottlenose dolphin are additionally listed singularly as species-specific EPS.
Notified features of SSSIs	Nature Conservation (Scotland) Act 2004 (as amended)	No	No SSSIs within the region have cetacean features.
Protected features of MPAs	Marine (Scotland) Act 2010	Yes	Potential connectivity with the Southern Trench pMPA

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Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
			(designated for minke whales).
PMFs	Marine (Scotland) Act 2010	Yes	Cetacean PMFs are known to be present.
Other sensitive natural heritage features	Appraisal of other features under: > Wildlife and Countryside Act 1981 > The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (relevant to projects located 0-12 NM from shore) > The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 > Marine (Scotland) Act 2010	Yes	Captures assessment of all other sensitive natural heritage features at a population/habitat scale of concern.

8.5 Appraisal of qualifying features of protected sites

The Southern Trench and Sea of Hebrides pMPAs are the only protected sites currently proposed in Scotland which include large whales as protected features. The minke whales which form biodiversity protected features of these sites capitalise on fronts and shelf deeps for foraging purposes, particularly in the summer months when vertical mixing increases nutrient upwelling and subsequent blooms of zooplankton and small fishes for this species to feed on (SNH, 2014 c,e). Minke whales are a highly mobile species which cover vast expanses of sea throughout the year. Although their movements are not clearly defined, the Northeast Atlantic population are thought to undertake seasonal migrations between summer feeding sites near Norway and the Barents Seas to unknown breeding areas in the south during the winter (Folkow *et al.*, 2000). As a species which targets patchy prey, minke whale movements are likely to have ample inter-individual variation shaped by prey availability (Skaug *et al.*, 2011). Whilst minke whales were seen with moderate frequency around Billia Croo during the 2009 – 2015 EMEC wildlife observation programme (n=118 animals total), these individuals are a part of a broader population of over 100,000 individuals whose distribution spans arctic and temperate seas from Newfoundland and New England to France and up to waters north of Greenland and Iceland (Glover, *et al.*, 2010). On average, less than 17 animals appeared as annual seasonal visitors in Billia Croo, representing only 0.07% of the Marine Mammal Management Unit (MMMU) for minke whales in UK and Irish waters (EMEC wildlife observations data 2009 - 2015). As such, in the unlikely instance that minke whales encountered at Billia Croo during their seasonal movements were affected by activities within the Project Envelope, this would generate negligible impacts to the population of minke whales protected by either the Southern Trench or Sea of Hebrides pMPAs.

Based on available data of minke whale distribution and abundance, there is possible connectivity between Billia Croo and the Southern Trench and Sea of Hebrides pMPAs, however, this is unlikely to be significant, given the wide spatial distribution of this species and the fact that Billia Croo does not form vital habitat as a migratory pathway or otherwise. For this reason, it is considered that activities within the Project Envelope will not impact upon the conservation status of minke whales from the Southern Trench or Sea of Hebrides pMPAs, or the integrity of these sites. Appraisal of potential impacts to minke whales as EPS is provided in Section 8.6.

Data suggests the waters surrounding the North East Lewis pMPA are a hotspot for Risso's dolphins, which forage along the headlands and slopes around this region (SNH, 2014d). Risso's dolphins in the North-east Atlantic are predominantly encountered in large groups offshore and along the continental slope (approximately 100 m depths), where they target cephalopods (i.e. squids, cuttlefish and octopus) and small fish (Reid *et al.*, 2003; Weir *et al.*, 2001). As such, this species is generally encountered along coastlines where the continental slope occurs close to shore, such as that occurring near North East Lewis. Given Risso's dolphins are considered relatively uncommon in shelf waters around the Northern Isles (Weir *et al.*, 2001; Reid *et al.*, 2003; Hammond *et al.*, 2017), it is unlikely that the shallow, coastal waters of Billia Croo form important habitat to this species. As such, it is considered that activities within the Project Envelope will not impact upon

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the site integrity or conservation status of Risso's dolphins associated with the North East Lewis pMPA. Appraisal of potential impacts to Risso's dolphins as EPS is provided in Section 8.6.

Scottish SACs designated for the protection of cetacean features include: The Moray Firth SAC (qualifying feature: bottlenose dolphin), and the Inner Hebrides and the Minches SCI and the Skerries and Causeway SAC (qualifying features: harbour porpoise). These sites are located approximately 95 km SSW, 140 km WSW, and 450 km SSW from the Billia Croo test site, respectively.

Bottlenose dolphins occurring within the Moray Firth SAC are a part of the East Coast Scotland Marine Mammal Management Unit (MMMU), proposed by ICES (2014), which extends along Scotland's northeast coastline from the Forth of Tay to John o' Groats. This MMMU has since been extended to include the Firth of Forth and the Orkney Islands, across the top of the mainland to Strathy (IAMMWG, 2015). The bottlenose dolphins of the Moray Firth SAC are a coastal ecotype which largely remain within the Moray Firth, preferring the southern coastline of this estuary as optimal habitat (Hastie *et al.*, 2003). Although the Project Envelope area falls within the East Coast Scotland MMMU, it does not comprise important habitat to this population. Observations of coastal bottlenose dolphins are limited in Orkney waters (Thompson *et al.*, 2011) and this is mirrored in the wildlife sightings data recorded at Billia Croo (n=1 sighting; EMEC wildlife observations data 2009 - 2015), it is considered that there is no likely significant effect to bottlenose dolphins from the Moray Firth SAC from activities taking place at the Billia Croo test site.

The harbour porpoise MMMU relevant to the Inner Hebrides and the Minches SCI is the West Scotland Management Unit, whilst the Skerries and Causeway SAC lies within the Celtic and Irish Seas Management Unit. These protected sites occur outside of the harbour porpoise MMMU relevant to the Billia Croo area: the North Sea Management Unit (IAMMWG, 2015). Despite their ability to move between vast expanses of ocean, harbour porpoise are not migratory species and changes in seasonal distribution appear to vary dramatically between individuals (NAMMCO, 2018; Read & Westgate, 1997). Fine-scale movement data suggests that animals are likely to maintain proximity to habitats with oceanographic features which support prey species, such as islands, headlands and channels which experience greater wake during flood tides (Johnston *et al.*, 2005). Considering the above, the harbour porpoise occurring at the Billia Croo test site are not considered to have connectivity with either of these sites and thus there will be no significant impacts to the qualifying features therein.

Appraisal conclusion for qualifying features of protected sites: Whilst there is some potential for connectivity with the Southern Trench, North East Lewis and Sea of Hebrides pMPAs, this is considered very limited in magnitude and activities at Billia Croo are not anticipated to impact upon the conservation objectives of this site or its cetacean protected features.

There is no connectivity with any of the SACs sites with cetacean features. For this reason, there is no Likely Significant Effect to bottlenose dolphin as a qualifying feature of the Moray Firth SAC, nor to harbour porpoise as a qualifying feature of the Inner Hebrides and the Minches SCI or Skerries and Causeway SAC. Therefore, no further information to support the HRA process is required.

8.6 Appraisal of EPS

EPS include those species listed under Annex IV of the Habitats Directive as species of European Community Interest, and therefore, in need of strict protection. Articles 12 and 16 of the Directive outline the protective measures required under this international policy. EPS in the UK are defined as those species listed on Annex IV of the Habitats Directive whose natural range includes any area within the UK and UKCS.

This legislation is transposed in the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) to cover the protection of EPS within Scottish territorial waters (to 12 nm). Scottish Natural Heritage (SNH) is the statutory nature conservation body which advises on the protection of EPS and acts as the licensing authority in Scotland (including Scottish waters) under the Habitats Regulations.

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8.6.1 Summary of the legal requirements for EPS

The Habitats Regulations provide protections for species of conservation importance, as listed in Schedules 2 & 4 therein and in Annex IV of the Habitats Directive, through the introduction of offences against disturbing, injuring or killing EPS.

(1) *Regulation 39(1) of the Habitats Regulations makes it an offence to:*

(a) deliberately or recklessly to capture, injure or kill a wild animal of a European protected species;

(b) deliberately or recklessly –

i. to harass a wild animal or group of wild animals of a European protected species;

ii. to disturb such an animal while it is occupying a structure or place which it uses for shelter or protection;

iii. to disturb such an animal while it is rearing or otherwise caring for its young;

iv. to obstruct access to a breeding site or resting place of such an animal, or otherwise to deny the animal use of the breeding site or resting place;

v. to disturb such an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs;

vi. disturb such an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young; or

vii. to disturb such an animal while it is migrating or hibernating;

(c) deliberately or recklessly to take or destroy the eggs of such an animal; or

(d) to damage or destroy a breeding site or resting place of such an animal.

An EPS licence is required for any activities with the potential to cause disturbance or injury to cetaceans.

8.6.1.1 *Licence requirements*

Impacts to EPS at the Billia Croo test site may arise from noise emissions from: vessel activities, installation and removal of device foundations or moorings and other infrastructure, device operations including mooring noise, or through the use of active acoustic equipment. These potential disturbance pathways, coupled with the risk of injury or mortality to cetaceans from device entanglement and/or entrapment, necessitate consideration of EPS licensing and its regulatory requirements. The appraisals below are informed by knowledge of cetacean populations at the time of writing. Proposed developments may require further assessment if there is any change in the status of cetacean populations, as these may have implications for the requirement of an EPS licence or the appropriate mitigation for those proposals. Mitigation may negate the need for an EPS licence, or may be included as a condition of the licence.

Licences may be granted to authorise activities that could affect EPS which would otherwise be illegal under the Habitats Regulations. Three tests must be satisfied before the licensing authority can issue a licence under Regulation 44(2) of the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) to permit otherwise prohibited acts. Appendix 1 outlines the three tests which must be satisfied in application for an EPS licence to disturb; such an application may be rejected unless these tests are satisfied.

The following appraisal first considers impacts in relation to whether an offence is likely under the protection afforded to cetaceans under the Habitats Regulations. It then considers whether an EPS Licence is required to address this and if so, provides commentary in relation to impacts upon Favourable Conservation Status (i.e. Test 3).

Further appraisal may be required if (a) a proposal is outside of the Project Envelope description, (b) if knowledge/data on the status of cetaceans at the test site or in their natural range changes, or (c) if knowledge regarding potential impact pathway changes. These scenarios aside, the appraisal below should be adequate

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to inform licensing and consenting decisions. Current knowledge on the population status of species relevant to Billia Croo is summarised in Section 8.3 above.

8.6.2 Mortality

8.6.3 Disturbance impacts

Marine Scotland (2014) defines disturbance as any activity which is likely "to significantly affect the local distribution or abundance of the species to which it belongs." Guidance from the European Commission (2007) states that a disturbance has a significant impact to a species localised distribution or abundance which may be long-term or temporary. JNCC (2017) guidance on minimising injury or disturbance to marine mammals from seismic activities interprets "any action that is likely to increase the risk of long-term decline of the population(s) of (a) species … as disturbance under the (Species) Regulations." These interpretations of disturbance can be summarised as any activity which may adversely impact the Favourable Conservation Status (FCS) of a population.

As noise specialists, cetacean species are particularly vulnerable to noise-related disturbances. Both odontocete (i.e. toothed whales) and mysticetes (i.e. baleen whales) use sound for communication, the development of social bonds, and predator aversion (Mann *et al*., 2000; Berta *et al.*, 2015). Odontocetes additionally use sound for foraging and to gather information about their environment (Berta *et al.*, 2015). Hearing abilities in these taxa peak over the following frequency ranges: 10 – 140 kHz for odontocetes (Richardson *et al.*, 1995) and 200 Hz – 10 kHz for mysticetes (Erbe, 2000). Sounds within these frequencies are likely to generate a behavioural response from individuals (from their respective taxa) which may have the potential to illicit a disturbance effect with significant individual or population-level impacts.

There are several sources of sound at the Billia Croo test site which have the potential to cause a disturbance, these include: vessels; active acoustic monitoring equipment; the devices themselves; and the installation of foundations or moorings and other infrastructure at the test site. Of these, the noise source with the greatest potential to generate a disturbance to cetacean populations is the installation of foundations or moorings. However, there is also potential for increased vessel presence generated by overlapping project timelines to generate high levels of noise which may contribute to disturbance of cetaceans occurring at or near the Project Envelope area.

Noise threshold values have been adopted from available cetacean auditory data to identify the potential for noise-related disturbance to cetaceans within the test site. These thresholds were developed from *in situ* measurements of Temporary Threshold Shift (TTS) from a variety of cetacean species (Stone, 1998; Kastak *et al.*, 2007; Popov *et al.*, 2013; NMFS, 2018). Disturbance is defined as behavioural disruption which has the potential to generate a significant impact to an individual or population. Table 8-5 below summarises the threshold criteria developed to identify the potential onset of disturbance and injury from continuous and impulsive sounds (NMFS, 2018).

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Table 8-5 Cetacean injury and disturbance thresholds for cumulative sound exposure and sound pressure levels from impulsive and continuous sounds (NMFS, 2018)

Hearing group	Type of sound	
	Impulsive sound	Continuous sound
Onset of acoustic injury from Cumulative sound exposure level[23] (dB re 1 µPa at 1 ms^{-1})		
Low-frequency cetaceans (e.g. Minke whale)	183	199
Mid-frequency cetaceans (e.g. bottlenose dolphins, Risso's dolphins)	185	198
High-frequency cetaceans (e.g. harbour porpoise)	155	173
Onset of strong disturbance as root mean square (RMS)[24] sound pressure (dB re 1 µPa at 1 m)		
All hearing groups	160	120

8.6.3.1 Underwater noise and presence of installation, decommissioning and maintenance vessel(s), including transiting and manoeuvring, leading to disturbance

Vessel-related disturbance is caused by continuous sound emissions from vessel engines which are above ambient levels. Ambient noise pressure at Billia Croo has been measured as falling roughly between 65-72 dB re 1 $\mu Pa^2\ Hz^{-1}$ for emissions within the 500 Hz – 1 kHz third octave band (Lepper *et al.*, 2012). A range of vessels are likely to be employed at the Billia Croo test site; these include: survey vessels, multicats, jack-ups, tug boats, crane barges, DP vessels, supply vessels, dive support vessels, and workboats. Vessels sizes will vary but are likely to be around 16 – 24 m on average (e.g. medium sized vessels), whilst the largest vessels are anticipated to be between 55 – 130 m in length. Noise data suggests that medium sized vessels, such a 25 m tug, can generate source pressure levels of 166 dB re 1 µPa at 1 m (Richardson *et al*., 1995), whereas larger vessels (such as those between 50 – 100 m) may generate source pressure levels between 165-180 dB re 1 µPa at 1 m (OSPAR, 2009). Whilst the vessels likely to be employed in the Billia Croo area all surpass the thresholds for strong disturbance in mysticetes and potentially some odontocete species, it should be noted that this threshold for disturbance is measured at 1 m from the sound source (i.e. within the vessel engine) and the actual received levels (i.e. by the animal) are anticipated to be lower.

There can be negative implications for nearby cetaceans if these noise emissions have frequencies which fall within the audible range of cetaceans. Larger vessels generate lower frequency noise emissions which generally range from 10 – 100+ Hz. Small to medium vessels (i.e. up to 30 m in length) can generate sounds which range from 20 Hz – 10 kHz (Richardson *et al.*, 1995; Thomsen *et al*., 2006). Noises generated by small to medium sized vessels are well within the anticipated range of audibility for mysticetes, and at the very low end of audibility for odontocetes. Whilst the vessels likely to be employed in the Billia Croo area all surpass the thresholds for strong disturbance in mysticetes and potentially some odontocete species, it should be noted that this threshold for disturbance is measured at 1 m from the sound source (i.e. within the vessel engine) and the actual received levels (i.e. by the animal) are anticipated to be lower.

Moreover, the received levels would have to be sufficiently above ambient noise levels to elicit a strong behavioural response which would generate a disturbance as defined by the guidance above. Ambient sounds around Billia Croo will include naturally occurring environmental noise generated by breaking waves, rain, wind and tidal flow, as well as anthropogenic noise from nearby shipping and vessel traffic. The area of the Project Envelope is anticipated to have elevated ambient noise from hydrographic processes and vessel movement, due to its coastal proximity. Indeed, acoustic recordings from recorders placed across the east coast of

[23] A measure of cumulative sound exposure levels normalised to 1 second to enable comparisons of noise emissions events which occur for differing durations.
[24] A measure of the source pressure level over time derived from the square root of the mean integrated pressure of a periodic wave, such as those generated by continuous sound sources.

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Scotland indicate ambient noise levels in the northern North Sea to fall between 80-120 dB re 1 µPa (Merchant *et al.*, 2016). As such, there is potential for ambient noise levels to fall within the threshold for strong disturbance from continuous sound, making it less likely for vessel noise to be significantly above ambient levels.

The potential disturbance generated using multiple vessels across the site will be managed by the EMEC SOPs (Lepper *et al.*, 2012). The SOPs control developer access and use of the test site under a permitting scheme to ensure any risks to health and safety are minimised across Billia Croo. Under this operating plan, a maximum of 12 vessels are permitted to operate on-site simultaneously. However, the prospect of this maximum being reached is small due to the low likelihood that the operating schedules of all permitted vessels will overlap. Those vessels which do overlap are likely to do so for a short-period. Moreover, should an area of the test site experience significantly higher cumulative noise because of the localised use of multiple vessels, vessel use will be reduced across the rest of the test site, so animals will have the opportunity to avoid these areas of elevated noise.

Still, there remains the potential that some animals may experience some level of disturbance during vessel activities, all of which are due to occur within the 12 nm limit defined in Regulation 39(2). For this reason, developers should consider an EPS licence to disturb for vessel-related noise emissions.

8.6.3.2 Underwater noise from foundation/mooring installation methods leading to disturbance

The installation of foundations or moorings is likely to be the greatest source of sound across the Billia Croo test site; however, the restriction of piling and pin insertion installation techniques to non-percussive methods greatly constrains source levels. Pin piling and rock-bolt insertion for moorings are likely to generate the most noise, as such non-percussive drilling has the potential to emit between 145 – 190 dB re 1 µPa at 1 m of continuous sound at the source (OSPAR, 2009). Anchor block placements have been recorded to generate maximum sound pressure levels of 167 re 1 µPa at 1 m (pk-pk), whilst the installation of the mooring chains may reach up to 173 re 1 µPa at 1 m (pk-pk), which both roughly equate to RMS values near 21 dB re 1 µPa at 1 m, respectively (Molecular Devices Corp., 2006). Once again, these values are recorded at the sound source and received levels are likely to be much lower. As such, the majority of non-percussive installation methods would not exceed the criteria for injury to cetaceans; rather, they are more likely to exceed the thresholds for disturbance (Table 8-5). The drilling of bottom foundations for platforms, similar to foundations which may be installed for WECs within the Project Envelope, have been shown to emit the strongest sounds at low frequencies (Richardson *et al.*,1995). In general, drilling noise has been reported to have the majority of its energy below 500 Hz - 1kHz (Kongsberg, 2012; Nedwell *et al.*, 2003 & 2010), which falls within the range of audibility for minke whales, and some odontocetes (Au *et al.*, 2000). For this reason, there remains the potential to elicit a disturbance to cetaceans occurring within the vicinity of the Project Envelope area.

Source levels will increase with the number of sockets needing to be drilled for monopile installation. Pins may be used for foundation structures, mooring structures, or to insert rock bolts for the attachment of mooring lines. The maximum number of pins per device is restricted to eight, while a maximum of four piles are allowed per device. It is anticipated that installation of individual pins or piles will take place in succession at a given device. In this way, the cumulative noise emissions would remain low during installation (i.e. only achieving a maximum source level of a single drilling event), but the potential disturbance caused by installation may be prolonged across the device, array or other infrastructure.

Given the size of the Billia Croo test site (approximately 11 km^2) in comparison to the area comprising the relevant marine mammal management units, and the low density of cetaceans across the Project Envelope area (Table 8-5), it is not anticipated that installation methods would generate disturbance on a scale which would be detrimental to the maintenance or conservation status of cetacean populations.

However, there remains the potential that some animals may experience some level of disturbance during installation activities, all of which are due to occur within the 12 nm limit defined in Regulation 39(2). For this reason, developers should consider an EPS licence for noise from foundation and mooring installation.

8.6.3.3 Underwater noise from active acoustic equipment leading to disturbance

The Project Envelope specifies the potential use of active acoustic devices and associated equipment for survey purposes by developers, as needed. The importance of this impact pathway will depend most upon

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the intensity of acoustic activity, the frequency of source levels, the duration of surveys, the water depth, and the likelihood and fidelity of cetaceans in the area and the opportunity for animals to avoid areas of disturbance. Mid to high frequency sounds emitted by geophysical and geotechnical survey equipment (e.g. side scan sonar, single-beam and multibeam echosounders, etc.) have the potential to disturb or, in extreme cases, injure marine mammals. The majority of seismic survey equipment generates pulsed noise emissions which fall between 10 – 300 kHz frequencies (MacGillivray *et al*., 2014), which is within the range of audibility for cetaceans. Although noise emissions from this equipment is unlikely to be sufficiently widespread to have an important effect on cetaceans, review of the implementation of these technologies should consider all behavioural responses with biological consequences and the need for an EPS licence to disturb cetaceans.

The use of active acoustic equipment will be highly project and equipment specific, and the particulars of this impact pathway is specified as requiring input from Marine Scotland and SNH in the Project Envelope. For this reason, this issue will need to be addressed on a case-by-case basis which considers the technology required, including characteristics such as source levels and frequencies, to assess the potential impact mechanisms of active acoustic equipment within the Billia Croo test site.

This issue requires a project-specific assessment and has not undergone further appraisal herein.

8.6.3.4 Underwater noise from device operation leading to disturbance

Noise emissions generated by the operation of WECs and other infrastructure are poorly understood, and data on the amplitude or frequency of this technology is currently unavailable. Devices will each have a unique acoustic signature reflecting the sum of their moving parts (including mooring chains) and the mechanics behind their movement in the marine environment. The inclusion of component parts, such as hydraulics, pressurised fluids, turbines or generators, is likely to increase noise emissions from devices (Patricio *et al.*, 2009). Moreover, device design which includes cavitation may generate additional vibrational noise when waves hit the device.

Some of the wave device types captured in the Project Envelope will generate impulsive sounds at varying scales from their mechanical movement in the water column; these include: oscillating wave surge converters, submerged pressure differentials, and point absorber devices. Whilst others, such as the rotating mass, may generate continuous noise. Devices which employ turbines, such as the overtopping and oscillating water column devices, may generate intermittent continuous noise when the turbines are operational.

Radiated noise from the operation of WECs is unlikely to cause significant behavioural impacts to cetaceans or other marine species over great distances (Robinson and Lepper, 2013). Radiated noise from wave energy devices varies considerably based on device design and devices with rotating parts, such as blades, gear boxes and generators, are likely to generate additional noise from induced turbulence (Polagye *et al.*, 2011). However, source levels for operational WECs have been estimated as falling between 165 - 175 dB re 1 µPa at 1 m (OSPAR, 2009), which exceeds the acoustic threshold for a strong disturbance to cetaceans from both continuous and impulsive noise (Table 8-5; NOAA, 2018; NMFS, 2016; JNCC, 2014). In contrast, preliminary acoustical recordings of WECs at Billia Croo have shown peak Third Octave Band (TOB) sound pressure measurements as peaking around 150 dB re 1 μPa^2/Hz at 1 m (EMEC Acoustic Characterisation Report, 2012). Moreover, there was ample variation in noise emissions generated by the WECs due to interactions with the marine environment altering the generation of sound; however, in all instances, the WECs did not reach source levels which meet the threshold for a strong behavioural response.

The potential magnitude of sound generated by operational devices will be limited by their deployment as prototypes for testing, rather than commercial scale devices which are expected to be continuously operational. Measurements of the acoustic environment at Billia Croo suggests high levels of variability across the site from commercial vessel presence, including the regular passage of ferries out of Stromness, and surf noise (EMEC Acoustic Characterisation Report, 2012). Ambient noise levels (TOB) were recorded as being above 160 dB re 1 μPa^2/Hz at 1 m on occasion due to environmental factors. In such instances, noise from operational WECs would be sufficiently below ambient levels to diminish the likelihood of a disturbance response from cetaceans.

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Given uncertainties about noise emissions from all WECs within the Project Envelope, it is impossible to rule out the potential for any disturbance to cetaceans, particularly if device design includes opportunities for radiated noise. For this reason, developers should consider an EPS licence to disturb cetaceans.

Appraisal conclusion for noise disturbance impacts to cetaceans as EPS: Within the bounds of the Project Envelope, it is considered that the potential disturbance impacts from noise emissions from vessels, installation of foundations and moorings, and operational WECs and other infrastructure will not be detrimental to the maintenance of the populations or the Favourable Conservation Statuses of relevant identified cetacean species across their natural range. However, developers should consider an EPS licence to disturb cetaceans for these impact pathways.

A licence to disturb EPS is recommended to address potential disturbance impacts, particularly from installation of foundation structures and moorings for devices. Mitigation measures have been proposed in Table 8-7 to further minimise potential disturbance impacts from vessels, installation methods, and device operation.

The use of active acoustic monitoring devices requires a project-specific appraisal and appropriate consultation to determine the need for a licence to disturb EPS. Percussive piling is out with the scope of this EA and would require an EPS Licence.

8.6.4 Injury impacts

8.6.4.1 Underwater noise from foundation/mooring installation methods leading to auditory injury

As discussed in Section 8.6.3.2, the installation of foundations or moorings is likely to be the greatest source of sound across the Billia Croo test site. Pin piling and rock-bolt insertion for moorings are likely to generate the most noise, as such non-percussive drilling has the potential to emit between 145 – 190 dB re 1 µPa at 1 m of continuous sound at the source (OSPAR, 2009). However, these values are recorded at the sound source and received levels are likely to be much lower. As such, the majority of non-percussive installation methods would not exceed the criteria for injury to cetaceans; rather, they are more likely to exceed the thresholds for disturbance (Table 8-5).

Still, as the potential for injury to cetaceans remains a possibility, developers should review methods to mitigate against the generation of injurious noise and consider applying for an EPS Licence.

8.6.4.2 Entanglement in mooring lines or cabling leading to injury or death

There are no published records of marine mammal entanglements with WECs (e.g., Sparling *et al*., 2013). The closest equivalent entanglement records come from marine mammal interactions with moored or derelict, unmoored fishing gears (IWC, 2009). These records indicate that the likelihood of an entanglement event occurring depends upon both the size of the animal making contact with the device and the tension of the mooring lines or cables connecting the device to the seabed (Sparling *et al*., 2013). Entanglement data from moored gears have illustrated that slack lines and cables are more likely to entangle animals than taut ones (Sparling *et al*., 2013) and that baleen whales are at greater risk for entanglement than odontocetes, due to issues with detection failure and how they move through the marine environment (Benjamins *et al.*, 2014).

Around the world, baleen whales are regularly entangled in slack ropes, most often from static fishing gears (e.g. creels and gillnets) (IWC, 2009). Buoyant synthetic rope is most often used for creel buoys and, throughout the year, there are an estimated 7,500 km of creel lines actively fishing around the Scottish coastline (Northridge *et al*., 2010). There is evidence that synthetic ropes are more difficult for minke whales to detect than black and white ropes (Benjamins *et al*., 2014). Coupled with their foraging technique of lunge-feeding, wherein they rapidly engulf shoals of fish, minke whales are more likely to be entangled across the mouth while distracted during foraging (Benjamins *et al*., 2014).

Currently, there are five grid-connected subsea export cables (11 kV) which transfer energy generated at the test berths back to shore. Although the majority of WECs onsite will connect to export cables, not all of the

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WECs will utilise mooring lines to maintain station or to connect to power cables. Many of the device types anticipated to occupy the 10 berth Billia Croo test site will utilise foundations with pins or piles or gravity-based foundation. Those devices with moorings will be expected to use a minimum four-point mooring system. Additionally, there may be a maximum of three mooring systems which are not directly linked to the devices which may be installed at each test berth (i.e. for mooring project vessels, other infrastructure etc.). The likelihood of an entanglement occurring increases as the number of devices with moorings and the number of moorings across an array increases. The use of synthetic mooring materials, which pose the greatest threat of entanglement, are restricted to 100 tons per device. The mooring system maximum footprint at Billia Croo is estimated at 0.073 km^2.

Hebridean Whale and Dolphin Trust (HWDT) developed a 'risk of entanglement measure' (REM) in which the metric increases as the overlap between whales and entangling gears (i.e. creel pots) increase (Northridge *et al.*, 2010). Some of the highest REM values for Scotland were predicted for the Angus/Fife coastlines and Orkney based on their interactions with creel pots (Northridge *et al.*, 2010). However, the density of minke whales across the test site is low (Figure 8-1) and entanglement events are not likely to occur, given the small footprint of mooring systems.

Still, as there remains some uncertainty about the potential for an entanglement occurring, given the variety of mooring configurations which could be used at the site, developers are urged to develop emergency shut-down procedures for moored or cabled devices with high risk of entanglement, should an entanglement event occur. In the event of entanglement Marine Scotland and SNH will be consulted. These and other mitigation methods to reduce the potential risk of injury from entanglement are outlined in Section 8.9 below.

8.6.4.3 Entrapment in devices, multiple mooring lines or cabling leading to injury or death

Entrapment involves an individual becoming trapped within a device or its moving parts. Devices and other infrastructure with large moving parts or cavities potentially pose the greatest risk for cetacean entrapment (Sparling *et al*., 2013). Mooring systems which utilise multiple lines or cables, such as a four-point mooring system, also increase the likelihood of entrapment, in which animals become unable to exit the device. As such, device design plays an integral role in determining the risks associated with entrapment.

Whilst there are no records of entrapment events occurring within WECs, there has not been dedicated monitoring in this regard and, therefore, it is impossible to disregard its potential as an injury mechanism. Behavioural characteristics and the physiology of the species which may interact with the WEC also affect the likelihood of entrapment occurring. Juvenile animals and smaller species, such as harbour porpoise or white-beaked dolphins, will have a greater potential for entrapment than a large whale. Moreover, those species which are less risk-averse, and more inquisitive, are likely at greater risk of making contact with parts of the device expected to entrap.

As device-design is so important for assessing the likelihood of an entrapment event occurring, appraisal of this impacting factor is highly project-specific. For this reason, this issue will need to be addressed on a case-by-case basis which considers device design to assess the potential impact mechanisms for entrapment at the Billia Croo test site.

This issue requires a project-specific assessment and has not undergone further appraisal herein.

Appraisal conclusion for injury impacts to cetaceans as EPS: It is considered that the potential impacts from noise and entanglement will not be detrimental to the maintenance of the population of the species concerned at Favourable Conservation Status across their natural range.

However, an EPS Licence to cover the potential for disturbance from noise emissions from non-percussive installation methods is recommended, as per Section 8.6.4.1. Mitigation measures to monitor the occurrence of cetaceans throughout the test site, particularly during installation activities, will help minimise the potential for disturbance impacts to individual animals.

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8.7 Appraisal of other natural heritage features

This section addresses impacts which haven't been covered under the legal requirements for EPS in earlier sections; it comprises an assessment of barrier effects at the Billia Croo test site.

8.7.1 Presence of WEC(s) and other infrastructure leading to barrier effects

Data deficiencies regarding the behavioural response of cetaceans to WECs makes it difficult to assess the potential for their generation of barrier effects to these species. Wildlife observations data at Billia Croo do not demonstrate site-fidelity for observed individuals, rather cetacean habitat use in the region encompassing the test site appears to be temporary (EMEC wildlife observations data 2009 - 2015). Although a variety of cetacean species have been recorded at the Billia Croo test site in varying relative abundance, published data does not suggest that this region is of particular importance to individuals compared to their greater natural occurrence (Reid *et al.*, 2003; Hammond *et al.*, 2017).

The location of the test site is not proximal to any regions requiring passage, such as sea lochs or straits, and only spans 4.5 km offshore to waters approximately 50 – 60 m in depth. As such, the risk of a barrier effect precluding individuals from utilising habitats to the north or south of the test site is considered very low because all cetacean species occurring in the region are capable of swimming around the test site or individual devices within the test site. The risk of a barrier effect at the Billia Croo test site is further reduced by the fact that a large portion of the test site area is either undeveloped or only cabled on the seabed and therefore available for passage. Assuming the absence of disturbance effects, such as avoidance behaviours, the separation between berth sites would not exclude the potential for passage between them. It is considered that the potential for barrier effects to cetacean receptors would not generate significant population or management scale impacts. Analysis of any future device specific and site wide monitoring will support further understanding of cetacean movement through the site.

Appraisal conclusion for cetaceans as other natural heritage features: The appraisal considers the potential for barrier effects on cetaceans to be negligible and not to generate any significant population-level or management unit-scale impacts.

8.8 Appraisal of cumulative impacts

For impacts to cetaceans, the relevant cumulative impact pathways include other sea users which have the potential to generate noise emissions which may compound the installation and vessel noise emissions at the test site. Relevant impact mechanisms may include recreational or commercial vessels (e.g. maintenance vessels, ferries, etc.) and construction activities. (i.e. the installation of pilings, etc.). Whilst a potential impact mechanism in some instances, MOD activities are considered outwith the range as to generate cumulative impacts with activities taking place at Billia Croo.

Vessel activity by other sea users will be limited within the Billia Croo test site area. The region is not targeted by recreational sea users, for example for fishing or wildlife watching activities. The 2019 NRA reports that most recreational crafts encountered in the vicinity of the Project Envelope tend to be on passage past Billia Croo and that most choose to pass either inshore or offshore of the test site (Marine Risk Consultants Ltd, 2019). Boating intensity for recreational crafts in the Project Envelope is classed as low, with less than 400 recreational boats passing within 500 m of the Project Envelope annually (Marine Risk Consultants Ltd, 2019).

There is some commercial vessel activity which has the potential to introduce cumulative impacts with Project Envelope vessel activities. This includes ferry vessels and vessels used for operations and maintenance at nearby aquaculture sites. The nearest ferry vessel transit lanes are those of the Stromness-Scrabster, Stromness-Graemsay, and Stromness-North Hoy ferry routes, located 2 km south, 6 km south-east, and 4 km south-east of the test site, respectively (Table 3-2). Although ferry vessels may be large and introduce a greater disturbance than some of the vessels described in the Project Envelope, these vessels are not anticipated to dramatically deviate from their set routes. Moreover, vessels which pass more closely to the test site, such as those along the Stromness-Scrabster route, will form a temporary disturbance mechanism

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which is unlikely to compound potential noise emissions at Billia Croo to such an extent as to generate significant disturbance to cetaceans. Neither the test site nor transiting ferry vessels will generate barrier effects, so individuals can avoid any temporary elevation in underwater noise levels by utilising the surrounding habitat. For this reason, potential disturbance impacts from temporal overlap between noise-generating activities at the test site and transiting ferry vessels will be highly constrained and are not anticipated to generate cumulative disturbance impacts to cetaceans across the test site area or the surrounding waters.

Similar to transiting ferry vessels, maintenance vessels servicing nearby commercial infrastructure, such as aquaculture sites or submarine cables, may generate underwater noise which has the potential to compound noise emissions at the Test Site. The nearest aquaculture site by vessel (i.e. not over land) is the Bring Head Fish Farm located 9 km south-east of the test site (Table 3-2). Five km north-east of the test site lies the Northern Lights telecommunications cable. Vessels likely be deployedd for the maintenance or operations of either commercial location are anticipated to be small to medium in size (i.e. likely 15-35 m in length). As such, they are expected to generate lower-pressure, high frequency sounds which will attenuate rapidly within the marine environment. Vessels of these sizes are not considered to constitute sources of significant disturbance to marine pinnipeds. For this reason, vessel noise from operational aquaculture sites and the maintenance of nearby submarine cables will not introduce cumulative impacts to cetaceans through noise-related disturbance.

The Stromness A dredge disposal site is located 2 km south-west of Billia Croo; it may be visited from time-to-time by local dredgers. Given its location (Figure 3-2), vessels utilising this site are likely to drive within closest proximity to the test site compared to any other commercial sea users. Dredgers servicing Stromness harbour and the nearby ferry lines, which are likely to be large vessels (e.g. 50 – 80 m), may intermittently utilise this disposal site to dump dredge material. Noise emissions from the dredge vessel engine are anticipated to drown out noise generated by the dumping of dredge material. However, underwater noise emissions from the dredge vessel engine will be limited in temporal scale to the duration of the transit to and from Stromness A and the duration of the dumping of dredge material. Such potential disturbances are not anticipated to be as frequent as the nearby passing ferries. For this reason, there is limited scope for use of the proximal dredge disposal site to compound noise emissions generated at Billia Croo which have been identified as having the potential to disturb cetaceans.

Several construction projects are anticipated to take place which may overlap with noise-generating installation activities at Billia Croo. Planning is in place for the construction of a fishing industry building at the Kirkwall Pier, 23 km due directly east of the test site (Table 3-2). As well, both Longhope Pier (more than 20 km south-east; straight-line distance) and Pierowall Pier (45 km north-east; straight-line distance) are expected to undergo pier repair works in the near future (Table 3-2). Installation and repair of these harbour structures may include some noise from piling installation, which may include percussive and/or non-percussive piling. Additionally, the N1 ScotWind potential lease area is located in excess of 20 km from Billia Croo which have the potential to experience large-scale foundation piling for wind farms over the next several years; however, it should be noted that there are no plans currently in place for the development of these sites.

As a worst-case scenario, percussive piling may generate underwater noise which can be heard up to 50 km away in an open water environment (Bailey *et al.*, 2010); however, noise emissions at the harbour works sites or potential forthcoming windfarms will be dampened through repeated refraction off the shallow seabed, and surrounding coastline and nearby islands. Furthermore, the potential to generate noise emissions which might cause significant disturbance to cetaceans will be limited to within the immediate area surrounding the noise source (Nehls *et al.*, 2016). Therefore, noise emissions generated by piling activities at nearshore and offshore construction sites in the wider area are unlikely to travel to the Billia Croo test site and are not anticipated to generate significant disturbance effects to cetaceans which would be detrimental to the maintenance or conservation status of cetacean populations. Moreover, mitigation measures, including the monitoring of cetacean species during installation activities, will limit the potential for individuals to be subjected to elevated noise levels at Billia Croo. As such, significant disturbance impacts are not anticipated to result from any construction activities, including piling, occurring in the wider area.

For these reasons, cumulative impacts to cetaceans from other sea users will not be detrimental to the maintenance of any cetacean populations at Favourable Conservation Status across their natural range.

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Appraisal conclusion for cumulative impacts on cetaceans: In review of activities undertaken by other sea users, it is considered that cumulative disturbance impacts from commercial or recreational vessel presence or construction activities near the test site and surrounding waters are minimal and will not be detrimental to the maintenance of the population of the species concerned at Favourable Conservation Status across their natural range.

Mitigation measures to monitor the occurrence of cetaceans throughout the test site, particularly during installation and decommissioning activities, will help minimise the potential for disturbance impacts to individual animals from test site activities and their potential overlap with the activities of other sea users.

8.9 Receptor conclusion

A summary of the appraisal for each of the receptors is provided in Table 8-6 below. Note that, even where no important impacts on the development site are identified, in some cases there may still be a recommendation for mitigation or monitoring. Under these circumstances, mitigation is regarded as good-practice, while monitoring may serve to improve generic understanding of the relationships between stressors and receptors. Where mitigation or monitoring is considered to be a likely licence or consent condition this is highlighted in Table 8-7.

Table 8-6 Summary of cetacean appraisal conclusions

Receptor	Appraisal mechanism/relevant legislation	Applicable Monitoring and Mitigation
Cetacean species	No important impacts predicted for EPS or other natural heritage features. No impacts predicted for cetaceans as qualifying features of protected sites, including Natura 2000 sites	Yes, see Table 8-7
Cetacean species	No important cumulative impacts are anticipated	Yes, see Table 8-7

No important impacts are predicted as a result of the proposed activities at the Billia Croo test site, as described in the Project Envelope. Where the possibility of disturbance to cetaceans remains, EPS licensing needs have been identified. These, along with other recommendations have been captured in the mitigation and monitoring strategies outlined in Table 8-7 below. However, the conclusion reached in all cases is that such potential disturbance impacts will not be detrimental to the maintenance of any cetacean populations or the Favourable Conservation Status across their natural range.

Project-specific assessments are required for aspects of the following impact pathways and, thus, each developer will need to identify any appropriate mitigation and/or monitoring in response to:

- Use of active acoustic equipment;
- Requirement for an EPS Licence in relation to noisy activities from installation activities;
- Requirement for the use of MMO protocol;
- Employment of percussive piling methods; and
- The potential for injury from entrapment in devices, particularly those with mooring configurations which generate an enclosure (e.g. four-point mooring systems) or devices with cavitation in their design.

Overall, injury impacts to cetacean receptors are anticipated to not be important, particularly with the implementation of the mitigation measures outlined in Table 8-7. Moreover, the mitigation measures will reduce the likelihood of the occurrence of a disturbance event. However, as the potential to disturb cetaceans is still a possibility for installation and decommissioning related activities, and from WEC operation, an EPS licence for disturbance is recommended for these impact pathways.

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Table 8-7 Suggested mitigation and monitoring

Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licence requirement/Likely condition of consent	Justification
Disturbance from underwater noise	Cetacean species	Installation, decommissioning and maintenance vessel(s) transiting and manoeuvring	Vessel movements and occupancy within the Billia Croo test site will be managed through EMEC's SOPs. The SOPs limit the number and size of vessels which can utilise the test site simultaneously.	No	SOPs will be used as good practice. The SOPs limit the numbers and sizes of vessels which can utilise the test site simultaneously, as well as put in place.
			A VMP, which includes a traffic management scheme, will be included as a part of the PEMP. Its implementation will minimise vessel overlap and provide further mitigation against potential disturbance to cetaceans.	Yes	a VMP including a traffic management scheme to minimise vessel overlap. This mitigation measure should reduce the potential impacts of cumulative noise from vessel activity onsite. A VMP is required as part of the PEMP.
		Foundation/mooring installation methods	The requirement for an MMO for installation and decommissioning activities will be considered on a case by case basis. For the activities included in the Project Envelope, the only likely requirement for an MMO will be for pin piling. If an MMO is required for installation activities, the EMEC MMO protocol will be utilised (SOP074). The MMO procedures will include the deployment of a dedicated MMO with protected species observation skills (as per standard MMO training) prior to and during device	Yes, but most likely only for pin piling activities.	The use of an MMO is considered best practice for mitigating against potential noise impacts to marine mammals from piling procedures. SNH have suggested that the use of C-POD in place or in addition to an MMO during installation could be investigated.

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Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licence requirement/Likely condition of consent	Justification
			installation. This will include a soft-start ramp up of piling noise to give animals time to move away from the noise source. C-PODs[25] may also be deployed at the Billia Croo test site.		The use of C-POD for monitoring during other phases of deployment and on a site wide basis could also be considered.
			On-site monitoring of cetaceans may be extended through the training of shipboard personnel on the SMWWC.	No	This will enable identification of cetaceans from at-sea vantage points and near the noise source.
			Due to the frequency and occurrence of cetacean species within the test site, a licence to disturb EPS is likely to be required for noise generating activities which could disturb cetaceans.	Likely only for noisy activities with the potential to disturb such as pin piling.	This should be reviewed on a case by basis, informed by activities associated with each deployment. EPS licensing provides an opportunity for considering device-specific mitigation measures where considered appropriate.
		Device operation	Due to the frequency and occurrence of cetacean species within the test site, a licence to disturb EPS is likely to be required for noise generating activities which could disturb cetaceans.	Possible	As knowledge increases about the noise emissions from WECs, identification of particularly noisy devices

[25] C-PODs detect the echolocation clicks of toothed cetaceans providing time data on animal activity as an indication of presence or habitat usage.

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Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licence requirement/Likely condition of consent	Justification
					with the potential to disturb should be possible. For these devices an EPS is likely to be required.
			Noise monitoring for specific devices. This may include deployment of C-PODs near the devices to monitor the occurrence of cetaceans and their behavioural responses (i.e. aversion or attraction) to WECs.	No	Noise emissions from WECs are poorly characterised. Measurements of source levels from operational wave devices and characterisation of ambient sounds in the marine environment comprising Billia Croo will help determine the likely received levels cetaceans will experience within the test site.
Injury from entanglement	Large whales (e.g. minke whales)	Mooring lines and cabling	Continued monitoring of habitat use by cetaceans, particularly large whales. On-site monitoring will enable identification of cetaceans from at-sea vantage points. In the event of entanglement, Marine Scotland and SNH will be consulted	No	This impact pathway is considered unlikely, due to the low frequency of large baleen utilising the test site each year. However, this monitoring measure is recommended to gain further information about the likelihood of entanglement occurring at Billia Croo.

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Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licence requirement/Likely condition of consent	Justification
			Developers are urged to develop emergency shut-down procedures for moored or cabled devices with high risk of entanglement, should an entanglement event occur.	Possible	As there is still uncertainty regarding the potential for cetaceans to become entangled in moorings and cables, monitoring and emergency shut down procedures will enable developers to rapidly respond to any potential entanglements, with guidance from Marine Scotland and SNH.

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9 PINNIPEDS

Stage 1 of this appraisal defined the categories of potential effect as presented in Table 3-1. The appraisal now picks up at Stage 2 of the methodology where effect pathways and importance are identified as described in Section 3.

9.1 Key data sources

The key data sources that have been used to inform this appraisal:

- EMEC Wildlife Observations Data 2009 – 2015, (EMEC, 2016);
- Small Mammals at Sea (SMRU) Estimated at-sea Distribution of Grey and Harbour Seals - updated maps 2017, (SMRU, 2017);
- Scientific Advice on Matters Related to the Management of Seal Populations: 2017. Report to the National Environment Research Council, (SCOS, 2017); and
- Utilisation of space by grey and harbour seals in the Pentland Firth and Orkney Waters, (SMRU, 2011).

9.2 Potential effects

For pinniped (i.e. phocid seal) receptors, the defined potential effect categories are applied to activities/effect pathways relevant to wave energy developments as described in the Project Envelope. First, potential effects are considered in broad-principles. Deployment, installation and decommissioning effects (Table 9-1) are addressed separately from those during the operational and maintenance phases (Table 9-2).

Note that details specific to Billia Croo, both environmental and relating to project-specifications, are not considered until the detailed appraisal later in this section.

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Table 9-1 Potential effects on pinniped receptors during deployment, installation and decommissioning of infrastructure

Potential effects from device installation and deployment
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels (e.g. jack-up barge; multi cat; workboat; DP vessel; dive-support vessel; crane-barge; tug; specialist cable-laying vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Underwater noise and presence of installation and decommissioning vessel(s), including transiting and manoeuvring, leading to disturbance	Grey and harbour seals	**Potentially important** – pinnipeds can be sensitive to noise emissions from vessels and their physical presence in the marine environment. Importance will depend upon ambient noise levels, the duration and intensity of vessel activity, the likelihood and fidelity of seals in the area and the opportunity for animals to avoid areas of disturbance. Whilst noise generated by even very small vessels (< 5 m) would be audible to pinnipeds, noise propagation modelling (Xodus, 2015) and source level data (Richardson *et al.*, 1995) from vessels likely to be employed indicate that vessel noise (i.e. small to large vessels; not supertankers) is not an impact pathway for injury to seals and is therefore not considered further. Underwater noise and vessel presence will need to be reviewed to ensure there are no Likely Significant Effects (LSEs) against sites designated for the protection of seals.
Underwater noise from foundation/mooring installation methods leading to disturbance or auditory injury	Grey and harbour seals	**Potentially important** – the installation of foundations and mooring systems via non-percussive measures is likely to be the greatest source of sound generated by activities within the Project Envelope. Although unlikely to be sufficiently widespread to have an important effect on pinnipeds, this activity will need to be appraised to ensure there are no LSEs against sites designated for the protection of these species. Importance will depend upon the duration and intensity of acoustic activity, the frequency of source levels, the likelihood and fidelity of pinnipeds in the area and the opportunity for animals to avoid areas of disturbance. Non-percussive installation methods are not expected to result in fatal injuries from noise emissions and has thus been scoped out from further appraisal.
Underwater noise from active acoustic equipment leading to disturbance	Grey and harbour seals	**Potentially important** – although unlikely to be sufficiently widespread to have an important effect on pinnipeds, case-by-case consideration should consider the potential impacts of active acoustic equipment including all behavioural responses with biological consequences to ensure that there are no LSEs against sites designated for the protection of these species. Importance will depend upon the duration and intensity of acoustic activity, the frequency of source levels, the likelihood and fidelity of pinnipeds in the area and the opportunity for animals to avoid areas of disturbance.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Entanglement in mooring lines or cabling leading to injury or death	Grey and harbour seals	**Potentially important** – pinnipeds may be exposed to potential interactions with cables and/or lines which may or may not be under tension (e.g. disconnected from the device or connected to the device before it is at station or in operation). Lines in the water form a major source of entanglement for marine mammal species, particularly large whales (Benjamins *et al.*, 2014). Although potential for interactions between pinnipeds and wave device cables or mooring lines remain poorly characterised, such interactions function as potential sources of injury or mortality from entanglement events. Importance will depend upon the likelihood and fidelity of pinnipeds occurring in the test site, the location and spacing of devices, and mooring and cabling configuration design.
Entrapment[26] in devices, multiple mooring lines or cabling leading to injury or death	Grey and harbour seals	**Potentially important** - the potential for entrapment of pinniped species in WECs is poorly understood; however, it is possible that pinnipeds may become trapped between multiple mooring lines or cables. Mooring lines and cabling are likely to be installed before deployment of devices, so require assessment during the installation phase. Importance will depend upon the likelihood and fidelity of pinnipeds occurring in the vicinity of the test site, the location and spacing of devices and other infrastructure, and mooring and cabling configuration design. This impact pathway will need to be reviewed to ensure there are no LSEs against sites designated for the protection of these species.
Increased suspended sediment/turbidity leading to disturbance	Grey and harbour seals	**Not important** – although pinnipeds may be negatively impacted by increased turbidity within the water column caused by disturbance of the seabed, WECs are generally situated in the upper water column or at the water's surface and will therefore have limited potential to agitate sediments. Installation of other infrastructure including foundations may generate some sediment suspension; however, this will be over a very limited spatial scale and for a short duration, and suspended material will disperse rapidly.

Table 9-2 Potential effects on pinniped receptors during operations and maintenance of infrastructure

Potential effects from device operation and maintenance
Summary of activity categories – see Project Envelope for detail > Physical presence of device(s), foundations, moorings, buoys and other infrastructure on the seabed, in the water column or above the surface > Operation of device(s)/power generation > Repeat removal and redeployment of equipment for maintenance (e.g. device removed from water or floating structure removed from berth; replacement of mooring system) > Other maintenance activities (e.g. biofouling removal; ROV/diver inspection or repairs)

[26] Entanglement is limited to becoming physically ensnared or tangled in an object, typically a line or cable, whereas entrapment consists of an animal becoming caught in an object. Entangled animals may continue to drag the entangling object if it is mobile, whereas entrapped animals are generally unable to exit and therefore mobility is restricted to the confines of the entrapping object.

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- Use of vessels (e.g. DP vessel; jack-up barge; multi cat; workboat; dive-support vessel; crane-barge; tug)
- Use of equipment to monitor devices in situ or other environmental parameters (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Underwater noise and presence of maintenance vessel(s), including transiting and manoeuvring, leading to disturbance	Grey and harbour seals	**Potentially important** – pinnipeds can be sensitive to vessel presence and associated activities. Importance will depend upon the duration and intensity of vessel activity, the likelihood and fidelity of pinnipeds in the area and the opportunity for animals to avoid areas of disturbance. This impact pathway will need to be appraised for any potential LSEs to protected sites designated for the protection of these species.
Underwater noise from device operation leading to disturbance	Grey and harbour seals	**Potentially important** – pinnipeds may be sensitive to noise emissions from operational WECs. Importance will depend upon the frequency, intensity and duration of noise production by devices and the likelihood and fidelity of pinnipeds in the area and the opportunity for animals to avoid areas of disturbance. This impact pathway will need to be appraised for any potential LSEs to protected sites designated for the protection of these species.
Underwater noise from active acoustic equipment leading to disturbance	Grey and harbour seals	**Potentially important** – although unlikely to be sufficiently widespread to have an important effect on pinnipeds, case-by-case consideration should be given to the potential impacts of active acoustic equipment, including all behavioural responses with biological consequences to ensure that there are no LSEs against sites designated for the protection of these species. Importance will depend upon the duration and intensity of acoustic activity, the frequency of source levels, the likelihood and fidelity of pinnipeds in the area and the opportunity for animals to avoid areas of disturbance.
Entanglement in devices, mooring lines or cabling leading to injury or death	Grey and harbour seals	**Potentially important** – pinnipeds may be exposed to potential interactions with cables and/or lines which may or may not be under tension. Lines in the water form a major source of entanglement for marine mammal species, particularly large whales (Benjamins *et al.*, 2014). Although potential for interactions between pinnipeds and wave device cables or lines remain poorly characterised, such interactions function as potential sources of injury or mortality from entanglement events. Importance will depend upon the likelihood and fidelity of pinnipeds occurring in the test site, the location and spacing of devices, and mooring and cabling configuration design.
Entrapment[27] in devices other	Grey and harbour seals	**Potentially important** – the potential for entrapment of pinniped species in WECs and other infrastructure is poorly understood; however, it is possible that pinnipeds may become trapped between multiple mooring lines

[27] Entanglement is limited to becoming physically ensnared or tangled in an object, typically a line or cable, whereas entrapment consists of an animal becoming caught in an object. Entangled animals may continue to drag the entangling object if it is mobile, whereas entrapped animals are generally unable to exit and therefore mobility is restricted to the confines of the entrapping object.

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Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
infrastructure, multiple mooring lines or cabling leading to injury or death		or cables. Mooring lines and cabling are likely to be installed before deployment of devices, so require assessment during the installation phase. Importance will depend upon the likelihood and fidelity of pinnipeds occurring in the vicinity of the test site, the location and spacing of devices, and mooring and cabling configuration design. This impact pathway will need to be reviewed to ensure there are no LSEs against sites designated for the protection of these species.
Other maintenance activities (i.e. non-vessel-based) leading to disturbance	Grey and harbour seals	**Not important** – maintenance activities include inspection (e.g. divers, ROV, etc.), repairs or temporary retrieval and replacement of device and other infrastructure as needed. In all cases, it is the presence of the accompanying vessel which presents the primary disturbance risk; this is appraised separately.
Presence of WEC(s) and other infrastructure leading to barrier effects	Grey and harbour seals	**Potentially important** - pinnipeds may utilise or move through areas identified for wave energy development. Importance will depend upon the spatial occupancy of the Project Envelope area by wave devices (in three-dimensional space) and other infrastructure, physical characteristics of the devices, the importance of the surrounding region for transit by pinnipeds, and the likelihood of disturbance from installation activities (e.g. from noise or vessel presence). This impact pathway will need to be reviewed to ensure that it does not impact upon the conservation status of these species.
Increased suspended sediment/turbidity leading to disturbance	Grey and harbour seals	**Not important** – although pinnipeds may be negatively impacted by increased turbidity within the water column caused by disturbance of the seabed, WECs are generally situated with the majority of moving parts located in in the upper water column or at the water's surface. Consequently, the operation of WECs have limited potential to agitate sediments and therefore not anticipated to generate increased turbidity within the water column.

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9.3 Natural heritage context

Two species of pinniped inhabit UK coastlines, both of which are phocid (i.e. true) seals: the harbour seal (*Phoca vitulina*) and the grey seal (*Halichoerus grypus*) (Pollock *et al*., 2000). In Scottish waters, harbour seals and grey seals are protected through their inclusion in the following legislation: Conservation of Seals Act 1970 as amended through the Seals (Scotland) Order 2002; Annex II of the Habitats Directive as adopted through the Conservation of Habitats and Species Regulations 2017; the Wildlife and Countryside Act 1981 and The Conservation (Natural Habitats, &c.) Regulations 1994 as amended; and the Marine (Scotland) Act 2010. Harbour seals are additionally protected as a UK Biodiversity Action Plan (BAP) species and both seal species are protected in the Scottish territorial seas as PMFs under a list developed jointly by SNH and the JNCC (Tyler-Walters *et al.*, 2016).

As species listed in Annex II of the Habitats Directive, both species are considered species of 'Community Interest', who require the designation of Special Areas of Conservation (SACs) for their protection. Additionally, The Protection of Seals (Designation of Haul-Out Sites) (Scotland) Order 2014 designates 194 known seal haul-outs as protected sites, making it an offence to harass, injure or kill a seal at those sites an offence. Beyond these protected sites, the Marine (Scotland) Act 2010 makes it an offence to kill, injury or take a seal at any time except to alleviate suffering under the relevant licence.

Harbour and grey seals are prevalent throughout the Northern North Sea, including the Northern Isles (Orkney and Shetland), which serve as optimal breeding and haul-out habitat for these protected species. Scotland remains a stronghold for both species, and the country's coastlines support nearly 80% of the harbour seals in the UK and approximately 30% of those in Europe (SCOS, 2017). Approximately 88% of the UK population of grey seals breed in Scotland, with the majority of breeding sites occurring in Northern and Hebridean Isles (SCOS, 2017). Harbour seals have however been in continued decline in Orkney since the late nineties, and population estimates from 2016 were down 85% from what they were in 1997 (SCOS, 2017). Conversely, grey seal populations are on a slow, steady increase in the UK (SCOS, 2017).

Whilst very similar in their habitat preferences, harbour and grey seals differ in their primary habitat use and current population status. Harbour seals are resident breeders in Northern Scotland and there are several important harbour seal breeding groups located in Orkney and the Tay Estuary (Thompson *et al*, 1996). As a strictly inshore species, there are few records of harbour seal sightings occurring in waters deeper than 200 m (Pollock *et al.*, 2000). Harbour seals predominantly forage within 2 km from their haul-out sites, maintaining a tighter coastal proximity than grey seals. Tagging data from female harbour seals suggests a maximum foraging-range of 38.4 km (Cordes *et al.*, 2011), whilst males may forage upwards of 60 km for their haul-outs (Thompson, *et al*. 1996). Individuals may travel up to 75 km to alternate haul-outs, however, they return to their natal breeding sites for reproduction (Thompson *et al*., 1996).

The distribution of grey seals across the north and west of Scotland is expansive, encompassing the rugged coastlines of both the mainland and far-reaching islands of the NE Atlantic and Northern North Sea (Pollock *et al.*, 2000). Whilst also an inshore species, grey seals do travel much farther and utilise deeper waters than harbour seals when on foraging trips or moving between haul-out sites (Thompson, *et al.* 1996). Male grey seals in particular are known to undertake prolonged foraging trips to reach deep water foraging habitat (Thompson *et al.*, 1996). Grey seals may forage upwards of 145 km from their haul-outs and may travel up to 365 km between haul-out sites (Thompson, *et al.* 1996); however, the average foraging trip distance is approximately 100 km from haul-outs (Cronin *et al.*, 2012). Grey seals around Orkney are known to target deep water demersal species such as cod, plaice and sculpins (Hammond *et al.*, 1994).

EMEC wildlife observations collected between 2009 and 2015 indicate the relative importance of the Billia Croo test site to nearby seals. Observations data were dominated by grey seal sightings (68%; n=1378), with only 4% (n=83) of sightings containing harbour seals (EMEC, 2016). Observations peaked in August and September, likely a reflection of increased foraging activity in the nearshore environment prior to the onset of the grey seal pupping season (EMEC, 2015). Relative abundance data illustrates that 95.5% (n=1821) of identified individuals were grey seals (EMEC, 2016). Demographic information for harbour and grey seals at Billia Croo are described in Table 9-3.

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Table 9-3 Pinniped demographics in the region comprising Billia Croo (SMRU, 2017; EMEC, 2015; SCOS, 2017)

Species	Density (animals/km^2) (SMRU and Marine Scotland, 2017b)	Sightings abundance (individuals)[28] (EMEC wildlife observations data 2009 – 2015)	UK abundance (individuals)[29] (SCOS, 2017)
Harbour seal (*Phoca vitulina*)	0.2	86	31,300
Grey seal (*Haliochorus gripus*)	0.6	1,821	141,000

The distribution of seals observed around Billia Croo varied between species, and evidence of seal density from tagging data and surveys is depicted in Figure 9-1 below. The density estimates have been extrapolated from tagging data which consists of a series of spatial locations (fixes) for tagged animals, with overlapping fixes increasing the likelihood of estimated habitat use. As central-place foragers which return to land repeatedly for the majority of life-history events (e.g. breeding, nursing, and moulting), habitat use estimates for tagged seals are often skewed towards the areas surrounding haul-outs, which seals must move through repeatedly to get to foraging habitat. Foraging may take place in regions where seal density appears low, and the importance of such habitat may not be adequately captured by tagging data.

9.3.1 Protected sites

A variety of protected sites are designated to protect seals in Scottish and UK waters; these include: designated seal haul-outs, SSSIs and SACs. There are 194 designated seal haul-outs and 45 breeding colonies located in Scottish waters, the majority of which occur in the Northern Isles and Outer Hebrides (NMPi, 2018). Some of the more significant designated haul-outs are also considered SSSIs, including the following protected sites in Orkney: Eynhallow, Switha, Ward Hill Cliffs, and Muckle and Little Green Holms. All four of these protected sites are located more than 20 km from Billia Croo. There are some beaches of elevated use by seals near Billia Croo, including south of the test site at Warebeth Beach. However, these are not designated haul-outs which are protected by the relevant legislation (outlined in Table 9-4) for the protection of seals at haul-outs. There are two SACs with seal features within 50 km from Billia Croo: the Sanday SAC (49.3 km east-northeast), designated for harbour seals, and the Faray and Holm of Faray SAC (38.5 km east-northeast), designated for grey seals. The Dornoch Firth and Morrich More SAC, designated for the protection of harbour seals, is also located 126.2 km south-southwest of Billia Croo. However, based on information on harbour seal movements and habitat use this site is considered outwith the relevant distance to have connectivity with Billia Croo or to incur impacts from activities within the Project Envelope. Therefore, it is not appraised further in Sections below.

[28] This is a measure of the total number species-specific seal recordings across all six years of data collection.
[29] This is a comprehensive estimation of the absolute abundance of a species within a given region. These values have been extrapolated from sightings data which included estimations of re-sighting rates to identify the total number of individuals within the survey area.

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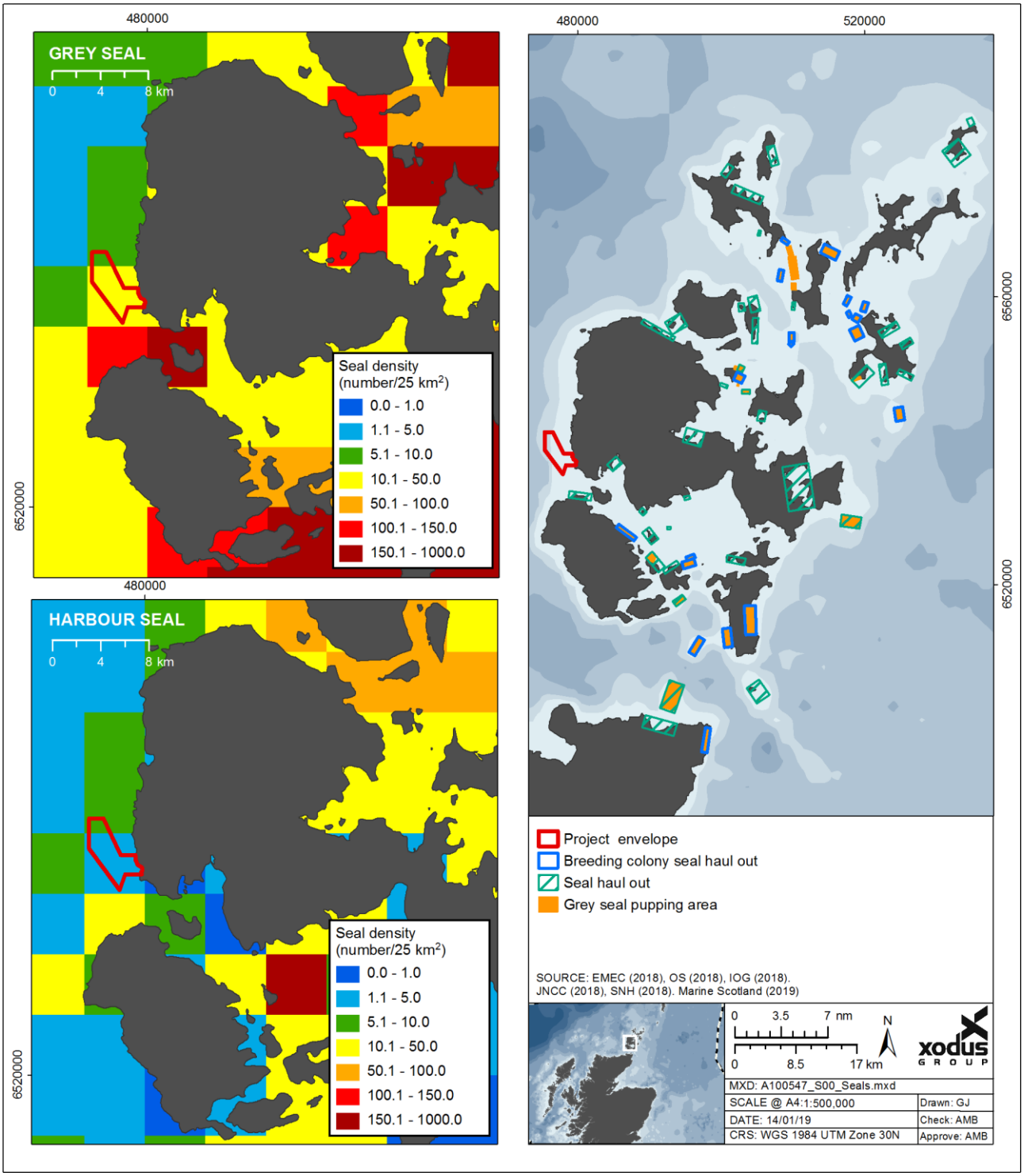
Figure 9-1 Grey and harbour seal densities and designated haul-outs around the Billia Croo test site (Marine Scotland, 2018c)



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9.4 Summary of impact appraisal for Billia Croo

This impact appraisal takes account of a maximum-case scenario based on the Project Envelope where all available berths within the test site are developed and operating at capacity. It addresses the differing consenting and licensing regimes. This appraisal will inform the consenting process for both Marine Licence and S36 applications. However, it should be noted that, if there are key deviations in the device design or in any activity (deployment, installation, decommissioning, operations and maintenance), further appraisal work may be required. Any additional appraisal work required will be undertaken by the individual developer (further advice should be sought from EMEC in the first instance).

Table 9-4 presents the relevant legislation and the reasons for undertaking an appraisal for several features in the test site area.

Table 9-4 Appraisal mechanism for pinniped species and habitats

Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
Qualifying features of European sites	The Conservation of Habitats and Species Regulations 2017 (Note: these regulations apply in Scotland in relation to certain specific activities (reserved matters), including consents granted under Sections 36) Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	Yes	Potential connectivity with Special Areas of Conservation (SAC) with seal qualifying features, including: Sanday SAC (designated for harbour seals) and the Faray and Holm of Faray SAC (designated for grey seals).
European Protected Species	The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) Marine (Scotland) Act 2010	No	Grey and harbour seals are not listed as EPS. However, they are subject to licensing requirements under the Marine (Scotland) Act 2010, which are similar to those for EPS, although harassment offenses are limited to 'designated seal haul-outs.'
Notified features of SSSIs	Nature Conservation (Scotland) Act 2004 (as amended)	Yes	Potential connectivity with the following SSSIs with pinniped features: East Sanday Coast, Eynhallow, Faray and Holm of Faray, Muckle and Little Green Holms, Switha, and Ward Hill Cliffs.
Protected features of MPAs	Marine (Scotland) Act 2010	No	No connectivity with any NCMPAs with seals as qualifying features. Therefore, not capable of affecting protected pinniped features of any MPAs.
Protected features of Seal Haul-Outs	Marine (Scotland) Act 2010	Yes	Both grey and harbour seals have designated seal haul outs in the region which may have potential connectivity.
PMFs	Marine (Scotland) Act 2010	Yes	Both grey and harbour seals are PMFs.
Other sensitive natural heritage features	Appraisal of other features under: > Wildlife and Countryside Act 1981 > The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (relevant to projects located 0-12 nm from shore)	Yes	Captures assessment of all other sensitive natural heritage features at a population/habitat scale of concern.

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Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
	> The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 > Marine (Scotland) Act 2010 > Conservation of Seals Act 1970 as amended through the Seals (Scotland) Order 2002		

9.5 Appraisal of qualifying features of protected sites

Designated Seal Haul-Outs and SSSIs

Designated haul-outs located within 100 km of the Billia Croo test site are described in Table 9-4 below. This distance has been selected as appropriate, as it captures the most likely distance from haul-outs in which both seal species are likely to forage. Whilst there is no direct overlap between Billia Croo and any seal haul-outs, there may be connectivity with seals associated with nearby haul-outs who utilise the Billia Croo area for foraging.

Table 9-5 Designated seal haul-outs located within 100 km of the Billia Croo test site (Marine Scotland, 2018d)

Haul-out	Distance and bearing
Selwick	2.5 km south-southeast
Bay of Ireland	4 km east-southeast
Northeast Hoy	10.2 km south-southeast
Holm of Houton	10.9 km east-southeast
Cava	13.2 km south-southeast
Damsay & Holm of Grimbister	14.8 km east-northeast
Barrel of Butter	15.3 km east-southeast
Ve Ness	15.5 km east-southeast
North and East Fara	16.1 km south-southeast
Flotta Oil Terminal	19 km south-southeast
North Flotta and Calf of Flotta	20 km east-southeast
Costa & Burgar	20.5 km north-northeast
Eynhallow (*SSSI*) & Westside	21.7 km north-northeast
Holm of Rendall	22.5 km east-northeast
Switha (*SSSI*)	23.3 km south-southeast
Gairsay	24.5 km east-northeast
Northwest Water Sound	24.5 km east-southeast
Taing Skerry & Grass Holm	24.7 km east-northeast
Sweyn Holm	25.5 km east-northeast
Helliar Holm North & Elwick	25.6 km east-northeast
Deer Sound	28.4 km east-southeast
Southeast Egilsay	29.3 km east-northeast
Swona	29.3 km south-southeast
Holm of Scockness	30.6 km east-northeast
South Ronaldsay East and West	30.6 km east-southeast
Egilsay North	31.8 km east-northeast
Stroma	32.3 km south-southeast
Muckle and Little Green Holms (*SSSI*)	33.5 km east-northeast
Gills Bay	35.5 km south-southeast
Seal Skerry (Eday)	36.5 km east-northeast
Rusk Holm	37.4 km east-northeast
Copinsay	37.5 km east-southeast
Pentland Skerries	39.2 km south-southeast
Greenli Ness	39.7 km east-northeast

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Haul-out	Distance and bearing
Skerry of Wastbist	39.9 km north-northeast
Duncansby Head	40.5 km south-southeast
South Westray	41.6 km north-northeast
Linga Holm	42 km east-northeast
Spo Ness to Ness of Brough	42.6 km north-northeast
Little Linga	42.7 km east-northeast
Sty Taing	43 km east-northeast
Holms of Spurness	43 km east-northeast
Bay of Holland East & Tor Ness	43.6 km east-northeast
Narr Ness	43.8 km north-northeast
Calf of Eday	44.5 km east-northeast
Holm of Huip	44.6 km east-northeast
Auskerry	44.6 km east-northeast
North end Mill Bay	45.6 km east-northeast
Bay of Houseby	46.1 km east-northeast
Odness	47.8 km east-northeast
Holm of Papa Westray & North Wick	48.8 km north-northeast
Sule Skerry	57.4 km west-northwest
South North Ronaldsay	66.6 km east-northeast
Eilean nan Ron (Tongue)	70.7 km west-southwest
Seal Skerry (N Ronaldsay)	71.8 km east-northeast
Dunbeath-Wick	72.2 km south-southeast
Loch Eriboll & Whiten Head	76.7 KM west-southwest
Kyle of Tongue Sandbanks	78 km west-southwest
Dunbeath Holmsdale	80.8 km south-southwest
Eilean Hoan	84.5 km west-southwest
Lothmore	98.7 km south-southwest

The majority of disturbance responses in seals have been measured on-land and focus on animals reacting to a disturbance by fleeing haul-out sites and moving into the water (Kelly *et al.*, 1987; Andersen *et al.*, 2011). Breeding and pupping seals at terrestrial haul-outs are particularly sensitive to disturbances from close approach by humans or nearby human activities, and they may stampede into the water in response (Marine Scotland, 2014a). This can have significant impacts on the health of seal pups, as they can be left without maternal care for an extended period and may be trampled during such a disturbance event.

The protection afforded to seals at designated haul-outs are regulated under the Marine (Scotland) Act 2010, Part 6—section 117. Recent guidance from Marine Scotland (2014) details the extent of a seal harassment offence, which is limited to only those seals on designated haul-out sites, not seals located in the water or on land outside a designated haul-out. Similarly, offences against SSSIs, which are designated under the Nature Conservation (Scotland) Act 2004 (as amended), are limited to the intentional or reckless damage of their protected natural features within the site.

Given that the Billia Croo area is not directly overlapping or immediately adjacent to any seal haul-outs or SSSIs, an appraisal of activities described in the Project Envelope against a seal harassment offence under the Marine (Scotland) Act 2010 or damage to the protected natural features of SSSIs under the Nature Conservation (Scotland) Act 2004 are strictly limited to disturbance from vessel movements. The SOP includes a Vessel Management Plan which will ensure vessel traffic transiting to and from the site and anchoring away from the site will not lead to disturbance to seals at any designated haul-outs, the nearest of which are located 2.5 km and 4 km from Billia Croo (Table 9-5). This includes limiting vessel speed and providing a conservative buffer zone of 500 m around designated seal haul-outs to minimise the potential for disturbance of harbour and grey seals at their haul-outs to negligible (Johnson and Acevedo-Gutierrez, 2006; Marine Scotland, 2014a). Moreover, all shipboard personnel will be trained in the SMWWC to ensure they can recognise seals and respond accordingly to any signs of distress (as outlined in Marine Scotland, 2014a) to limit the potential for any harassment to seals. These and other mitigation measures are provided in Table

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9-8 below. As the potential for harassment of seals at designated haul-outs has been mitigated against in EMEC's SOPs, this impact pathway is not appraised further.

It is an offence to injure or kill seals, regardless of their location (i.e. within or outside of designated seal haul-outs) under this Act, and these impacts have been appraised in Section 9.8.

Special Areas of Conservation (SACs)

There are several SACs with seal qualifying features which have potential connectivity with Billia Croo due to the presence of seals which may have emanated from those sites; they include: Sanday SAC (designated for harbour seals) and Faray and Holm of Faray SAC (designated for grey seals). Whilst there is also evidence of grey seal movement to and from Orkney waters which may enable connectivity with SACs beyond Orkney (i.e. North Rona, Isle of May, and Berwickshire and North Northumberland SACs), this connectivity is anticipated to be highly limited (SMRU Ltd, 2011). As such, there are not likely to be any LSE to grey seal qualifying features from these more distant European sites, thus they have been excluded from the appraisal below.

The closest European site, the Faray and Holm of Faray SAC, is located 38.5 km east-northeast of Billia Croo, whilst the Sanday SAC is situated 49.3 km east-northeast of Billia Croo. Both sites are additionally designated as SSSIs under the Nature Conservation (Scotland) Act 2004 for seal qualifying features. The long stretch of sandy beach comprising the East Sanday Coast SSSI encompasses Orkney's largest harbour seal colony, whilst the islands of the Faray and Holm of Faray SSSI support an internationally important breeding colony of grey seals.

The Faray and Holm of Faray SAC comprises two uninhabited islands in northern Orkney with ample freshwater pools which support the second-largest grey seal breeding colony in the UK, contributing approximately 9% of the annual pup production in the UK. The Sanday SAC, located in the north-east of the Orkney islands, supports the largest breeding harbour seal aggregation in the UK which is connected to the surrounding Orkney population of harbour seals. The Sanday coastline and adjacent kelp forests provide ideal breeding and foraging habitat for nearly 4% of the UK population of this species.

The conservation objectives of the Faray and Holm of Faray SAC and the Sanday SAC both focus on ensuring that the following characteristics of their qualifying species are maintained in the long term:

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

An appraisal of activities within the Project Envelope against the above conservation objectives is undertaken in Section 9-7: Habitats Regulation Appraisal.

Appraisal conclusion for qualifying features of protected sites: The Project Envelope area is not directly overlapping any designated seal haul-outs. This reduces the likelihood of Project Envelope activities committing a seal harassment offence under the Marine (Scotland) Act 2010 to negligible. However, further appraisal of potential injury or mortality of seals is required under Part 6 of the Marine (Scotland) Act 2010 on 'Conservation of Seals.'

The Billia Croo test site is not directly connected with, or necessary to site or conservation management of, any SAC in the UK. However, there is potential connectivity with the Sanday and Faray and Holm of Faray SACs. As such, activities occurring at Billia Croo have the potential to impact the seal qualifying features of these sites, and thus it is necessary to undertake further appraisal of potential implications on conservation objectives. This appraisal is provided in Section 9.7: HRA.

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9.6 Appraisal under Marine (Scotland) Act 2010

The following Section outlines the appraisal undertaken in relation to the Marine (Scotland) Act 2010. A summary of the legal requirements of this legislation are defined below.

9.6.1 Summary of the legal requirements

Part VI – Conservation of Seals in the Marine (Scotland) Act 2010 makes the following an offence and provides mechanisms for relevant exemptions in the form of seal licences:

(1) The following is an offence:

(a) intentional or reckless killing, injuring or taking a live seal;
(b) harassment at haul-out sites; and
(c) harassment at seal conservation areas.

(2) Exceptions: it is not an offence under section 107 for a person to end a seal's life humanely (or to injure a seal when attempting to do so if—

(a) alleviating suffering because:
(i) it has been seriously disabled;
(ii) has no reasonable chance of recovering; or
(iii) it is the only satisfactory way to end its suffering and is not detrimental to the maintenance of the population of any species of seal at a favourable conservation status in their natural range (within the meaning of Article 1(e) of the Habitats Directive).

(b) it is a licenced activity authorised:
(i) for scientific, research or educational purposes;
(ii) to conserve natural habitats;
(iii) to conserve seals or other wild animals (including wild birds) or wild plants;
(iv) in connection with the introduction of seals, other wild animals (including wild birds) or wild plants to particular areas;
(v) to protect a zoological or botanical collection;
(vi) to protect the health and welfare of farmed fish;
(vii) to prevent serious damage to fisheries or fish farms;
(viii) to prevent the spread of disease among seals or other animals (including birds) or plants;
(ix) to preserve public health or public safety; or
(x) for other imperative reasons of overriding public interest, including those of asocial or economic nature and beneficial consequences of primary importance for the environment.

(3) Subject to the provisions of this Part, it is an offence to deliberately or recklessly injure or kill any seal, and to harass seals at protected sites. A licence may be required to ensure an offense under this legislation is not committed.

9.6.1.1 Licence conditions

A seal licence is required from the Scottish Government for any activities which will injure or kill seals or harass seals at designated protection sites. Licence applications are assessed against Potential Biological Removal (PBR) for each of seven Management Regions, of which the 'Orkney and North Coast' region is relevant to this appraisal for both seal species. PBR is the number of individual seals that can be removed from each of these management units without population-scale impacts; it is calculated annually using the latest seal data. The PBR values (for 2018) are eight harbour seals and 2,249 grey seals for the Orkney and North Coast Management Region.

The following appraisal first considers impacts in relation to whether an offence is likely under the protection afforded to pinnipeds under the Marine (Scotland) Act 2010. It then considers whether a licence to injure, take, or harass seals is required to address this.

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9.6.2 Mortality impacts

Activities due to take place at the Billia Croo test site which have been identified to be of potential importance to the conservation and management of seal populations in Scotland are presented in Section 9.2. None of the activities which have been identified for further assessment are anticipated to generate instances of mortality to either grey or harbour seals. For this reason, this impact has not undergone further appraisal herein.

9.6.3 Injury impacts

9.6.3.1 Underwater noise from foundation/mooring installation methods leading to auditory injury

Seals utilise sound for a variety of behavioural and biological functions, such as communication and the development of social bonds, including those with their young (Berta *et al.*, 2015). Moreover, pinnipeds can hear better in-water than in-air; thus, this taxon is particularly susceptible to impacts from noise emissions within the marine environment.

The installation of foundations or moorings is likely to be the greatest source of sound across the Billia Croo test site; however, the restriction of piling and pin insertion installation techniques to non-percussive methods greatly constrains source levels. Pin piling and rock-bolt insertion for moorings are likely to generate the most noise, as such non-percussive drilling has the potential to emit between 145 – 190 dB re 1 µPa at 1 m of continuous sound at the source (OSPAR, 2009). Anchor block placements have been recorded to generate maximum sound pressure levels of 167 re 1 µPa at 1 m (pk-pk), whilst the installation of the mooring chains may reach up to 173 re 1 µPa at 1 m (pk-pk), which both roughly equate to RMS values near 21 dB re 1 µPa at 1 m, respectively (Molecular Devices Corp., 2006). These values are recorded at the sound source and received levels are likely to be much lower. As such, the majority of non-percussive installation methods would not exceed the criteria for injury to pinnipeds from continuous sound; rather, they are more likely to exceed the thresholds for disturbance (Table 8.5).

The drilling of bottom foundations for platforms, similar to foundations which may be installed for WECs within the Project Envelope, have been shown to emit the strongest sounds at low frequencies (Richardson *et al.*,1995). In general, drilling noise has been reported to have the majority of its energy below 500 Hz - 1kHz (Kongsberg, 2012; Nedwell *et al.*, 2003 & 2010), which falls within the range of audibility for phocid seals, including grey and harbour seals (Kastelein *et al.*, 2009; NMFS, 2018). For this reason, there remains the potential to elicit a disturbance to seals occurring within the vicinity of the Billia Croo test site; however, as this would not occur at any designated haul-out sites, such disturbance has been ruled out as a potential harassment offence under Section 117 of the Marine (Scotland) Act 2010.

Table 9-6 Seal injury and disturbance thresholds for cumulative sound exposure and sound pressure levels from impulsive and continuous sounds (NMFS 2018)

Hearing group	Type of sound	
	Impulsive sound	Continuous sound
Onset of acoustic injury from cumulative sound exposure level[30] (dB re 1 µPa at 1 ms^{-1})		
Phocid seals (e.g. grey seals and harbour seals)	185	201
Onset of strong disturbance as root mean square (rms)[31] sound pressure (dB re 1 µPa at 1 m)		
All hearing groups	160	120

[30] A measure of cumulative sound exposure levels normalised to 1 second to enable comparisons of noise emissions events which occur for differing durations.
[31] A measure of the source pressure level over time derived from the square root of the mean integrated pressure of a periodic wave, such as those generated by continuous sound sources.

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9.6.3.2 Entanglement in mooring lines or cabling leading to injury or death

There are no records of pinniped entanglements with WECs available in the published literature (Sparling *et al*., 2013). The closest equivalent entanglement records come from seal and sea lion interactions with marine debris, including derelict and active fishing gears (Laist, 1987; Laist, 1997; Kauppinen *et al.*, 2005; Karamanlidis *et al*., 2008; Allen *et al*., 2012; NOAA, 2014). Data indicate that the likelihood of an entanglement event occurring depends upon both the size of the animal making contact with the device and the tension of the mooring lines or cables connecting the device to the seabed (Sparling *et al*., 2013). Entanglement data from moored gears have illustrated that slack lines and cables are more likely to entangle animals than taut ones (Sparling *et al.*, 2013), and this is reflected in pinniped entanglement reports which indicate that these animals are more likely to entangle on marine debris than active gears (NOAA, 2014).

Currently, there are five grid-connected subsea export cables (11 kV) which transfer energy generated at the test berths back to shore. Although the majority of WECs onsite will connect to export cables, not all of the WECs will utilise mooring lines to maintain station or to connect to power cables. Many of the device types anticipated to occupy the 10 berth Billia Croo test site will utilise foundations with pins or piles or gravity-based foundation. Those devices with moorings will be expected to use a minimum four-point mooring system. Additionally, there may be a maximum of three mooring systems which are not directly linked to the devices which may be installed at each test berth (i.e. for mooring project vessels, other infrastructure etc.). The likelihood of an entanglement occurring increases as the number of devices with moorings and the number of moorings across an array increases. The use of synthetic mooring materials, which pose the greatest threat of entanglement, are restricted to 100 tons per device. The mooring system at each array is limited to a total footprint of 0.073km km^2 if the maximum allowable number of devices, electrical hubs and independent mooring systems were to be deployed

The number of seals which would potentially interact with mooring lines is contingent on the movement of seals across the test site, as described in Section 9.3.1 Based on high-resolution seal density data, approximately 1.7 harbour seals and 2.3 grey seals may potentially interact with mooring lines across the 11 km^2 test site at any given time (SMRU, 2016). However, seal numbers are likely to vary in response to environmental factors.

Male grey seals are known to undertake prolonged foraging trips to reach deep water foraging habitat (Thompson *et al.*, 1996), making individuals from this species found in the test site particularly likely to be associated with distant haul-outs. However, given that grey seals around Orkney are known to target deep water demersal species such as cod, plaice and sculpins (Hammond *et al.*, 1994), it is unlikely that the relatively shallow waters of the Billia Croo test site would comprise critical foraging habitat for grey seals in this region. Rather, the area around Billia Croo may serve as a movement pathway to deeper waters in which opportunistic (rather than dedicated) foraging may occur. Thus, connectivity with grey seal haul-outs in the region is likely to be on a temporary basis and not anticipated to impact upon the conservation objectives of any haul outs, which are 'designed to offer protection to seals on land, when they are at their most vulnerable' (Scottish Government, 2014).

Harbour seals predominantly forage within 2 km of their haul-outs, with foraging trip maxima recorded at around 60 km (Thompson *et al*., 1996). Given available information on habitat use by harbour seals (Section 9-3), and as the nearest haul-out is located more than 10 km away from Billia Croo, connectivity with harbour seal features at nearby haul-outs is anticipated to be limited. Moreover, no impacts to the conservation objectives which protect harbour seals at designated haul-outs will result from activities taking place at Billia Croo.

Whilst individual animal's reactions to the devices and other infrastructure (e.g. exploratory versus evasive behavioural responses to novel marine features) would also contribute to the occurrence of an entanglement event; it is unlikely that seals will become entangled with the WECs and other infrastructure based on the low likelihood of physical interactions with mooring and cabling lines and the rapid habituation to novel objects seen in many pinniped species (Bowles and Anderson, 2012).

Furthermore, personnel will be present throughout installation and operational testing to identify any entangled animals which might be caught in the mooring and cabling and determine the best method for removal. This ability to respond quickly should reduce the likelihood of injury or death from entanglement.

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As there is uncertainty about the potential for an entanglement occurring, developers should consider the development of emergency shut-down procedures for their moored or cabled devices, should an entanglement event occur. Proposed mitigation measures are outlined in Table 9-8.

9.6.3.3 Entrapment in devices, multiple mooring lines or cabling leading to injury or death

Entrapment involves an individual becoming trapped within a device or other infrastructure and their moving parts. Devices with large moving parts or cavities potentially pose the greatest risk for pinniped entrapment (Sparling *et al*., 2013). Mooring systems which utilise multiple lines or cables, such as a four-point mooring system, also increase the likelihood of entrapment. As such, device or other infrastructure design plays an integral role in determining the risks associated with entrapment.

Whilst there are no records of entrapment events occurring within WECs, there has not been dedicated monitoring in this regard and, therefore, it is impossible to disregard its potential as an injury mechanism. Behavioural characteristics and the physiology of the species which may interact with the WEC and other infrastructure also affect the likelihood of entrapment occurring. Highly mobile species which regularly utilise at-sea infrastructure as temporary haul-outs (e.g. buoys and platforms), such as the grey seal, may be more likely to attempt to mount a floating WEC. Moreover, individuals which are less risk-averse, and more inquisitive, are likely to have a greater risk of interacting with devices and their moving parts or cavities.

As device/infrastructure design is so important for assessing the likelihood of an entrapment event occurring, appraisal of this impacting factor is highly project-specific. For this reason, this issue will need to be addressed on a case-by-case basis which considers device design to assess the potential impact mechanisms for entrapment at the Billia Croo test site.

This issue requires a project-specific assessment and has not undergone further appraisal herein.

Appraisal conclusion for injury or mortality to grey or harbour seals in Scottish waters: The Billia Croo test site is not directly overlapping with or immediately adjacent to any seal haul-outs, and therefore the potential for committing a harassment offence under Section 117 – 'Protection at Seal Haul-Outs' is considered negligible and therefore not important.

The distance from haul-outs also reduces the likelihood of activities within the Project Envelope generating an injury offence under Part 6 of the Marine (Scotland) Act 2010. Seal injury events resulting from project activities are limited to injuries from mooring installation noise and entanglement. Given the available information on habitat use by both grey and harbour seals, such events are considered unlikely and impacts to the conservation-status of seal populations or fitness of individuals are anticipated to be negligible.

Provided EMEC's SOPs, are followed at Billia Croo, including the management of vessel numbers, activities and mooring use throughout the site, there are anticipated to be no harassment offences against seals at designated haul-outs from use of this site and therefore it is not anticipated that a Seal Licence will be required.

9.7 Habitats Regulation Appraisal

The following section provides the information required by the Competent Authority with regards to HRA. This includes appraisal of:

- The connectivity to a site, either due to proximity to the site or the importance of the test site as a migratory route for the qualifying features of the site;
- The importance of the test site to the biological functions of the qualifying features of the protected site, for example as foraging or breeding habitat; and
- The potential impact pathways of project activities and the relative sensitivities of the qualifying features against those pathways.

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The sites identified as relevant for this appraisal, are the Sanday SAC (49.3 km east-northeast); and Faray and Holm of Faray SAC (38.5 km east-northeast). Given that grey and harbour seals are non-migratory species, the following appraisal will focus on the proximity of the Project Envelope area to these SACs to determine the potential connectivity of project activities to the sites. An appraisal of the significance of potential impacts to both SACs is provided in the sections below.

9.7.1 Mortality impacts

Activities due to take place at the Billia Croo test site which have been identified to be of potential importance to the conservation and management of seal populations in Scotland are presented in Section 9-5. None of the activities which have been identified for further assessment are anticipated to generate instances of mortality to either grey or harbour seals. For this reason, this impact has not undergone further appraisal herein.

9.7.2 Injury impacts

As described in Section 9.6.3, there are three identified sources of potential injury to seals from activities contained within the Billia Croo Project Envelope; they include:

- Underwater noise from foundation/mooring installation methods leading to: auditory injury;
- Entanglement in mooring lines or cabling; and
- Entrapment in devices, multiple mooring lines or cabling.

As potential impacts from entrapment are highly device-specific, this impact has not been appraised herein and will need to be appraised on a case-by-case basis by the developer.

The appraisal on the potential impacts of entanglement on seal populations undertaken in Section 9.6.3.2 found that there would be no significant impacts to grey or harbour seal populations if an injury or mortality event were to occur. Given the test site does not constitute significant foraging habitat to harbour seals, the likelihood of entanglement is low for this species (Section 9.6.3.2). Moreover, the abundance of grey seals within the Orkney Islands is sufficiently high that the potential impacts of entanglement on grey seal populations would be negligible (Table 9-3).

As such, there would be no LSEs on either grey seal features of the Faray and Holm of Faray SAC or harbour seal features of the Sanday SAC from any potential entanglement events. For this reason, it is concluded that there will be no adverse effects to either European site or the Natura 2000 network of sites from project activities and further assessment under HRA is not required.

9.7.2.1 Underwater noise from foundation/mooring installation methods leading to auditory injury

As discussed in Section 9.6.3.1 the installation of foundations or moorings is likely to be the greatest source of sound across the Billia Croo test site. Whilst pile-driving installation methods produce noise emissions which may exceed threshold levels for received noise at around 750 m from the source (Lepper *et al.*, 2012), pin piling and rock-bolt insertion methods, are expected to have much smaller distances over which received levels would be observed. These methods of mooring installation are expected to generate the most noise, as non-percussive drilling has the potential to emit between 145 – 190 dB re 1 µPa at 1 m of continuous sound at the source (OSPAR, 2009). However, these values are recorded at the sound source and received levels are likely to be much lower. As such, non-percussive installation methods are not anticipated to exceed the criteria for injury to pinnipeds from continuous noise (i.e. 201 dB re 1 µPa at 1 m); rather, they are more likely to exceed the thresholds for disturbance (Table 9-6). Disturbance impacts from non-percussive mooring and foundation installation methods and whether or not they generate LSEs to the grey seal features of the Faray and Holm of Faray SAC or harbour seal features of the Sanday SAC is discussed further in Section 9.7.3.

9.7.3 Disturbance impacts

Disturbance of seals associated with the Sanday SAC and Faray and Holm of Faray SAC has the potential to affect the integrity of those sites, should disturbance events cause displacement or impact upon the breeding

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success of those animals. As described in Section 9.7.3, disturbance to seals on land are anticipated to be negligible for activities within the Project Envelope due to the distance of Billia Croo from important haul-outs. However, there is potential for seals to be impacted by disturbances within the marine environment with potential implications for the conservation objectives of European sites designated to protect them. Noise emissions form the leading impact pathway for disturbance to seals. Hearing abilities in phocid seals within the marine environment peak over the following frequency range: 50 Hz – 86 kHz (NMFS, 2018). Sounds falling within these frequencies have an increased potential to generate a behavioural response which may be interpreted as a disturbance.

There are several noise-emissions sources at the Billia Croo test site which have the potential to disturb seals, including: vessels; active acoustic monitoring equipment; WECs; and the installation of foundations or moorings at the test site. Of these, the noise source with the greatest potential to generate a disturbance to seals are the installation of foundations or moorings. However, there is also potential for increased vessel presence generated by overlapping project timelines to generate higher levels of noise which may contribute to disturbance of pinnipeds occurring near Billia Croo.

Noise threshold values have been adopted from available marine mammal auditory data to identify the potential for noise-related disturbances within the test site. These thresholds were developed from *in situ* measurements of Temporary Threshold Shift (TTS) from several pinniped species, including harbour seals (NMFS, 2018). Table 9-6 above summarises the threshold criteria developed to identify the potential for a disturbance from both continuous and impulsive sounds (NMFS, 2018). Disturbances to seals in the marine environment could be detrimental to seal populations if it precludes their use of important habitat or hinders their return to breeding and resting sites. Limiting access to terrestrial haul-outs can be a particularly detrimental if it increases the separation time between mothers and pups, as this decreases the likelihood of pup survival after the weaning period (Jansen *et al.*, 2010).

Disturbance impacts to seals from underwater noise generated by vessels, the installation of foundations and moorings, active acoustic equipment and device operation are assessed below.

9.7.3.1 Underwater noise and presence of installation, decommissioning and maintenance vessel(s), including transiting and manoeuvring, leading to disturbance

Disturbance of seals by vessel presence appears to be limited to idle or anchored vessels near haul-outs and noise emissions from active vessels (Johnson and Acefedo-Gutierrez, 2007). The distance from vessels at which a behavioural response has been recorded in seals differs dramatically between individuals; for arctic seals, responses occurred in the order of a few metres to approximately 2.5 km for arctic seals (McFarland *et al.*, 2017; Marine Scotland, 2014a). However, none of these responses were considered strong disturbance which would significantly impact the distribution or fitness of individuals (McFarland *et al.*, 2017). For this reason, the appraisal of disturbance from vessels within the Project Envelope will focus on vessel noise.

Vessel disturbance is caused by continuous sound emissions from vessel engines which are above ambient levels. A range of vessels will be employed at the Billia Croo test site (See Section 2 and Project Envelope).

There can be negative implications if these noise emissions have frequencies which fall within the audible range of pinnipeds. Larger vessels generate lower frequency noise emissions which generally range from 10 – 100+ Hz. Small to medium vessels (i.e. up to 30 m in length) can generate sounds which range from 20 Hz – 10 kHz (Richardson *et al.*, 1995; Thomsen *et al.*, 2006). Noises generated by both large and small to medium sized vessels are well within the anticipated range of audibility for pinnipeds, and thus there is potential for seals within the test site to incur a strong disturbance, given the anticipated sources levels of these vessels.

It should be noted that this threshold for disturbance is measured at 1 m from the sound source (i.e. within the vessel engine) and the actual received levels are anticipated to be lower. Moreover, the received levels would have to be sufficiently above ambient noise levels to elicit a strong behavioural response which would generate a disturbance per the NOAA (2018) guidelines (Table 9-6). Ambient sounds around Billia Croo will include vessel noise from nearby shipping and vessel traffic lanes, as well as environmental sounds from breaking waves, rain, wind and tidal flow.

The potential disturbance generated by the use of multiple vessels across the site will be managed by the EMEC Standard Operating Procedures (SOPs). The SOPs control developer access and use of the test site

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under a permitting scheme to ensure any risks to health and safety are minimised across Billia Croo. Under this operating plan, a maximum of 12 vessels are permitted to operate on-site simultaneously. However, the prospect of this maximum being reached is small due to the low likelihood that the operating schedules of all permitted vessels will overlap. Those vessels which do overlap in operating time are likely to do so for a short-period.

Given their reduced, declining population, noise-related impacts to harbour seals have the greatest potential to generate population-level consequences (Table 9-3**.**). The Sanday SAC, located approximately 49.3 km east-north-east of Billia Croo, supports a harbour seal population of approximately 1,250 individuals (JNCC, 2015a). Based on available published density data, an average of approximately 2.2 harbour seals may occur within the Billia Croo area at any given time, which is lower than in other areas of Orkney (Table 9-3 and Figure 9-1). As a worst-case scenario, there is potential to disturb less than 0.2% of the population at the Sanday SAC, assuming strict connectivity with this site. However, such exclusive connectivity is deemed highly improbable, given the distance of this site from Billia Croo and the fact that harbour seals generally remain within 2 km of their haul-outs whilst foraging (Thompson *et al*., 1996). Thus, connectivity with the harbour seal qualifying features of the Sanday SAC, located nearly 50 km away, is anticipated to be very limited. Disturbance to this proportion of the population is not expected to have significant or irreversible population-level impacts for harbour seals, nor impact the integrity of the Sanday SAC.

Grey seals may forage upwards of hundreds of km from their haul-outs (Cronin *et al.*, 2012; Thompson *et al*., 1996) and there is evidence of moderate levels of habitat use by grey seals occurring within the Billia Croo test site (Table 9-3 and Figure 9-1). There are many grey seal haul-outs scattered throughout the Orkney Islands, and individuals occupying the test site may or may not be associated with the Faray and Holm of Faray SAC. Given its location approximately 40 km from Billia Croo, it is reasonable to assume connectivity with this site, even if the degree of connectivity is unclear. The Faray and Holm of Faray SAC supports 9% of the annual UK pup production for grey seals, which roughly equates to an average adult population of 7,800 animals (JNCC, 2015b). Density estimates suggest an average of 6.6 grey seals utilising the Billia Croo area. Should all of these individuals emanate from the Faray and Holm of Faray SAC, this would be approximately 0.08% of the population of that site which may experience elevated noise levels from vessels which meet the threshold for disturbance.

Vessels present at Billia Croo are not anticipated to generate sufficient levels of noise to generate a significant disturbance which would impact the conservation of either grey or harbour seals. Disturbance events from vessel activities would be highly constrained to the area comprising the test site and will not impact upon the distribution of grey or harbour seals within their prospective sites. Additionally, vessel disturbance is not anticipated to preclude the free passage of individuals to surrounding habitats of elevated relative importance, such as the islands located to the southeast of Billia Croo, or the use of the habitat therein (Figure 9-1).

For these reasons, it is not anticipated that disturbance to grey seals from vessel noise emissions will generate LSEs to the Faray and Holm of Faray SAC or the Sanday SAC. For this reason, it is concluded that there will be no adverse effects to either European site or the Natura 2000 network of sites from project activities and further assessment under HRA is not required.

9.7.3.2 Underwater noise from foundation/mooring installation methods leading to disturbance

The installation of foundations or moorings is likely to be the greatest source of sound across the Billia Croo test site; however, the restriction of piling and pin insertion installation techniques to non-percussive methods greatly constrains source levels. Pin-piling and rock-bolt insertion for moorings are likely to generate the most noise, as non-percussive drilling can generate between 145 – 190 dB re 1 µPa at 1 m of sound (OSPAR, 2009). Anchor block placements have been recorded to generate maximum sound pressure levels of 167 re 1 µPa at 1 m (pk-pk), whilst the installation of the mooring chains may reach up to 173 re 1 µPa at 1 m (pk-pk). As such, these non-percussive installation methods do not meet the threshold criteria for injury to pinnipeds. However, they have the potential to exceed the thresholds for disturbance.

The drilling of bottom foundations for platforms, similar to foundations which may be installed for WECs within the Project Envelope, have been shown to emit the strongest sounds at low frequencies (Richardson *et al.*,1995). In general, drilling noise has been reported to have the majority of its energy below 500 Hz - 1kHz (Kongsberg, 2012; Nedwell *et al*., 2003 & 2010), which is within the range of audibility for grey and harbour

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seals (Kastelein *et al.*, 2012); however, seals hear best at frequencies between 1-30 kHz (Richardson *et al.*, 2005). For this reason, there remains a limited potential for underwater sound from drilling activities to elicit a disturbance to pinnipeds occurring within the vicinity of Billia Croo.

Cumulative received noise levels will increase with the number of sockets needing to be drilled for monopile installation. Pins may also be used for foundation structures, mooring structures, or to insert rock bolts for the attachment of mooring lines. The maximum number of pins per device is restricted to eight, while a maximum of four piles are allowed per device. It is anticipated that installation of individual pins or piles will take place in succession at a given device. In this way, the cumulative noise emissions would remain low during installation (i.e. only achieving a maximum source level of a single drilling event), but the potential disturbance caused by installation may be slightly prolonged across the device or array.

The Project Envelope is small (approximately 11 km^2) in comparison to the areas comprising important habitat to grey and harbour seals in the Orkney Islands (Figure 9-1). It is not anticipated that installation methods would generate any noise-related disturbances on such a scale as to cause detriment to the maintenance or conservation status of either seal species. Disturbance events from foundation installation will be temporary and will not impact upon the distribution of grey or harbour seals within their prospective SACs nor preclude the free passage of individuals to surrounding habitats of elevated relative importance, such as the islands located to the southeast of Billia Croo, or the use of the habitat therein (Figure 9-1).

Based on the above information, there would be no LSEs on either grey seal features of the Faray and Holm of Faray SAC or harbour seal features of the Sanday SAC from noise emissions from foundation or mooring installations. For this reason, it is concluded that there will be no adverse effects to either European site or the Natura 2000 network of sites from project activities and further assessment under HRA is not required.

9.7.3.3 Underwater noise from active acoustic equipment leading to disturbance

The Project Envelope specifies the potential use of active acoustic devices and associated equipment for survey purposes by developers, as needed. The importance of this impact pathway will depend most upon the intensity of acoustic activity, the frequency of source levels, the duration of surveys, the water depth, and the likelihood and fidelity of pinnipeds in the area and the opportunity for animals to avoid areas of disturbance. Mid to high frequency sounds emitted by geophysical and geotechnical survey equipment (e.g. side scan sonar, single-beam and multibeam echosounders, etc.) have the potential to disturb or, in extreme cases, injure marine mammals. The majority of seismic survey equipment generates pulsed noise emissions which fall between 10 – 300 kHz frequencies (MacGillivray *et al.*, 2014), which is within the range of audibility for phocid seals, such as harbour and grey seals (NMFS, 2018). Although noise emissions from this equipment is unlikely to be sufficiently widespread to have an important effect on pinnipeds, review of the implementation of these technologies should consider all behavioural responses with biological consequences and consultation with the Competent Authority regarding emissions frequencies is recommended.

The use of active acoustic equipment will be highly project-specific, and the particulars of this impact pathway is specified as requiring input from Marine Scotland and SNH in the Project Envelope. For this reason, this issue will need to be addressed on a case-by-case basis which considers the technology required, including characteristics such as source levels and frequencies, to assess the potential impact mechanisms of active acoustic equipment within the Billia Croo test site.

This issue requires a project-specific assessment and has not undergone further appraisal herein.

9.7.3.4 Underwater noise from device operation leading to disturbance

Noise emissions generated by the operation of WECs are poorly understood, and data on the amplitude or frequency of this technology is currently unavailable. Devices will each have a unique acoustic signature reflecting the sum of their moving parts and the mechanics behind their movement in the marine environment. The inclusion of component parts, such as hydraulics, pressurised fluids, turbines or generators, is likely to increase noise emissions from devices (Patricio *et al.*, 2009). Moreover, device design which includes cavitation may generate additional vibrational noise when waves hit the device.

Some of wave device types captured in the Project Envelope will generate impulsive sounds at varying scales from their mechanical movement in the water column; these include: oscillating wave surge converters,

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submerged pressure differentials, and point absorber devices. Whilst others, such as the rotating mass may generate continuous noise. Devices which employ turbines, such as the overtopping and oscillating water column devices, may generate intermittent continuous noise when the turbines are operational.

Radiated noise from the operation of WECs is unlikely to cause significant behavioural impacts to pinnipeds over great distances (Robinson and Lepper, 2013). However, source levels for operational wave devices have been estimated as falling between 165 - 175 dB re 1 µPa at 1 m (OSPAR, 2009), which exceeds the acoustic threshold for a strong disturbance to pinnipeds from both continuous and impulsive noise (Table 9-6; NOAA, 2018; NMFS, 2016; JNCC, 2014). In contrast, preliminary acoustical recordings of WECs at Billia Croo have shown peak Third Octave Band (TOB) sound pressure measurements as peaking around 150 dB re 1 μPa^2/Hz at 1 m (EMEC Acoustic Characterisation Report, 2012). Moreover, there was ample variation in noise emissions generated by the WECs due to interactions with the marine environment altering the generation of sound; however, in all instances, the WECs did not reach source levels which meet the threshold for a strong behavioural response.

The potential magnitude of sound generated by operational devices will be further limited by their deployment as prototypes for testing, rather than commercial scale devices which are expected to be continuously operational. Measurements of the acoustical environment at Billia Croo suggests high levels of variability across the site from commercial vessel presence, including the regular passage of ferries out of Stromness, and surf noise (EMEC Acoustic Characterisation Report, 2012). Ambient noise levels (TOB) were recorded as being above 160 dB re 1 μPa^2/Hz at 1 m on occasion due to environmental factors. In such instances, noise from operational WECs would be sufficiently below ambient levels to diminish the likelihood of a disturbance response from seals.

Given that strong disturbance to seals from noise emissions from WECs is unlikely, it is not anticipated that any of the conservation objectives for the Sanday SAC or Faray and Holm of Faray SAC will be impacted by underwater noise from device operations. Noise-related disturbances from operational devices are not anticipated to generate LSEs to either site. For this reason, it is concluded that there will be no adverse effects to either European site or the Natura 2000 network of sites from project activities and further assessment under HRA is not required.

Appraisal conclusion for grey and harbour seals as qualifying species of European sites: The Billia Croo test site is not directly connected with, or necessary to site or conservation management of, any SAC in the UK.

The activities within the Project Envelope are not anticipated to generate any mortality or injury events. Disturbance from underwater noise generated by vessels, installation and decommissioning methods and WEC and other infrastructure operation are not anticipated to occur on a scale as to adversely impact the seal qualifying features of the Sanday SAC or Faray and Holm of Faray SAC.

There will be no LSE on grey seals or harbour seals as a qualifying feature of any SAC. For this reason, it is concluded that there will be no adverse effects to either European site or the Natura 2000 network of sites from project activities and further assessment under HRA is not required.

9.8 Appraisal of natural heritage features

This section addresses impacts which haven't been covered under the legal requirements of the Marine (Scotland) Act 2010 in earlier sections. It comprises an assessment of barrier effects at Billia Croo which is the only other impact requiring appraisal.

9.8.1 Presence of WEC(s) and other infrastructure leading to barrier effects

Data deficiencies regarding the behavioural response of pinnipeds to WECs makes it difficult to assess the potential for their generation of barrier effects to these species. Wildlife observations data at Billia Croo do not demonstrate site-fidelity for observed individuals, rather pinniped habitat use of the region encompassing the

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test site appears to be temporary (EMEC wildlife observations data 2009 – 2015). Although both grey and harbour seals have been recorded in the Project Envelope area in varying relative abundance, the sightings data does not suggest that this region is of particular importance to harbour seals comparted to their greater natural occurrence, and is only moderately used by grey seals (Figure 9-1.).

The location of the test site is not proximal to any regions requiring passage, such as sea lochs or straits, and only spans 4.5 km offshore to waters approximately 50 – 60 m in depth. As such, the risk of a barrier effect precluding individuals from utilising habitats to the north or south of the test site is considered very low because all pinniped species occurring in the region are capable of swimming around the test site. The risk of a barrier effect at the Billia Croo test site is further reduced by the fact that a large portion of the test site area is either undeveloped or only cabled below the seabed and therefore available for passage. Assuming the absence of disturbance effects, such as avoidance behaviours, the separation between berth sites would not exclude the potential for passage between them. Disturbance responses would likely be limited in time, due to the intermittent nature of device operation at the test site. Consequently, it is considered that the potential for barrier effects to pinniped receptors would not generate significant population or management scale impacts.

Analysis of any device-specific or site-wide wildlife observation data collected in future can help shed further light on pinniped movement throughout the site. Moreover, biologging, or tagging, studies are able to offer information on seal behavioural responses to WECs in the form of fine-scale movement data. Finally, information on the potential impacts of WECs on seal distributions, particularly on-land, can be taken from historical and continued records of pup counts at the nearby Warebeth Beach to identify potential changes in distribution and habitat use from the period prior to the development of Billia Croo.

Appraisal conclusion for grey and harbour seals as other natural heritage features: The appraisal considers the potential for barrier effects on grey and harbour seals to be negligible and not to generate any important population-level impacts.

9.9 Appraisal of cumulative impacts

For impacts to pinnipeds, the relevant cumulative impact pathways include other sea users which have the potential to generate noise emissions which may compound the installation and vessel noise emissions at the test site. Relevant impact mechanisms may include recreational or commercial vessels (e.g. maintenance vessels, ferries, etc.) and construction activities. (i.e. the installation of pilings, etc.). Whilst a potential impact mechanism in some instances, MOD activities are considered outwith the range as to generate cumulative impacts with activities taking place at Billia Croo.

Vessel activity by other sea users will be limited within the Billia Croo test site area. The region is not targeted by recreational sea users, for example for fishing or wildlife watching activities. The 2019 NRA reports that most recreational crafts encountered in the vicinity of the Project Envelope tend to be on passage past Billia Croo and that most choose to pass either inshore or offshore of the test site (Marine Risk Consultants Ltd, 2019). Boating intensity for recreational crafts in the Project Envelope is classed as low, with less than 400 recreational boats passing within 500 m of the Project Envelope annually (Marine Risk Consultants Ltd, 2019).

There is some commercial vessel activity which has the potential to introduce cumulative impacts with Project vessel activities. This includes ferry vessels and vessels used for operations and maintenance at nearby aquaculture sites. The nearest ferry vessel transit lanes are those of the Stromness-Scrabster, Stromness-Graemsay, and Stromness-North Hoy ferry routes, located 2 km south, 6 km south-east, and 4 km south-east of the test site, respectively (Table 3-2). Although ferry vessels may be large and introduce a greater disturbance than some of the vessels described in the Project Envelope, these vessels are not anticipated to dramatically deviate from their set routes. Moreover, vessels which pass more closely to the test site, such as those along the Stromness-Scrabster route, will form a temporary disturbance mechanism which is unlikely to compound potential noise emissions at Billia Croo to such an extent as to generate significant disturbance to pinnipeds. Neither the test site nor transiting ferry vessels will generate barrier effects, so individuals can avoid any temporary elevation in underwater noise levels by utilising the surrounding habitat. For this reason, potential disturbance impacts from temporal overlap between noise-generating activities at the test site and

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transiting ferry vessels will be highly constrained and are not anticipated to generate cumulative disturbance impacts to pinnipeds across the test site area or the surrounding waters.

Similarly, to transiting ferry vessels, maintenance vessels servicing nearby commercial infrastructure, such as aquaculture sites or submarine cables, may generate underwater noise which has the potential to compound noise emissions at the test site. The nearest aquaculture site by vessel (i.e. not over land) is the Bring Head Fish Farm located 9 km south-east of the test site (Table 3-2). Five km north-east of the test site lies the Northern Lights telecommunications cable. Vessels likely be deployed for the maintenance or operations of either commercial location are anticipated to be small to medium in size (i.e. likely 15-35 m in length). As such, they are expected to generate lower-pressure, high frequency sounds which will attenuate rapidly within the marine environment. Vessels of these sizes are not considered to constitute sources of significant disturbance to marine mammals. For this reason, vessel noise from operational aquaculture sites and the maintenance of nearby submarine cables will not introduce cumulative impacts to pinnipeds through noise-related disturbance.

The Stromness A dredge disposal site is located 2 km south-west of Billia Croo; it may be visited from time-to-time by local dredgers. Given its location (Figure 3-2) vessels utilising this site are likely to drive within closest proximity to the test site compared to any other commercial sea users. Dredgers servicing Stromness harbour and the nearby ferry lines, which are likely to be large vessels (e.g. 50 – 80 m), may intermittently utilise this disposal site to dump dredge material. Noise emissions from the dredge vessel engine are anticipated to drown out noise generated by the dumping of dredge material. However, underwater noise emissions from the dredge vessel engine will be limited in temporal scale to the duration of the transit to and from Stromness A and the duration of the dumping of dredge material. Such potential disturbances are not anticipated to be as frequent as the nearby passing ferries. For this reason, there is limited scope for use of the proximal dredge disposal site to compound noise emissions generated at Billia Croo which have been identified as having the potential to disturb pinnipeds.

Several construction projects are anticipated to take place which may overlap with noise-generating installation activities at Billia Croo. Planning is in place for the construction of a fishing industry building at the Kirkwall Pier, 23 km due directly east (straight-line distance) of the test site (Table 3-2). As well, both Longhope Pier (more than 20 km south-east; straight-line distance) and Pierowall Pier (45 km north-east; straight-line distance) are expected to undergo pier repair works in the near future (Table 3-2). Installation and repair of these harbour structures may include some noise from piling installation, which may include percussive and/or non-percussive piling. Additionally, the N1 ScotWind leasing area is approximately 20 km from Billia Croo which have the potential to experience large-scale foundation piling for wind farms over the next several years; however, it should be noted that there are no plans currently in place for the development of these sites.

As a worst-case scenario, percussive piling may generate underwater noise which can be heard up to 50 km away in an open water environment (Bailey *et al.*, 2010); however, noise emissions at the harbour works sites or potential forthcoming windfarms will be dampened through repeated refraction off the shallow seabed, and surrounding coastline and nearby islands. Furthermore, the potential to generate noise emissions which might cause significant disturbance to pinnipeds will be limited to within the immediate area surrounding the noise source (Nehls *et al.*, 2016). Therefore, noise emissions generated by piling activities at nearshore and offshore construction sites in the wider area are unlikely to travel to the Billia Croo test site and are not anticipated to generate significant disturbance effects to pinnipeds which would be detrimental to the maintenance or conservation status of pinniped populations. Moreover, mitigation measures, including the monitoring of pinniped species during installation activities, will limit the potential for individuals to be subjected to elevated noise levels at Billia Croo. As such, significant disturbance impacts are not anticipated to result from any construction activities, including piling, occurring in the wider area.

For these reasons, cumulative impacts to pinnipeds from other sea users will not be detrimental to the maintenance of any pinniped populations at Favourable Conservation Status across their natural range.

Appraisal conclusion for cumulative impacts on grey and harbour seals: In review of activities undertaken by other sea users, it is considered that cumulative disturbance impacts from commercial or recreational vessel presence or construction activities near the test site and surrounding waters are minimal

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and will not be detrimental to the maintenance of the population of the species concerned at Favourable Conservation Status across their natural range.

Mitigation measures to monitor the occurrence of pinnipeds throughout the test site, particularly during installation activities, will help minimise the potential for disturbance impacts to individual animals from test site activities and their potential overlap with the activities of other sea users.

9.10 Receptor conclusion

A summary of the appraisal for each of the receptors is provided in Table 9-7 below. Note that, even where no important impacts on the development site are identified, in some cases there may still be a recommendation for mitigation or monitoring. Under these circumstances, mitigation is regarded as good-practice, while monitoring may serve to improve generic understanding of the relationships between stressors and receptors. Where mitigation or monitoring is considered to be a likely licence or condition of consent this is highlighted in Table 9-8.

Table 9-7 Summary of pinnipeds appraisal conclusions

Receptor	Appraisal conclusion	Applicable Monitoring and Mitigation
Grey and harbour seals	No important impacts predicted which would generate LSEs to seals as qualifying features of any European sites. No important impacts identified to seals at haul-outs or to other natural heritage features	Yes see Table 9-8
Grey and harbour seals	No important cumulative impacts are anticipated	Yes see Table 9-8

No important impacts are predicted because of the proposed activities a Billia Croo, as described in the Project Envelope. Recommendations have been captured in the mitigation and monitoring strategies outlined in Table 9-8 below. However, the conclusion reached in all cases is that potential disturbance impacts will not be detrimental to seals at haul-outs or as qualifying features of SACs, and no injury or mortality impacts are anticipated from any of the activities contained within the Project Envelope.

Site-wide monitoring and research ideas may be more effectively pursued at a strategic level (by EMEC/Crown Estate Scotland/Marine Scotland/developer consortium), but developer input or ideas are welcomed.

Project-specific assessments are required for aspects of the following impact pathways and, thus, each developer will need to identify any appropriate mitigation and/or monitoring in response to:

- Use of active acoustic equipment;
- Employment of percussive piling methods;
- The requirement for an MMO will be dealt with on a case by basis; and
- The potential for injury from entrapment in devices.

Overall, injury impacts to pinniped receptors are not anticipated to be important, particularly with the implementation of the mitigation measures outlined in Table 9-8. Disturbances to seals are unlikely and will not generate important impacts to seal populations or LSEs to European sites with seal features. Assessment under the Marine (Scotland) Act 2010 has been carried out and the requirement for a Seal Licence is not considered necessary as no disturbance is predicted to seals within designated sites (including seal haul outs). The mitigation measures outlined above will further reduce the likelihood of a disturbance event occurring at Billia Croo.

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Table 9-8 Suggested mitigation and monitoring

Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licence requirement / Likely condition of consent	Explanation
Disturbance from underwater noise	Grey and harbour seals	Installation, decommissioning and maintenance vessel(s) transiting and manoeuvring	Vessel movements and occupancy within the Billia Croo test site will be managed through EMEC's SOPs. The SOPs limit the number and size of vessels which can utilise the test site simultaneously. All shipboard personnel will be trained in the SMWWC to ensure they can recognise seals and respond accordingly any signs of distress (i.e. by moving away from the animal) to limit the potential for any harassment to seals.	Yes	SOPs will be used as good practice. The SOPs limit the numbers and sizes of vessels which can utilise the test site simultaneously, as well as put in place a traffic management scheme to minimise vessel overlap. This mitigation measure should reduce the potential impacts of cumulative noise from vessel activity onsite.
			A VMP, which includes a traffic management scheme, will be included as a part of the PEMP. Its implementation will minimise vessel overlap and provide further mitigation against noise impacts to seals. This includes limiting vessel speed and providing a conservative buffer zone of 500 m around designated seal haul-outs.	Yes	A VMP is required as part of the PEMP.
		Foundation/ mooring installation and decommissioning methods	The requirement for an MMO for installation and decommissioning activities will be considered on a case by case basis. For the activities presented in the Project Envelope, the only likely requirement for an MMO will be for pin piling. If an MMO is required for installation activities, the EMEC MMO protocol will be utilised (SOP074). The MMO procedures will include the deployment of a dedicated MMO with protected species observation skills (as per standard MMO training) prior to and during device installation. This will include a soft-start ramp up of piling noise to give animals time to move away from the noise	Yes, but most likely only for pin piling activities.	This is considered best practice for mitigating against potential noise impacts from installation and decommissioning activities.

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Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licence requirement / Likely condition of consent	Explanation
			source. Additionally, training of all vessel personnel in the SMWWC will enable identification of basking sharks from all vessels on-site.		
		Device operation	Noise monitoring for specific devices.	No	To assess the occurrence of seals and their behavioural responses (i.e. aversion or attraction) to WECs and other infrastructure.
Injury from entanglement	Grey and harbour seals	Mooring lines and cabling	Continued monitoring of habitat use by seals. On-site monitoring will enable identification of seals from at-sea vantage points. In the event of entanglement, Marine Scotland and SNH should be consulted.	No	This impact pathway is considered unlikely, due to the low risk level entanglement in mooring lines poses to seal receptors. However, this monitoring measure is recommended to gain further information about the likelihood of entanglement occurring at Billia Croo.
			Developers are urged to develop emergency shut-down procedures for moored or cabled devices with high risk of entanglement, should an entanglement event occur.	Possible	As there is still uncertainty regarding the potential for seals to become entangled in WEC moorings and cables, monitoring and emergency shut down procedures will enable developers to rapidly respond to any potential entanglements, with guidance from Marine Scotland and SNH.

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10 ORNITHOLOGY

Stage 1 of this appraisal defined the categories of potential effect as presented in Table 3-1. The appraisal now picks up at Stage 2 of the methodology where effect pathways and importance are identified as described in Section 3.

This appraisal considers all effects on birds using the marine environment and also the effects of offshore lighting on migrant land birds. The examination of potential effects of the onshore elements of the EMEC Billia Croo facility on birds is not part of this EA.

10.1 Key data sources:

The following is a list of the key data sources and references which have been used to inform the ornithology EA and HRA:

- EMEC Wildlife Observation Data (raw data; Robbins, 2012; Long, 2017);
- Information on numbers and distribution of seabirds in UK waters. (Kober *et al*., 2010),
- Digital aerial survey data of seabirds recorded in October and November 2014 in vicinity of Billia Croo (HiDef Ltd.2015). Applicability of strategic digital aerial survey at sea of marine mammals and seabirds in Scotland. DOI: 10.7489/1779-1);
- Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). (Furness, 2015);
- Seabird foraging ranges as a tool for identifying Marine Protected Areas. (Thaxter *et al*., 2012)
- Seabird populations of Britain and Ireland. (Mitchell *et al*., 2004);
- SNH SiteLink website (https://sitelink.nature.scot/home);
- JNCC web site, SPA pages. (http://jncc.defra.gov.uk/page-1402); and
- Information on the behavioural responses of wintering waterbirds in Orkney to marine activity (Jarrett *et al*., 2018).

10.2 Potential effects

The use of the Billia Croo for the deployment of wave energy devices, other infrastructure and associated activities, as described in the Section 2: Project Envelope, has the potential to affect bird receptor populations through a variety of impact pathways.

The potential effects of wave energy projects on seabirds are identified as habitat loss and change, disturbance (including by visual and noise including from vessel movements and lighting of devices and vessels), displacement and attraction effects and the accidental release of contaminants into the marine environment. These potential effects vary in their nature with regard to likelihood, duration, magnitude and whether or not the affect is adverse or beneficial. Furthermore, the vulnerability to these potential effects varies from one bird species to another and seasonally (Williams *et al*., 1995; Garthe and Huppop, 2004; Furness *et al*., 2012; McCluskie *et al*., 2012). Potential deployment, installation and decommissioning effects are examined in Table 10-1 in terms of the project activities causing the effect, the nature of the effect, the bird species potentially affected and the potential importance of the effect on receptors. Similarly, potential effects on birds arising during the operational and maintenance phase are summarised in the same way in Table 10.2. It should be noted that some potential effects are relevant to all phases and therefore occur in both these tables. The species considered in Tables 10-1 and 10-2 are limited to those that could potentially be affected by the Billia Croo facility. Note that details specific to Billia Croo, relating to project specifications, are not considered until the detailed appraisal later in this section.

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Table 10-1 Potential effects on birds from device installation and decommissioning

Activity / potential effect pathway	Bird natural heritage feature (bird group or species)	Potential importance and reasoning
Installation vessel(s) presence, manoeuvring and travelling to/from test site, leading to temporary disturbance and resulting in displacement from feeding /resting habitat This may impact birds' energy budgets and hence survival and/or reproductive potential leading potentially to population level impacts.	> Auk species (common guillemot, razorbill, Atlantic puffin, black guillemot and little auk) > Diver species > European shag > Duck species	**Potentially important:** > These species have moderate to very high vulnerability to disturbance by vessels (Furness *et al*., 2012; Jarrett *et al*, 2018; Mendel *et al*., 2019). > Common eider, common guillemot and razorbill have additional vulnerability when they have attendant dependent young (typically June - August) and during their annual wing moult when they are flightless (typically July - September). > Importance will depend upon intensity and regularity of vessel activity, the importance of the location for the species, the time of year and the degree of species-specific connectivity with designated sites.
	> All other species	**Not important:** > These species are unlikely to be vulnerable to vessel disturbance (Furness *et al*., 2012).
High intensity work lights on project vessels to facilitate night working leading to: > Disorientation of nocturnally active birds, especially during conditions of low visibility,	> Manx shearwater and petrel species > Atlantic puffin > Seaduck species > Migrant land birds	**Potentially important:** > Fledglings of burrow nesting species (e.g. Manx shearwater, European storm petrel and Atlantic puffin) are vulnerable to disorientation by bright lights up to 10 km from colonies. > Migrant land birds some sea duck species (e.g. eider and long-tailed duck) can be attracted to high intensity lighting on vessels, especially in low visibility (Merkel, 2010).

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Activity / potential effect pathway	Bird natural heritage feature (bird group or species)	Potential importance and reasoning
> Collision by flying birds with surface-piercing elements leading to injury or death.	> All other seabird species	**Not important:** > These species are unlikely to show a response to vessel and navigation lighting.
Seabed habitat loss, change and creation of artificial reef leading to: > Changes in prey availability. > Artificial reef may enhance feeding opportunities.	> Black guillemot > Diver species > European shag > Sea duck species (common eider and long-tailed duck)	**Potentially important:** > These species regularly forage on or close to the seabed for benthic /demersal prey and are thus are potentially vulnerable to loss or change of seabed habitat. > The size of the areas seabed potentially affected by wave devices and infrastructure are likely to be very small in the context of the areas of seabed foraging habitat available. > Negative effects of seabed habitat loss may be offset by positive effects of seabed artificial reef habitat creation.
	> All other species	**Not important:** > These species are unlikely to be vulnerable to small-scale changes to seabed habitat as they typically forage either at the sea surface, or in the water column well above the seabed (Furness *et al*., 2012).

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Activity / potential effect pathway	Bird natural heritage feature (bird group or species)	Potential importance and reasoning
Accidental release of contaminants leading to death or reduced fitness through plumage fouling or poisoning.	> All species using sea surface or water column	**Potentially important:** > All species of birds using the marine environment are vulnerable to pollution events involving oil and other contaminants. > Surface active birds such as European shag, divers, Northern fulmar, seaducks and auk species have particularly high vulnerability. > Common eider, common guillemot and razorbill have additional vulnerability when they have attendant dependent young (typically June - August) and during their annual wing moult when they flightless (typically July - September). > Given the relatively small volumes of potential contaminant contained in wave devices and project vessels, any incident is likely to be of small scale only. > Deployment of wave energy devices is only likely at relatively exposed locations; thus, any contamination incidents are likely to be dispersed relatively quickly.

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Table 10-2 Potential effects on birds from operations and maintenance

Activity / potential effect pathway	Bird natural heritage feature (bird group or species)	Potential importance and reasoning
Installation vessel(s) presence, manoeuvring and travelling to/from test site, leading to temporary disturbance and resulting in displacement from feeding /resting habitat and lost time and energy.	> Auk species (common guillemot, razorbill, Atlantic puffin, black guillemot and little auk) > Diver species > European shag > Duck species	**Potentially important:** > These species have moderate to very high vulnerability to disturbance by vessels (Furness *et al*., 2012; Jarrett *et al*, 2018; Mendel *et al*., 2019). > Common eider, common guillemot and razorbill have additional vulnerability when they have attendant dependent young (typically June - August) and during their annual wing moult when they are flightless (typically July - September). > Importance will depend upon intensity and regularity of vessel activity, the importance of the location for the species, the time of year and the degree of species-specific connectivity with designated sites.
	> All other species	**Not important:** > These species are unlikely to be vulnerable to vessel disturbance (Furness *et al*., 2012).
High intensity work lights on project vessels to facilitate night working leading to: > Disorientation of nocturnally active birds, especially during conditions of low visibility. > Collision by flying birds with surface-piercing elements leading to injury or death.	> Manx shearwater and petrel species > Atlantic puffin > Seaduck species > Migrant land birds	**Potentially important:** > Fledglings of burrow nesting species (e.g. Manx shearwater, European storm petrel and Atlantic puffin) are vulnerable to disorientation by bright lights up to 10 km from colonies. > Migrant land birds some sea duck species (e.g. eider and long-tailed duck) can be attracted to high intensity lighting on vessels, especially in low visibility (Merkel, 2010).
	> All other species	**Not important:** > These species are unlikely to show a response to vessel and navigation lighting.

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Activity / potential effect pathway	Bird natural heritage feature (bird group or species)	Potential importance and reasoning
Navigation lighting > Disorientation of nocturnally active birds, especially during conditions of low visibility.	> All species	**Not important:** > No species is likely to show more than a negligible response to the lighting installed for vessel navigation safety. The lighting of WEC devices should comply with Northern Lighthouse Board's aids to navigation strategy. Note that the lighting for WEC devices is significantly different to the lighting required for offshore windfarms and oil rig platforms, which require lights for aviation as well as vessel navigational safety.
Seabed habitat loss, change and creation of artificial reef leading to: > Changes in prey availability, > Artificial reef may enhance feeding opportunities.	> Black guillemot > Diver species > European shag > Seaduck species (e.g., eider, long-tailed duck)	**Potentially important:** > These species regularly forage on or close to the seabed for benthic / demersal prey and are thus potentially vulnerable to loss or change of seabed habitat. > The area of seabed potentially affected by wave devices and infrastructure would be very small in the context of the areas of seabed foraging habitat available. > Negative effects of seabed habitat loss may be offset by positive effects of seabed habitat creation through artificial reef habitat.
	> All other species	**Not important:** > These species are unlikely to be vulnerable to small scale changes to seabed habitat as they typically forage either at the sea surface, or in the water column well above the seabed (Furness *et al*., 2012).

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Activity / potential effect pathway	Bird natural heritage feature (bird group or species)	Potential importance and reasoning
Accidental release of contaminants leading to: death or reduced fitness through plumage fouling or poisoning.	> All species	**Potentially important:** > All species of seabirds are vulnerable to pollution events involving oil and other contaminants. > Surface active species such as shag, diver, seaduck and auk species have particularly high vulnerability. > Common eider, common guillemot and razorbill have additional vulnerability when they have attendant dependent young (June - August) and during their annual wing moult when they flightless (typically July - September). > Given the relatively small volumes of potential contaminant contained in wave devices and project vessels, any incident is likely to be of small scale only. > Deployment of wave energy devices is only likely at relatively exposed locations; thus any contamination incidents are likely to be dispersed relatively quickly.

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10.3 Natural heritage context

10.3.1 Spatial context

For this EA it is relevant to examine the ornithological natural heritage context of the area potentially affected by the project at a range of spatial scales. The generally high energy, nutrient rich status of the seas around Orkney supports a rich and abundant marine life including high numbers of marine birds year-round. The Orkney waters are part of a much wider marine area extending around the coast of Scotland that has international importance for its populations of several seabird species. This importance is formally recognised by the numerous sites that have been designated under international legislation (e.g. EU Birds Directive and Ramsar Convention), to protect breeding sites (Figure 1.2), foraging grounds and wintering areas. Thus, the Billia Croo Project Envelope comprises a small area lying approximately centrally within a very much large marine area, extending up to a few hundreds of kilometres all around, of high importance to seabirds.

With few exceptions (e.g. black guillemot), seabirds such as auks, gannets, fulmars and petrels are highly mobile species, both during the breeding season when they may travel distances of up to several hundreds of kilometres (depending on species) distances from breeding colonies to foraging areas (Thaxter *et al*., 2012), and at other times of year when they typically disperse to alternative sites or become nomadic (e.g. Furness, 2015; Wareham *et al*., 2002). Additionally, many waterfowl species migrate substantial distances between summer breeding grounds and wintering areas at sea. This high mobility leads to connectivity between different marine areas, for example a seabird colony and feeding grounds, and between breeding grounds and wintering areas. This connectivity needs to be taken into consideration in this EA, for example when examining if the Project Envelope is likely to be important for individuals that are part of the qualifying interest of designated sites.

10.3.2 Baseline surveys

The use by seabirds of the Billia Croo test site and immediately adjacent surrounding waters (for convenience these surrounding waters are included in reference to the test site unless otherwise stated) is summarised below. The information on the occurrence of birds in the test site is based on the results of the EMEC Wildlife Observation survey programme undertaken between 2008 and 2015 (Robbins, 2012; Long, 2017). These surveys recorded birds in a study area approximately centred on the existing offshore lease site (as of February 2019 – see Figure 1.1) and including surrounding area extending eastwards to the coast (and thereby covering the inshore lease area) and in other directions to approximately one kilometre. The survey programme consisted of regular systematic shore-based observation scans from an elevated vantage point on the coast to the east of the test site. The survey area gave coverage of the whole of the lease site and approximately half of the proposed extension area (Figure 1-1). The outer part of the extension area and those parts within approximately 400 m of the coast were not effectively covered by surveys, either because they were too far from the vantage point to efficiently detect and identify birds or they were not visible from the vantage point.

In October and November 2014, the Billia Croo test site and a surrounding buffer was covered by aerial survey using high definition video (Hi Def, 2015). In addition, the waters off the west coast of Orkney Mainland and of Hoy Sound have been in part covered by boat-based European Seabirds at Sea (ESAS) surveys, and these data have contributed to the national ESAS data held by JNCC and used to map the distribution and abundance of seabirds around the UK (e.g. Kober et al, 2010, Lawson et al., 2015).The overview of the ornithology relevant to Billia Croo and the species accounts that follow are based on the results of these surveys.

10.3.3 Overview of ornithological interests

10.3.3.1 Number of species

The bird surveys show that the test site (and the immediately adjacent surrounding waters) is regularly used by 22 species of bird (regular use is defined as recorded at least once a year during the seven-year EMEC Wildlife Observation survey programme). Several other species, all migratory, were recorded irregularly using or passing through the test site in very small numbers only (in all cases there were <10 records over the survey

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period, mostly of single birds). These species were mostly seen in the autumn or winter months and included: Leach's petrel, sooty shearwater, grey phalarope, Sabine's gull, lesser black-backed gull (summer months), Iceland gull, glaucous gull winter months and pomarine skua. The test site is not considered to have any particular importance to sustaining the populations of these species and they are therefore not considered further in the appraisal.

10.3.3.2 Behaviour

The test site is used by birds throughout the year, primarily for foraging. Birds also use the area for resting, though in most cases this is likely to represent short periods of inactivity between foraging bouts, rather than birds deliberately seeking out the area as a rest site. Birds also commonly transit through the test site, typically by flying. During such transits, although birds are not as such using the site or exploiting its resources, they may nevertheless still be vulnerable to some of the potential project impact pathways.

The birds that use the test site use a variety of feeding methods. Diver species, shag, auk species, common eider and long-tailed duck all feed by diving from the surface to search for fish or invertebrate prey underwater. Of these, the diver species, European shag, black guillemot, common eider and long-tailed duck normally target benthic or demersal prey and as a consequence profitable foraging is usually limited to the relatively shallow areas. Typically, they select areas where the depth to the seabed does not exceed 30 - 40 m (there is some variation in depth tolerance between species). The immediate vicinities of the project's five offshore berths (Berths 1 to 5) have seabed depths in excess of 40 m and thus these areas are unlikely to be attractive foraging habitat for seabed-foraging species.

Northern gannets, gulls, terns, skuas and shearwaters, petrels all search for prey in flight, either dipping down or alighting on the surface to peck items from the surface or plunge diving to below the surface to catch fish (in particular gannet and terns). Northern gannets and Manx shearwaters may at times also swim down to some depth to catch prey, propelling themselves with their wings. The two skua species also chase smaller seabird species to steal prey from them. Some great skua individuals will also prey on small seabird species including auks.

10.3.3.3 Seasonality of occurrence

Many of the bird species that use the test site area show strong seasonal variation in their abundance. For example, seven species regularly occur only during the breeding season months and five species only during the non-breeding (autumn/winter) period.

During the breeding season (approximately April to August or September for most marine bird species) the site is regularly used for foraging and resting by 17 species of seabird that breed locally or in the wider region. The species most commonly present in summer are northern fulmar, European shag, northern gannet, black-legged kittiwake, herring gull, great black-backed gull, Arctic tern, great skua, Arctic skua, common guillemot, razorbill, Atlantic puffin and black guillemot. [redacted] Manx shearwater, European storm petrel, lesser black-backed gull and common eider, all of which breed either locally or regionally, also use the site in small numbers in the breeding season.

In the winter months (approximately corresponding to the period November to March) the site is regularly used by overwintering seabirds. These include some of the same species that are present in the breeding season such as northern fulmar, northern gannet, European shag, black guillemot, common guillemot, herring gull, great-black-backed gull, though in most cases at reduced abundance. Common eider is unusual in showing greatest abundance in the winter period. The occurrence of five other regularly occurring species, albeit all in low numbers only, is largely confined to the winter months. These species are: great northern diver (occasionally seen in spring and summer also), long-tailed duck, Eurasian wigeon, common gull and little auk.

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10.3.4 Categorisation of importance

The results of the surveys combined with other information are also used to determine the value of the test site (and immediately adjacent surrounding waters) to seabird species populations. Due to the lack of equivalent survey data for other areas in the wider region; it is not possible to determine the absolute value of the test site to a species. However, the approximate value is apparent from considering the frequency of encounter and numbers of individuals seen during surveys and published information on regional breeding and winter population sizes and a species' habitat preferences and behaviour.

The categorisation of the importance of the test site and its immediate vicinity to species is determined from examination of survey results in the context of information on population size and foraging behaviour. Due to the imprecise nature of some of the information, expert judgement has also been factored into categorising importance. The following definitions were used to guide categorisation:

- Negligible importance – Site used by extremely small numbers of individuals in the context of the population size (<0.1%) and is likely to make a very extremely small contribution (<0.1%) to populations' foraging requirements or resting habitat.
- Very low importance – Site used by very low numbers of individuals in the context of the population size (<1%) and is likely to make a very small contribution (<1%) to populations' foraging requirements or resting habitat.
- Low importance – Site used by low numbers of individuals in the context of the population size (approx. 1-5%) and is likely to make a small contribution (approx. 1-5%) to populations' foraging requirements or resting habitat.
- Moderate – Site used by moderate numbers of individuals in the context of the population size (approx. 5-20%) and is likely to makes a moderate contribution (approx. 5-20%) to populations' foraging requirements or resting habitat.

10.3.5 Species accounts

10.3.5.1 [redacted]

[redacted]

10.3.5.2 Great-northern diver

Small numbers of great-northern diver regularly forage in the test site area during the non-breeding period of the year (mainly between November and March). Most records are within 1.5 km of the coast in waters of <40 m depth. The maximum number seen in the study area was four birds. More typically the maximum number present was only one or two individuals, and none were seen on the vast majority of observation scans. This species is also occasionally seen in the breeding season months; these are presumably immature non-

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breeding birds that have not migrated back to the breeding grounds. It is concluded that the Billia Croo test site area has very low importance for this species.

Great-northern diver do not breed in the UK, the closest breeding grounds are in Iceland, Greenland and eastern Canada.

Non-breeding (wintering) great-northern divers are a qualifying interest of the Scapa Flow pSPA and North Orkney pSPA (see section 10.4.1: HRA screening).

Recent survey work found approximately 1,000 birds winter in the Scapa Flow pSPA (Jackson, 2018), approximately 780 in North Orkney pSPA (Upton *et al*., 2018) and it is likely that several hundred more winter elsewhere in Orkney. The official estimate of the UK wintering population is 2,600 birds (Musgrove *et al*, 2013). However, more recent sources (e.g. Austin *et al* 2017; Furness, 2015; Lawson *et al*., 2015) indicate that the GB wintering population exceeds 4000 birds. The current national and biogeographic wintering population estimates are awaiting systematic review.

10.3.5.3 Common eider

Common eiders use the test site year-round. They occur in small numbers during the breeding season, with counts when present in the study area averaging fewer than 10 individuals and with a maximum count of 25 individuals. Up to two broods of duckling have been seen in some breeding seasons, always very close to the coast. These numbers are very small in the context of the size of the Scottish and Orkney breeding eider populations of approximately 20,000 and 2,000 nesting females, respectively (Forrester and Andrews, 2007).

The numbers present in the autumn and winter months is somewhat greater with 10 to 40 individuals regularly seen in the study area and a maximum of 97 individuals. These numbers represent a very small proportion of the totals wintering in Orkney (approximately 6,000 individuals) (Jackson, 2018; Upton *et al*., 2018). It is concluded that the test site has low importance for this species.

The records of eider are largely confined to the shallow water areas (<10 m depth) within 1 km of the coast. Eider feed on benthic prey, especially mussels.

Wintering common eider is a qualifying feature for both Scapa Flow pSPA and North Orkney pSPA (see section 10.4.1: HRA screening).

10.3.5.4 Long-tailed duck

Long-tailed duck are a winter visitor from Arctic and sub-Arctic breeding grounds. Very small numbers (1 - 8 individuals) have been occasionally seen using the test site area, with ten records only spread over eight years of survey. It is concluded that the test site has negligible importance for this species.

The records of long-tailed duck are confined to the shallow water areas (approximately <10 m depth) within 1 km of the coast. Long-tailed duck feed on benthic prey such as small molluscs and crustaceans and occasionally small fish (Andrews, 2018).

Wintering long-tailed duck are a qualifying feature of Scapa Flow pSPA and North Orkney pSPA (see section 10.4.1: HRA screening).

10.3.5.5 Eurasian wigeon

Very small numbers (1 - 9 individuals) have been occasionally seen within 300 m of the coast in winter months, with seven records only spread over eight years of survey. A passage flock of 150 birds was seen one September resting on the sea.

Several thousand wigeon over winter in Orkney and a others pass through on migration (Branscombe, 2014). It is concluded that the test site area has negligible importance for this species.

10.3.5.6 Northern fulmar

Northern fulmar is the most abundant species recorded in the test site. They are recorded in large numbers throughout the year, but the numbers present in the site at any one time is extremely variable. It is not uncommon for several hundred individuals, and occasionally several thousand individuals, to be present. The peak count for the study area is around 5,000 individuals. Northern fulmars use the test site for foraging and

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for resting; the largest flocks seen were of resting individuals. Large numbers (up to hundreds of birds per hour) also commonly transit through the site.

Northern fulmars breed in very large numbers around the coast of Orkney (approximately 91,000 pairs) and the coast of Scotland in general (approximately 486,000 pairs) (Mitchell *et al*., 2004). Northern fulmars are surface feeders. During the breeding season they will travel very long distances to forage; the mean maximum foraging range reported by Thaxter *et al*. (2012) is 400 km. The most likely origins of the birds seen in the Billia Croo area during the breeding season are colonies along the west coast of Orkney Mainland and the west side of Hoy.

Outside the breeding season fulmars wander widely away from breeding areas (Wernham *et al*., 2003; Kober *et al*. 2010), though some individuals will remain close to their breeding colonies. The occasional winter sighting of 'blue phase' individuals suggests that at this time of year at least some of the birds present are from Arctic breeding grounds.

Breeding northern fulmar is a qualifying interest for several SPAs in Scotland (see section 10.4.1: HRA screening). Of relevance is Hoy SPA as the closest part is only 6 km from the test site. Hoy is the second largest fulmar colony in the UK and supports approximately 36,000 breeding pairs (Mitchell *et al*., 2004).

It is concluded that Billia Croo has low to moderate importance for this species. It is likely that the site has particular importance as a resting/congregating site for birds breeding at local colonies including Hoy SPA.

10.3.5.7 Manx shearwater

Manx shearwater occurs occasionally in the test site during the summer and early autumn months, with low numbers (usually <10 individuals, maximum count 19 individuals) transiting through or sometimes feeding or resting. There are no currently confirmed breeding colonies in Orkney (Mitchell *et al*., 2004). There are historical records from the 1980s of small numbers (40-50 pairs) breeding at Enegars, an upland cliff site on Hoy approximately 5 km from the test site (Forrester and Andrews, 2007). It is possible that this species continues to breed in small numbers at Enegars.

The closest recently confirmed colonies are in western Scotland, most notably the large colonies on Rum and St Kilda, both approximately 300 km to the south-west of Billia Croo. Both these colonies are SPAs where this species is a qualifying feature (see Section 10.4.1: HRA screening). These colonies are the most likely origin of the birds seen in the test site.

Manx shearwaters are mainly surface feeders, but they will also surface dive to depths of up to 50 m to catch prey at depth (Shoji *et al*., 2015). During the breeding season Manx shearwater will travel very long distances to forage; the mean maximum foraging range reported by Thaxter *et al*. (2012) is 330 km. outside the breeding season, Manx shearwater range widely across the Atlantic Ocean, flying to wintering areas off South America.

It is concluded that Billia Croo has negligible importance for this species; the site forms a tiny fraction of the foraging area available to birds breeding in western Scotland.

10.3.5.8 European storm petrel

Very small numbers of European storm petrel were occasionally recorded using the test site area during the summer and autumn months. Typically, single birds were present, and the peak number seen was two individuals. However, due to its diminutive size and tendency to forage away from the coast, this species is easily overlooked during shore-based surveys. Therefore, this species is likely to occur more frequently and at somewhat greater abundance than suggested by the EMEC Wildlife Observation data.

Approximately 2,300 breeding pairs of European storm petrel are estimated to breed on islands around Orkney and off the north coast of Sutherland (Mitchell *et al*., 2004). These colonies are the most likely origins of the birds seen at Billia Croo. The closest SPAs where European storm petrel is a qualifying species at Sule Skerry and Sule Stack SPA (approximately 59 km west of Billia Croo) and Auskerry SPA (approximately 60 km by sea east of Billia Croo) (see section 10.4.1: HRA screening).

Breeding storm petrels range large distances (maximum foraging range 65 km, Thaxter *et al*., 2012) from colonies to forage offshore and thus have very extensive feeding grounds available.

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It is concluded that Billia Croo has very low importance for this species; the site forms a very small fraction of the foraging area available to birds breeding in the wider region.

10.3.5.9 European shag

European shag was the second most abundant species recorded in the surveys. They occur in the test site and its immediate vicinity in moderate to large numbers throughout the year; however, the numbers present at any one time are extremely variable. Counts for the study area of up to several hundred individuals, and exceptionally over 1,000 individuals, occur many times a year, but typically the numbers are well below 100 individuals.

European shags primarily use the site for foraging (shags roost on land). European shags typically feed on benthic/demersal fish prey and normally choose areas where the depth to the seabed is generally less than 40 m (Wanless *et al*., 1997). The distribution of European shag recorded in the surveys reflects this with the estimated location of the great majority of records being inshore of the 40 m depth contour. Indeed, European shags were recorded only in moderate numbers inside the Billia Croo lease area, however much larger numbers were seen close by, off Breckness headland and in the tide race of Hoy Sound.

European shags breed in moderate numbers around the coasts of Orkney (approximately 1,900 pairs) (Mitchell *et al*., 2004). The maximum foraging range of breeding European shag is reported to be around 17 km only (Thaxter *et al*., 2012). The birds seen in the test site in the breeding season months are likely to originate from the colonies on the west coast of Orkney Mainland and Hoy. European shags winter around the coast of Orkney in moderate numbers with a wintering population of at least 6,000 individuals. Many of these are associated with the Scapa Flow pSPA (Jackson, 2018) and North Orkney pSPA (Upton *et al*., 2018).

Breeding European shag is a qualifying species for Sule Skerry and Sule Stack SPA (approximately 59 km west of Billia Croo). Overwintering European shags are a qualifying species for Scapa Flow pSPA and North Orkney pSPA.

It is concluded that Billia Croo has moderate importance for this species; it is likely that at times >1% of the regional breeding and wintering population use the test site and its close vicinity (e.g., off Breckness headland and Hoy Sound) and that there is strong connectivity to the Scapa Flow pSPA.

10.3.5.10 Northern gannet

Northern gannets occur in the Billia Croo test site and its immediate vicinity in low to moderate numbers through the summer and autumn (April to October). Typically, <10 individuals are present, but occasionally as many as 100 individuals are present and exceptionally over 300. In winter months gannets occur less frequently and in generally lower numbers.

Northern gannets primarily use the site for foraging, searching in flight for pelagic fish prey which is caught by plunge diving from height. The records of gannets seen during the surveys were approximately evenly distributed across the study area. However, almost all flocks of >25 birds were estimated to be more that 2 km offshore.

During the breeding season Northern gannets will travel very long distances to forage; the mean maximum foraging range reported by Thaxter *et al*. (2012) is 229 km.

Northern gannets breed in relatively few large colonies, nearly all of which are SPAs (see Section 10.4.1: HRA screening). The closest colonies to Billia Croo are the relatively small colonies on Westray (approximately 1,100 pairs, 39 km to north), Sule Stack (approximately 5,000 pairs, 62 km to west) and Sule Skerry (approximately 2000 pairs, 59 km to west) (Mitchell, et al. 2004; Murray *et al*., 2015). These colonies are the most likely origins of the birds seen in the breeding season.

It is concluded that the test site has very low importance for gannet, representing a very small proportion of the extensive foraging areas available in the region.

10.3.5.11 Black-legged kittiwake

Black-legged kittiwake occurs in the test site and its immediate vicinity in low to moderate numbers through the summer and autumn (April to October). Typically, <10 individuals are present, but occasionally feeding

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groups of as many as 150 individuals are present and exceptionally up to 300. In winter months kittiwakes occur less frequently and in generally lower numbers.

Kittiwakes primarily use the site for foraging, searching in flight for fish prey which is generally caught by dip-feeding or plunge diving. It is also likely to be used for resting by birds breeding at local colonies. The records of kittiwakes seen during the surveys were approximately evenly distributed across the study area.

Outside the breeding season, kittiwakes move away from breeding grounds, dispersing widely over the North Atlantic and mixing with birds from other breeding areas.

Kittiwakes breed in large numbers around the coasts of Orkney, but numbers have declined massively in recent decades. There were approximately 58,000 pairs in the Seabird 2000 (Mitchel *et al*., 2004) census but numbers have now declined to approximately 5,000 pairs (based on counts of selected colonies, JNCC Seabird Monitoring Programme database). During the breeding season kittiwakes will travel long distances to forage; the mean maximum foraging range reported by Thaxter *et al*. (2012) is 60 km. The birds seen in the test site during the summer months are likely to originate from the colonies along the west coast of Orkney Mainland, in particular the closest colonies which are <5 km away and Marwick Head. The breeding colonies on Hoy, Rousay and Westray are also well within the mean maximum foraging range distance.

Kittiwakes are a qualifying species for several SPAs in Orkney and along the north coast of mainland Scotland, either in their own right or as part a breeding seabird assemblage (see section 10.4.1: HRA screening). The closest of these are Marwick Head SPA (approximately 12 km north of Billia Croo) and Hoy SPA (approximately 6 km to the south of Billia Croo).

On the basis that the test site is sometimes used by relatively large numbers of individuals (>100) for foraging, it is concluded that Billia Croo has moderate importance for kittiwake in the breeding season. However, the test site represents a very small proportion of the extensive foraging areas available in the region. Outside the breeding season the test site has very low importance.

10.3.5.12 Common gull

Common gull were commonly seen in the Billia Croo test site outside the breeding season, typically <10 birds were seen; very occasionally flocks of up to 100 were present and on one occasion a flock of 300. This species was rarely seen during the breeding season, reflecting its preference for inland habitats at this time of year. Almost all records were estimated to be within 750 m of the coast. Like other gulls, common gull is a surface feeder and searches for food on the wing.

Common gulls breed in moderate numbers across Orkney (approximately 11,000 pairs), moderate numbers also winter in Orkney, mainly along the coast and on pastures (Balmer *et al*., 2013).

Common gull is not a qualifying species for any of the SPAs in northern Scotland.

It is concluded that the test site has very low importance for common gull at all times of year.

10.3.5.13 Herring gull

Herring gulls were commonly seen in the Billia Croo area throughout the year, typically <10 birds were present, very occasionally flocks totalling up to approximately 100 were present and on one occasion a flock totalling 175. Almost all records were estimated to be within 1 km of the coast and were particularly concentrated off Breckness headland. Herring gulls feed from the sea surface, searching for food on the wing; they also feed along the coast and inland.

Herring gulls breed in moderate numbers around the coast of Orkney (approximately 2,000 pairs) and moderate numbers also winter in Orkney (Balmer *et al*., 2013). During the breeding season herring gulls will travel long distances to forage; the mean maximum foraging range reported by Thaxter *et al*. (2012) is 61 km. The birds seen in the test site during the summer months are likely to originate from the colonies on the west coast of Orkney Mainland, in particular those on the immediately adjacent coast <5 km away. The breeding colonies on Hoy, Rousay and Westray are also well within the mean maximum foraging range distance.

Herring gull is not a qualifying species for any of the SPAs in Orkney.

It is concluded that the test site has low importance for herring gull at all times of year.

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10.3.5.14 Great black-backed gull

Great black-backed gull were commonly seen in the test site throughout the year, typically <5 birds were present, occasionally flocks totalling up to approximately 40 were present and on two occasions a flock of approximately 90 individuals was seen. Records of great black-backed gull were spread across the survey area, but were more concentrated within 1 km of the coast, especially off Breckness headland. Great black-backed gulls are a surface feeding species and search for food on the wing; they also feed along the coast. There were several records during the surveys of this species feeding on dead auks and also records of individuals associating with fishing boats.

Great black-backed gulls breed in moderate numbers around the coast of Orkney (approximately 5,500 pairs) and moderate numbers also winter in Orkney (Balmer *et al*., 2013). There is uncertainty how far breeding great black-backed gulls will travel to forage from breeding sites, but it is likely that they travel similar distances to herring gull (mean maximum foraging range of 61 km). The birds seen in the test site during the summer months are likely to originate from the small colonies on the west coast of Orkney Mainland, in particular those on the immediately adjacent coast <5 km away, and the larger colonies on Hoy.

Breeding great black-backed gull is a qualifying species at three SPAs in Orkney including Hoy SPA (see section 10.4.1: HRA screening).

It is concluded that the Billia Croo test site has low importance for great black-backed gulls at all times of year.

10.3.5.15 Arctic tern

Arctic tern is a summer visitor to Orkney. This species occurs in the test site and its immediate vicinity in low to moderate numbers through the summer months (late April to August). Typically, <10 individuals are present, but occasionally as many as 100 individuals are present and exceptionally up to approximately 500.

Arctic tern use the site for foraging (this species prefers to rest on land), searching in flight for small fish prey, such as sand eels, which is caught by dip-feeding or plunge diving. The records of Arctic terns seen during the surveys were approximately evenly distributed across the Billia Croo test site.

During the breeding season Arctic tern will travel moderate distances to forage; the mean maximum foraging range reported by Thaxter *et al*. (2012) is 24 km. In the late summer (typically August) Arctic terns migrate to southern hemisphere wintering areas (Wernham *et al*., 2002).

Arctic terns breed in large numbers around the coasts of Orkney, approximately 13,500 pairs were counted in Seabird 2000 census (Mitchell *et al*., 2004). The birds seen in the test site during the summer months are most likely to originate from the small colonies on the west coast of Orkney Mainland, in particular the closest colonies which are <5 km away. The relatively large breeding colonies on Rousay (approximately 25 km north east) lie a little beyond the mean maximum foraging range but within the maximum foraging distance (30 km), and therefore birds at these colonies may also use the test site.

Arctic tern is a qualifying species at five SPAs in Orkney including Rousay SPA (see section 10.4.1: HRA screening).

On the basis that the test site is occasionally used by relatively large numbers of individuals (>100) for foraging, it is concluded that Billia Croo has moderate importance as a foraging site for breeding Arctic terns. However, the test site represents a small proportion of the extensive foraging areas available in the region. Outside the breeding season the site has no importance for this species.

10.3.5.16 Great skua

Great skua is a summer visitor to Orkney. This species occurs in the test site and its immediate vicinity in low numbers through the summer months and autumn (April to October). Typically, <5 individuals are present, but occasionally as many as 25 individuals were present and exceptionally a flock of 50.

Great skuas use the site for foraging and resting. The records of great skua seen during the surveys were approximately evenly distributed across the Billia Croo test site. Great skua is a predator and a scavenger. There were many records of this species stealing food from other seabirds, especially gannet, and others of great skua eating small seabirds, some of which were identified as auk species.

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During the breeding season great skua will travel large distances to forage; the mean maximum foraging range reported by Thaxter *et al*. (2012) is 86 km. In the autumn great skuas migrate to wintering areas off the coast of southern Europe and West Africa (Wernham *et al*., 2002).

Great skuas breed in moderate numbers on moorland sites across Orkney, especially on Hoy; approximately 2,200 pairs were counted in Orkney in the Seabird 2000 census (Mitchell *et al*., 2004). The birds seen in the test site are most likely to originate from the large colony on Hoy, the closest colony to Billia Croo.

The only SPA in Orkney where breeding great skua is a qualifying species is Hoy SPA (see section 10.4.1: HRA screening).

It is concluded that the test site has low importance as a foraging site for breeding great skuas, representing a small proportion of the extensive foraging areas available in the region. Outside the breeding season the site has no importance for this species.

10.3.5.17 Arctic skua

Arctic skua is a summer visitor to Orkney. This species occurs in the Billia Croo test site and its immediate vicinity in very low numbers through the summer months and autumn (April to August). Typically, 0-3 individuals are present, but occasionally as many as 10 individuals were present and exceptionally a flock of 15.

Arctic skuas use the site for foraging and resting. The Arctic skua seen during the surveys were spread across the study area but were most often recorded within 1 km of the coast, especially off Breckness Headland. Arctic skuas obtain much of their food through the stealing of fish prey from other seabirds, especially Arctic terns and kittiwakes.

During the breeding season Arctic skuas will travel large distances to forage; the mean maximum foraging range reported by Thaxter *et al*. (2012) is 63 km. In the autumn Arctic skua migrate to wintering areas off the coast of southern Europe and Africa.

Arctic skua breed in small and declining numbers on moorland and coastal heaths at sites across Orkney (approximately 720 pairs in were recorded during Seabird 2000, but this has since declined by approximately 80% to around 150 pairs (Perkins *et al*., 2018). The birds seen in the test site during the summer months are most likely to originate from the small colony on Black Craig hill, approximately 1 km north-east of the lease site.

Arctic skua is a qualifying species at four SPAs in Orkney including Hoy SPA and Rousay SPA (see section 10.4.1: HRA screening), both of which are less than the mean maximum foraging range distance from the test site.

On the basis that the test site used only a few individuals it is concluded that the Billia Croo test site has low importance as a foraging site for breeding Arctic skua. The test site represents a small proportion of the extensive foraging areas available in the region. Outside the breeding season the site has no importance for this species.

10.3.5.18 Common guillemot

Common guillemot was the third most abundant species recorded in the surveys. Common guillemots occur very often in the test site area and its immediate vicinity during the breeding season months (April to August). In the non-breeding period they occur in lower numbers but are still commonly seen in all months. At all times of year the numbers present at any one time are extremely variable. Breeding season survey counts for the study area were typically <25 individuals but up to 100 individuals were recorded on many occasions and exceptionally up to 380 individuals were present. These numbers are likely to be biased low by about one third as they exclude individuals recorded as 'unidentified auk species'. The birds recorded as 'unidentified auks' are believed to have mostly comprised either common guillemot or razorbill; assuming this was the case, the unidentified birds made up approximately 34% of all records of these two species.

Common guillemots use the test site for foraging and resting. Common guillemots typically feed on fish prey such as sand eels, which are caught by pursuit diving in water depths of up to around 60 m (Thaxter *et al*., 2010; Shoji *et al*., 2015a). The distribution of survey records is approximately evenly distributed across the

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survey area. It is likely that the marked fall-off in records at distances >2 km from the observation vantage point reflects the reduction in detection and identification rates of auk species at these distances. There is also a tendency for relatively low densities in areas when the seabed depth is <25 m. Apart from this, the distribution of survey records is approximately evenly distributed across the survey area.

Common guillemots breed in very large numbers around the coasts of Orkney (approximately 181,000 birds, corresponding to approximately 121,300 pairs) and the north and west Sutherland (approximately 162,000 pairs, corresponding to approximately 108,500 pairs) (based on Seabird 2000 census counts, Mitchell *et al*., 2004). The mean maximum foraging range of breeding common guillemot is reported to be 84 km (Thaxter *et al*., 2012). The most likely origins of the birds seen in the summer months are the colonies on the west coast of Orkney Mainland and Hoy. Common guillemots winter around the coast of Orkney in moderate numbers. At this time of year, the birds using the Billia Croo test site are likely to be a mixture of local breeding birds and birds from other breeding grounds.

Breeding common guillemots is a qualifying species at five SPAs in Orkney and five more in north Sutherland and Caithness (see section 10.4.1: HRA screening). Of these, Hoy SPA (approximately 6 km south) and Marwick Head SPA (approximately 13 km north) are the closest to Billia Croo.

It is concluded that the test site area has low importance as a foraging site for breeding common guillemots, representing a very small proportion of the extensive foraging areas available in the region.

10.3.5.19 Razorbill

Razorbills commonly occur in low numbers in the test site and its immediate vicinity during the breeding season months (April to August); in the non-breeding period they are uncommon. At all times of year, the numbers present at any one time are extremely variable. Breeding season survey counts for the study area were typically <5 individuals but up to 20 individuals were recorded on a few occasions and exceptionally up to 40 individuals were present. These numbers are likely to be biased low by about one third as they exclude individuals recorded as 'unidentified auk species'. The birds recorded as 'unidentified auks' are believed to have mostly comprised either common guillemot or razorbill; assuming this was the case, the unidentified birds made up approximately 34% of all records of these two species.

The breeding season ratio of razorbill to common guillemot positively identified in the surveys was approximately 1:17, which closely accords to the approximate 1:18 ratio of their corresponding Orkney breeding population sizes based on Seabird 2000 counts (Mitchel *et al*., 2004).

Razorbills use the test site for foraging and resting. Razorbills typically feed on fish prey such as sand eels, which are caught by pursuit diving to depths of up to around 30 m (Thaxter *et al*., 2010; Shoji *et al*., 2015a). As with common guillemot, it is likely that the marked fall-off in records at distances >2 km from the observation vantage point reflects the reduction in detection and identification rates of auk species at these distances. Apart from this, the distribution of survey records is approximately evenly distributed across the survey area.

Razorbills breed in large numbers around the coasts of Orkney (approximately 10,200 birds, corresponding to approximately 6,800 pairs) and the north and west Sutherland (approximately 22,000 pairs, corresponding to approximately 14,700 pairs) (Mitchell *et al*., 2004). The mean maximum foraging range of breeding razorbills is reported to be around 49 km (Thaxter *et al*., 2012). The most likely origins of the birds seen in the summer months are the colonies on the west coast of Orkney Mainland and Hoy. Razorbills also winter around the coast of Orkney in low numbers

The only SPA in Orkney where breeding razorbill is a qualifying species is West Westray SPA (approximately 39 km north-east of the Billia Croo test site) (see section 10.4.1: HRA screening).

It is concluded that Billia Croo has low importance as a foraging site for breeding razorbills, representing a very small proportion of the extensive foraging areas available in the region.

10.3.5.20 Atlantic puffin

Atlantic puffins commonly occur in low numbers in the test site and its immediate vicinity during the breeding season months (April to August); in the non-breeding period they occur only rarely and in very small numbers.

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Breeding season survey counts for the study area were typically <5 individuals, but up to approximately 30 individuals were recorded on a few occasions and exceptionally up to 60 individuals were present.

Atlantic puffins use the test site for foraging and resting. Atlantic puffins typically feed on small fish prey such as sand eels, which are caught by pursuit diving to depths of up to around 20 m (Spencer, 2012). As with common guillemot, it is likely that the marked fall-off in records of this species at distances >2 km from the observation vantage point reflects the reduction in detection and identification rates of auk species at these distances. There is also a tendency for relatively low densities in areas when the seabed depth is <20 m and/or that are <500 m from the coast. Apart from this, the distribution of survey records is approximately evenly distributed across the survey area.

Atlantic puffins breed in large numbers around the coasts of Orkney, but numbers have declined massively in recent decades. There were approximately 62,000 pairs in the Seabird 2000 (Mitchel *et al*., 2004) census but numbers have now declined to approximately 6,675 pairs (Hughes *et al*., 2018). There are also smaller numbers breeding on the coasts and offshore islands of north and west Sutherland and north Caithness; these areas had approximately 10,000 pairs in the Seabird 2000 census (Mitchell *et al*., 2004). The mean maximum foraging range of breeding puffin is reported to be around 105 km (Thaxter *et al*., 2012). The most likely origins of the birds seen in the summer months are the colonies on the west coast of Mainland Orkney and Hoy. Atlantic puffin winter in Orkney waters in very low numbers.

Breeding Atlantic puffin is a qualifying species at four SPAs in Orkney, north Sutherland and Caithness, by far the closest of these is Hoy SPA (approximately 6 km south of Billia Croo) (see section 10.4.1: HRA screening).

Given the small numbers seen in the Billia Croo test site in the context of the Orkney population size and the very large extent of foraging areas, it is concluded that the test site has very low importance as a foraging site for breeding puffins.

10.3.5.21 Black guillemot

Black guillemots (also known as tysties) are very commonly present in low numbers in the test site and its immediate vicinity during the breeding season months (April to August); in the non-breeding period they are also commonly present, but in lower numbers. Black guillemot is a non-migratory species remaining in the vicinity of it breeding areas throughout the year.

Black guillemot was the second most recorded auk species (after common guillemot) seen in the test site during the surveys. Breeding season counts for the study area were typically <10 individuals, but up to approximately 20 individuals were recorded on many occasions and, on one occasion, 29 individuals were present.

Black guillemots use the test site for foraging and resting. Black guillemots feed on benthic and demersal fish prey such as butterfish, which are caught by diving to the seabed. Studies have shown that this species seldom forages where the depth to the seabed exceeds around 40 m (Shoji *et al*., 2015b; Masden *et al*., 2013), as foraging at greater depths becomes unprofitable. The distribution of black guillemots recorded during the surveys reflects this with the estimated location of the great majority of records being inshore of the 40 m depth contour.

Black guillemots were commonly seen gathering around and perched on EMEC cardinal buoys (especially the east cardinal buoy of the offshore lease area) and on the Pelamis and Wello wave devices when these technologies were being tested (EMEC, 2016).

Black guillemots breed in moderate numbers around the coasts of Orkney (approximately 6,000 adults were counted in the Seabird 2000 census, corresponding to approximately 3,000 breeding pairs) (Mitchell *et al*., 2004). Black guillemots rarely forage more than approximately 10 km from breeding sites to forage (Johnston *et al*., 2018). The most likely origins of the birds seen in the summer months are the colonies on the immediately adjacent west coast of Mainland Orkney, some birds could also come from colonies along the north-west coast of Hoy.

Black guillemot is not a qualifying species for any SPA, however this species is a feature of interest for Papa Westray MPA which is located approximately 53 km north-east of the test site.

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Given the small numbers seen in the test site in the context of the Orkney population size and the very large extent of foraging areas, it is concluded that Billia Croo has very low importance as a foraging site for breeding black guillemots.

10.3.5.22 Little auk

Small numbers of little auk are occasionally present in the test site most winters (late October to March). Little auks are winter visitors from Arctic breeding grounds where they breed in very large numbers (millions). Counts for the study area were typically of just one or two individuals, the largest count was eight birds. The diminutive size and dark colour of little auks means they are easily overlooked, especially in winter conditions. It is therefore likely that the species is somewhat more common than the survey records suggest. Most records were within 1.5 km of the observation vantage point, but it is likely that this reflects the difficult of detecting and identifying this species at greater distances.

Little auk is a not a qualifying interest for any SPA or MPA.

The numbers of little auks visiting the UK to winter is believed to vary considerably from year to year, probably in response to weather patterns. There is no population estimate available for UK waters. Skov *et al*. (1995) estimated 850,000 individuals wintering in the North Sea, and Kober *et al*. (2010) indicate that little auk are widespread at low density in Scottish offshore waters including the waters around Orkney.

Given the very small numbers seen in the test site in the context of the numbers wintering in Scottish waters and the very large extent of foraging areas, it is concluded that Billia Croo has negligible importance as a foraging site for wintering little auk.

10.4 Impact appraisal mechanisms for Billia Croo

This impact appraisal takes account of a maximum-case scenario based on the Project Envelope, where all available berths within the test site are developed and operating at capacity and allowing for the possibility that a small number of new berths may be added. It addresses the requirements with respect to assessment of environmental impacts under the relevant consenting and licensing regimes such as HRA and EIA. This appraisal will inform the consenting process for both Marine Licence and S36 applications. However, it should be noted that, if there are key deviations in the device design or in installation, maintenance or decommissioning activities, further appraisal work may be required. Any additional appraisal work required will be undertaken by the individual developer (further advice should be sought from EMEC in the first instance).

Table 10-3 presents the relevant legislation and the reasons for undertaking an appraisal for several features in the test site area.

Table 10-3 Appraisal mechanism for birds

Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
Qualifying interests of European sites	The Conservation of Habitats and Species Regulations 2017 (Note: these regulations apply in Scotland in relation to certain specific activities (reserved matters), including consents granted under S36) Habitats Regulations Appraisal (HRA) Habitats Regulations 1994 (as amended).	Yes	Various qualifying species from a variety of SPAs may have connectivity with the site.
European Protected Species	EPS legislation - Habitats Regulations 1994 (as amended in Scotland).	No	No bird species are listed as EPS.
Notified features of SSSIs	SSSI legislation - Nature Conservation (Scotland) Act 2004.	Yes	Captures assessment of SSSIs with birds as notified features.
Protected features of MPAs	Marine (Scotland) Act 2010	No	No connectivity with any MPAs with protected bird features.

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Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
PMFs	Marine (Scotland) Act 2010	No	No bird species are listed as PMFs.
Other sensitive natural heritage features	Appraisal of other features under: Electricity Works (EIA) (Scotland) Regulations (Amendment) 2008; Marine Works (EIA) (amendment) Regulations 2011; Marine (Scotland) Act 2010.	Yes	Captures assessment of all other sensitive natural heritage features at a population/habitat scale of concern.

10.4.1 Habitat Regulations Appraisal of qualifying bird interests of European sites

The following commentary outlines the HRA screening undertaken in relation to the bird SPA qualifying interests. The process is designed to identify those SPAs considered to have connectivity and for which a significant effect is considered likely.

Step 1: Is the test site at Billia Croo directly connected with or necessary for the conservation management of the SPA?

The test site is not directly connected with or necessary to site management for the conservation management of any SPA in Scotland.

Step 2: Is the test site at Billia Croo likely to have a significant effect on the qualifying interests of the SPA either alone or in combination with other plans or projects?

Step 2 acts as a screening process and has two stages which together determine the potential for LSE to SPAs. This step removes from the HRA those proposals (plans or projects) which clearly have no connectivity to SPA qualifying interests or where it is very obvious that the proposal will not undermine the conservation objectives for these interests, despite a connection.

The first stage of Step 2 is to determine the potential strength of connectivity between the SPA qualifying species and the Billia Croo test site (Table 10-4). Only qualifying interests of each SPA with potential for at least low connectivity have progressed to this stage in the appraisal.

The second stage of Step 2 further evaluates the potential for LSE for all qualifying species determined to have at least moderate potential connectivity through considering the potential for an impact pathway with an activity or stressor. This evaluation is based on the importance of the Project Envelope Billia Croo test site to a SPA qualifying species and a species' vulnerability to the effects of wave energy devices, component testing and other associated activities (Furness *et al*., 2012).

Once potential connectivity and potential impact pathways are considered, information on the local context of the Billia Croo test site and the population status (i.e., condition of SPA qualifying feature) are also taken into account in determining if there is potential for LSE.

10.4.1.1 Determining potential connectivity (stage1)

All the SPA breeding qualifying species considered in respect of the test site undertake relatively large (approximately 10-100s of km) foraging trips away from breeding sites to marine feeding grounds. This means that SPA breeding sites may be 'connected to' marine areas even at great distances. Wintering seabirds may also undertake moderately large movements (up to tens of kilometres) within their wintering areas during the course of their day-to day activities. Although connectivity is thus established, where the proposal is located further away from a designated site, and/or where there are other potential colonies or sites that could also be a source of individuals, impacts are less likely on the qualifying species associated with that SPA.

The potential breeding season connectivity (none, low, medium or high) by a qualifying species between individual SPAs and the Billia Croo test site and activities noted in the Project Envelope (Table 10-4) is determined by combining information on the distance to the SPA and breeding season foraging range metrics (review by Thaxter *et al.,* 2012), (SNH, 2012).

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Where the distance between the SPA and the test site is below the mean foraging distance the potential connectivity is assumed to be high, and where it is between the mean and the MMFR the potential connectivity is assumed to be moderate. Cases where the distance between the SPA and the Billia Croo test site is between the MMFR and the maximum foraging range are considered to have potential connectivity of low strength and where the distance exceeds the maximum foraging it is assumed there is no potential for connectivity. However, as the foraging ranges are subject to some variance they are not been used as a definitive threshold (e.g. a SPA only a few kilometres further than the foraging range is not automatically scoped out). Current casework advice from SNH is, in the first instance, to screen-in only those SPA qualifying interests that have potential for high or moderate connectivity with a development site.

Foraging range metrics are not available for breeding great black-backed gull. For the purposes of estimating great black-backed gull connectivity it is considered reasonable to use the herring gull foraging metrics, a species with a broadly similar ecology. Thaxter *et al.*, (2012) do not give a credible value for the mean foraging range of Atlantic puffin. Therefore, for the purposes of estimating connectivity, an approximate mean foraging range of 50 km is assumed; this value is derived from the MMFR for puffin and the ratios of mean foraging range to mean maximum foraging range reported for common guillemot and razorbill.

There is currently no SNH guidance on determination of the potential for connectivity between a SPA and a development site for non-breeding (wintering) qualifying species. SNH has advised that it should be assumed there will be limited influence by projects outside a SPA/pSPA boundary, unless there is some established connectivity. SNH endorsed the suggestion by the authors that the appraisal should include marine SPAs that are reasonably close to Billia Croo (within 50km), and that the potential for connectivity should be judged from the numbers of a qualifying species using the site, and a specie's ecology and scale of day-to-day movements to be expected during the overwintering period.

Using the approach outlined above it was determined that there is potential for connectivity between the test site and the qualifying species of Scapa Flow pSPA ((2 km from the test site, at closest) and North Orkney pSPA (28 km (sea route) from the test site, at closest lies from the Billia Croo test site (Table 10-4).

At closest the North Orkney pSPA lies 28 km (sea route) from Billia Croo. Although detailed studies are lacking on the size and frequency of between-site winter movements by the qualifying species, in consideration of the relatively large distance between this pSPA and the test site it is concluded that the potential for connectivity is low for all qualifying species. Furthermore, the very low importance of the test site for all the North Orkney pSPA qualifying species indicates that the site is unlikely to be an important alternative site that qualifying species from this pSPA are likely to visit.

At closest the Scapa Flow pSPA lies just 2 km from Billia Croo test site and this close proximity means there is relatively high potential for connectivity to this pSPA. During the non-breeding months seaduck species and European shag are commonly observed undertaking local flights of up to a few kilometres. These flights are likely to be of birds moving between foraging areas and roosting areas, or between foraging sites. In contrast, diver and grebe species are relatively seldom seen flying on the wintering grounds suggesting that there is less potential for connectivity between sites, However, wintering divers are likely to move up to several kilometres by swimming. It is concluded that the potential for connectivity between the test site and Scapa Flow pSPA is moderate for the seaduck species, European shag and great northern diver, and low for the Slavonian grebe (Table 10-4).

10.4.1.2 Potential for impact pathway (stage 2)

In judging the appropriate potential connectivity category (none, low, medium or high) (Table 10-4) for a particular species/SPA combination consideration is given to the use by a species of the test site (as shown by the EMEC Wildlife Observation data) and its abundance in the context of the numbers breeding both in the SPA under consideration and, other colonies or sites lying within the foraging range distance. In cases where the distance between a site and a SPA breeding colony is less than a species' mean foraging range and that species regularly uses the site in at least reasonable numbers in the context of the SPA population size (>1%), and taken into consideration other potential closer colonies, it is concluded there is likely to be high connectivity for that qualifying species. Similarly, where the distance between the site and an SPA is between the mean and mean maximum foraging distance and a species regularly present in at least reasonable numbers it is concluded there is likely to be medium connectivity.

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Determination of potential for a 'likely significant effect' (LSE) is not just based on the occurrence of a species at the test site, or the potential for connectivity, but also involves a judgement as to whether any of the SPA conservation objectives might be undermined. Such judgement is also informed by a simple consideration of the importance of the area in question for the relevant species and the potential for impact pathways that could negatively affect one or more SPA conservation objectives. In determining the potential for impact pathways to arise from the Billia Croo test site, information on the vulnerability of seabird species to the potential effects of wave energy devices and component testing is highly relevant. The question of vulnerability of Scottish seabird species to wave energy developments (i.e. the deployment of wave energy devices and associated activities) is reviewed by Furness *et al*. (2012), in which each species' overall vulnerability is categorised on a five-point scale (very low, low, moderate, high and very high), these categories being derived from a species total score to several contributing vulnerability factors (e.g. vessel disturbance, displacement response to fixed structures, risk of collision, foraging habitat and feeding behaviour). Additional information from other studies is also relevant for determining the potential for impact pathways. The recent study on the disturbance response of waterbirds wintering in Orkney to vessel activity is also of high relevance to determining the potential for impact pathways (Jarrett *at al*., 2018).

Consideration has also been given to the condition status of each of the species as qualifying interests to the SPA. Negative impacts upon even a relatively small number of individuals could have important implications, particularly considering the potential for cumulative impacts within Orkney waters. This is particularly relevant for a number of seabird species, including shag, Arctic skua, herring gull, great black-backed gull, kittiwake, Arctic terns, and common guillemots, for which there have been declines in Scottish populations (JNCC, 2016). These species, in particular, are currently vulnerable to any impacts, which could lead to their further population decline or prevent their recovery.

Table 10-4 Stage 1 ornithology screening of SPAs based on potential connectivity

SPA name	Distance by sea (km)	Distance direct (km)	Qualifying species	Qualifying season	Potential connectivity
Scapa Flow pSPA (marine SPA)	2	2	[redacted]	Breeding	High
			Great northern diver	Non-breeding	Moderate
			Slavonian grebe	Non-breeding	Low
			European shag	Non-breeding	Moderate
			Common eider	Non-breeding	Moderate
			Long-tailed duck	Non-breeding	Moderate
			[redacted]	Non-breeding	Moderate low
			Red-breasted merganser	Non-breeding	Moderate
North Orkney pSPA (marine SPA)	28	15	Great northern diver	Non-breeding	Low
			Slavonian grebe	Non-breeding	Low
			European shag	Non-breeding	Low
			Common eider	Non-breeding	Low
			Long-tailed duck	Non-breeding	Low
			Velvet scoter	Non-breeding	Low
			Red-breasted merganser	Non-breeding	Low

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SPA name	Distance by sea (km)	Distance direct (km)	Qualifying species	Qualifying season	Potential connectivity
Hoy SPA	4	4	[redacted]	Breeding	Moderate/high
			Northern fulmar	Breeding	High
			Arctic skua	Breeding	High
			Great skua	Breeding	High
			Great black-backed gull	Breeding	High
			Black-legged kittiwake	Breeding	High
			Common guillemot	Breeding	High
			Atlantic puffin	Breeding	High
Marwick Head SPA	13	13	Black-legged kittiwake	Breeding	High
			Common guillemot	Breeding	High
Rousay SPA	31	26	Northern fulmar	Breeding	High
			Arctic skua	Breeding	Moderate
			Black-legged kittiwake	Breeding	Moderate
			Arctic tern	Breeding	Moderate
			Common guillemot	Breeding	High
North Caithness Cliffs SPA	35	34	Northern fulmar	Breeding	High
			Black-legged kittiwake	Breeding	Moderate
			Common guillemot	Breeding	High
			Razorbill	Breeding	Moderate
			Atlantic puffin	Breeding	High
Pentland Firth Islands SPA	35	33	Arctic tern	Breeding	None
West Westray SPA	42	39	Northern fulmar	Breeding	High
			Arctic skua	Breeding	Moderate
			Black-legged kittiwake	Breeding	Moderate
			Arctic tern	Breeding	None
			Common guillemot	Breeding	Moderate
			Razorbill	Breeding	Moderate
Copinsay SPA	46	41	Northern fulmar	Breeding	High
			Great black-backed gull	Breeding	Moderate
			Black-legged kittiwake	Breeding	Moderate
			Common guillemot	Breeding	Moderate
Caithness and Sutherland Peatlands SPA	55	55	[redacted]	Breeding	None
			[redacted]	Breeding	None
			Arctic skua	Breeding	Moderate
Calf of Eday SPA	55	46	Northern fulmar	Breeding	High
			Great cormorant	Breeding	None
			Great black-backed gull	Breeding	Moderate
			Black-legged kittiwake	Breeding	Moderate
			Common guillemot	Breeding	Moderate
Papa Westray SPA	55	51	Arctic skua	Breeding	Moderate
			Arctic tern	Breeding	None
	59	59	Northern gannet	Breeding	High

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SPA name	Distance by sea (km)	Distance direct (km)	Qualifying species	Qualifying season	Potential connectivity
Sule Skerry and Sule Stack SPA			European storm-petrel	Breeding	High
			Leach's storm-petrel	Breeding	High
			European shag	Breeding	None
			Common guillemot	Breeding	Moderate
			Atlantic puffin	Breeding	Moderate
Auskerry SPA	60	47	European storm-petrel	Breeding	High
			Arctic tern	Breeding	None
East Caithness Cliffs SPA	73	64	Northern fulmar	Breeding	Moderate
			Great cormorant	Breeding	None
			European shag	Breeding	None
			Black-legged kittiwake	Breeding	Moderate
			Herring gull	Breeding	Moderate
			Great black-backed gull	Breeding	Moderate
			Common guillemot	Breeding	Moderate
			Razorbill	Breeding	Low
			Atlantic puffin	Breeding	Moderate
Cape Wrath SPA	94	94	Northern fulmar	Breeding	Moderate
			Black-legged kittiwake	Breeding	Low
			Common guillemot	Breeding	Low
			Razorbill	Breeding	Low
			Atlantic puffin	Breeding	Moderate
Fair Isle SPA	126	117	Northern fulmar	Breeding	Moderate
			Northern gannet	Breeding	Moderate
			European shag	Breeding	None
			Arctic skua	Breeding	None
			Great skua	Breeding	Low
			Black-legged kittiwake	Breeding	Low
			Arctic tern	Breeding	None
			Common guillemot	Breeding	Low
			Razorbill	Breeding	None
			Atlantic puffin	Breeding	Low
Handa SPA	131	123	Northern fulmar	Breeding	Moderate
			Great skua	Breeding	Low
			Black-legged kittiwake	Breeding	None
			Common guillemot	Breeding	Low
			Razorbill	Breeding	None
North Rona and Sula Sgeir SPA	155	155	Northern fulmar	Breeding	Moderate
			European storm-petrel	Breeding	None
			Leach's storm-petrel	Breeding	None
			Northern gannet	Breeding	Moderate
			Great black-backed gull	Breeding	None
			Black-legged kittiwake	Breeding	None

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SPA name	Distance by sea (km)	Distance direct (km)	Qualifying species	Qualifying season	Potential connectivity
			Common guillemot	Breeding	None
			Razorbill	Breeding	None
			Atlantic puffin	Breeding	Low
Troup, Pennan and Lion`s Heads SPA	164	157	Northern fulmar	Breeding	Moderate
			Herring gull	Breeding	None
			Black-legged kittiwake	Breeding	None
			Common guillemot	Breeding	None
			Razorbill	Breeding	None
Sumburgh Head SPA	160	154	Northern fulmar	Breeding	Moderate
			Black-legged kittiwake	Breeding	None
			Arctic tern	Breeding	None
			Common guillemot	Breeding	None
Foula SPA	148	147	[redacted]	Breeding	None
			Northern fulmar	Breeding	Moderate
			Leach's storm-petrel	Breeding	None
			European shag	Breeding	None
			Arctic skua	Breeding	None
			Great skua	Breeding	Low
			Black-legged kittiwake	Breeding	None
			Arctic tern	Breeding	None
			Atlantic puffin	Breeding	Low
			Common guillemot	Breeding	None
			Razorbill	Breeding	None
Noss SPA	194	185	Northern fulmar	Breeding	Moderate
			Northern gannet	Breeding	Moderate
			Great skua	Breeding	Low
			Black-legged kittiwake	Breeding	None
			Common guillemot	Breeding	None
			Atlantic puffin	Breeding	Low
Buchan Ness to Collieston Coast SPA	202	195	Northern fulmar	Breeding	Moderate
			Herring gull	Breeding	None
			European shag	Breeding	None
			Black-legged kittiwake	Breeding	None
			Common guillemot	Breeding	None
Ronas Hill – North Roe and Tingon Ramsar site	203	201	[redacted]	Breeding	None
			Northern fulmar	Breeding	Moderate
			Arctic skua	Breeding	None
			Great skua	Breeding	Low
			Black guillemot	Breeding	None
The Shiant Isles SPA	213	211	Northern fulmar	Breeding	Moderate
			European shag	Breeding	None
			Black-legged kittiwake	Breeding	None

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SPA name	Distance by sea (km)	Distance direct (km)	Qualifying species	Qualifying season	Potential connectivity
			Common guillemot	Breeding	None
			Razorbill	Breeding	None
			Atlantic puffin	Breeding	None
Fowlsheugh SPA	266	238	Northern fulmar	Breeding	Moderate
			Herring gull	Breeding	None
			Black-legged kittiwake	Breeding	None
			Common guillemot	Breeding	None
			Razorbill	Breeding	None
Fetlar SPA	254	225	Northern fulmar	Breeding	Moderate
			Arctic skua	Breeding	None
			Great skua	Breeding	None
			Arctic tern	Breeding	None
Flannan Isles SPA	256	256	Northern fulmar	Breeding	Moderate
			Leach's storm-petrel	Breeding	None
			Black-legged kittiwake	Breeding	None
			Common guillemot	Breeding	None
			Razorbill	Breeding	None
			Atlantic puffin	Breeding	None
Hermaness, Saxa Vord and Valla Field SPA	249	244	[redacted]	Breeding	None
			Northern fulmar	Breeding	Moderate
			Black-legged kittiwake	Breeding	None
			European shag	Breeding	None
			Northern gannet	Breeding	Moderate
			Great skua	Breeding	None
			Common guillemot	Breeding	None
			Atlantic puffin	Breeding	None
Rum SPA	328	281	[redacted]	Breeding	None
			Manx shearwater	Breeding	Moderate
			Black-legged kittiwake	Breeding	None
			Common guillemot	Breeding	None
St Kilda SPA	324	322	Northern fulmar	Breeding	Moderate
			Manx shearwater	Breeding	Moderate
			European storm-petrel	Breeding	None
			Leach's storm-petrel	Breeding	None
			Northern gannet	Breeding	Low
			Great skua	Breeding	None
			Black-legged kittiwake	Breeding	None
			Common guillemot	Breeding	None
			Razorbill	Breeding	None
			Atlantic puffin	Breeding	None
Mingulay and Berneray SPA	358	347	Northern fulmar	Breeding	Moderate
			European shag	Breeding	None

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SPA name	Distance by sea (km)	Distance direct (km)	Qualifying species	Qualifying season	Potential connectivity
			Black-legged kittiwake	Breeding	None
			Common guillemot	Breeding	None
			Razorbill	Breeding	None
			Atlantic puffin	Breeding	None

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Table 10-5 Stage 2 ornithology screening of SPAs- determination of LSE based on connectivity, use of Project Envelope and vulnerability to activities in the Project Envelope

Abbreviations

N.I.P Nationally Important Population

I.M.P Important Migratory Population

I.B.B.A Internationally Important Breeding Assemblage

SPA name	Qualifying species	Qualifying reason [1]	SPA population size	Potential connectivity	Use of Project Envelope in qualifying season	Potential importance of Project Envelope to SPA population	Vulnerability to wave energy developments (Furness *et al.*, 2012)	Vulnerability to vessel activity (Jarrett *et al.*, 2018)	Potential for LSE
Scapa Flow pSPA (marine SPA)	[redacted]	[redacted]	[redacted]	High	Uncommon	Low	Moderate	Very high	Yes Note, Linkage with Hoy SPA
	Great northern diver	N.I.P. Annex 1 species (non-breeding)	506 individuals	Moderate	Uncommon	Very low	Moderate	High	No
	[redacted]	[redacted]	[redacted]	Moderate	None	None	Moderate	Very high	No
	Slavonian grebe	N.I.P. Annex 1 species (non-breeding)	135individuals	Low	None	None	Low	Very high	No

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SPA name	Qualifying species	Qualifying reason [1]	SPA population size	Potential connectivity	Use of Project Envelope in qualifying season	Potential importance of Project Envelope to SPA population	Vulnerability to wave energy developments (Furness *et al.*, 2012)	Vulnerability to vessel activity (Jarrett *et al.*, 2018)	Potential for LSE
	European shag	I.M.P. non-Annex 1 species (non-breeding)	2,929 individuals	Moderate	Very common	Low	Low	Medium	No
	Common eider	N.I.P non-Annex 1 species (non-breeding)	1,994individuals	Moderate	Common	Low	Low	Medium	No
	Long-tailed duck	N.I.P non-Annex 1 species (non-breeding)	1,393individuals	Moderate	Rare	Very low	Very low	High	No
	[redacted]	N.I.P non-Annex 1 species (non-breeding)	[redacted]	Moderate	None	None	Low	Not included in study	No
	Red-breasted merganser	N,I.P non-Annex 1 species (non-breeding)	539individuals	High	None	None	Low (assumed)	Very high	No
Hoy SPA	[redacted]	N.I.P. Annex 1 species	[redacted]	Moderate	Uncommon	Low	Moderate	Links to Scapa Flow pSPA	Yes

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SPA name	Qualifying species	Qualifying reason [1]	SPA population size	Potential connectivity	Use of Project Envelope in qualifying season	Potential importance of Project Envelope to SPA population	Vulnerability to wave energy developments (Furness *et al.*, 2012)	Vulnerability to vessel activity (Jarrett *et al.*, 2018)	Potential for LSE
	Northern fulmar	I.I.B.A. component only	35,000 pairs	High	Very common	Low	Very low	Not included in study	No
	Arctic skua	I.I.B.A. component only	59 pairs	High	Uncommon	Low	Very low	Not included in study	No
	Great skua	I.M.P. non-Annex 1 species	1,900 pairs	High	Common	Low	Very low	Not included in study	No
	Great black-backed gull	I.I.B.A. component only	570 pairs	High	Common	Low	Very low	Not included in study	No
	Black-legged kittiwake	I.I.B.A. component only	3000 pairs	High	Very common	Moderate	Very low	Not included in study	No
	Common guillemot	I.I.B.A. component only	13,400 pairs	High	Very common	Moderate	Low	Not included in study	No
	Atlantic puffin	I.I.B.A. component only	3,500 pairs	High	Very common	Low	Low	Not included in study	No
North Caithness Cliffs SPA	Northern fulmar	I.I.B.A. component only	14,700 pairs	High	Very common	Low	Very low	Not included in study	No
	Black-legged kittiwake	I.I.B.A. component only	13,100 pairs	Moderate	Very common	Low	Very low	Not included in study	No

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SPA name	Qualifying species	Qualifying reason [1]	SPA population size	Potential connectivity	Use of Project Envelope in qualifying season	Potential importance of Project Envelope to SPA population	Vulnerability to wave energy developments (Furness *et al.*, 2012)	Vulnerability to vessel activity (Jarrett *et al.*, 2018)	Potential for LSE
	Common guillemot	I.M.P. non-Annex 1 species	26,994 pairs	High	Very common	Low	Low	Not included in study	No
	Razorbill	I.I.B.A. component only	2,680 pairs	Moderate	Common	Low	Low	Not included in study	No
	Atlantic puffin	I.I.B.A. component only	1,750 pairs	High	Very common	Low	Low	Not included in study	No
Caithness & Sutherland Peatlands SPA	Arctic skua	I.M.P. non-Annex 1 species	39 pairs	Moderate	Uncommon	Very low	Very low	Not included in study	No
Copinsay SPA	Northern fulmar	I.I.B.A. component only	1,615 pairs	High	Very common	Low	Very low	Not included in study	No
	Great black-backed gull	I.I.B.A. component only	490 pairs	Moderate	Common	Very low	Very low	Not included in study	No
	Black-legged kittiwake	I.I.B.A. component only	9,550 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
	Common guillemot	I.I.B.A. component only	19,732 pairs	Moderate	Very common	Very low	Low	Not included in study	No

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SPA name	Qualifying species	Qualifying reason [1]	SPA population size	Potential connectivity	Use of Project Envelope in qualifying season	Potential importance of Project Envelope to SPA population	Vulnerability to wave energy developments (Furness *et al.*, 2012)	Vulnerability to vessel activity (Jarrett *et al.*, 2018)	Potential for LSE
Marwick Head SPA	Black-legged kittiwake	I.I.B.A. component only	7,700 pairs	High	Very common	Moderate	Very low	Not included in study	No
	Common guillemot	I.M.P. non-Annex 1 species	24,388 pairs	High	Very common	Moderate	Low	Not included in study	No
East Caithness Cliffs SPA	Northern fulmar	I.I.B.A. component only	15,000 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
	Black-legged kittiwake	I.M.P. non-Annex 1 species	31,930 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
	Herring gull	I.M.P. non-Annex 1 species	9,370 pairs	Moderate	Common	Very low	Very low	Not included in study	No
	Great black-backed gull	I.I.B.A. component only	800 pairs	Moderate	Common	Very low	Very low	Not included in study	No
	Common guillemot	I.M.P. non-Annex 1 species	71,509 pairs	Moderate	Very common	Very low	Low	Not included in study	No
	Atlantic puffin	I.I.B.A. component only	1,750 pairs	Moderate	Very common	Very low	Low	Not included in study	No
Auskerry SPA	European storm-petrel	N.I.P. Annex 1 species	3,600 pairs	High	Rare	Low	Very low	Not included in study	No

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SPA name	Qualifying species	Qualifying reason [1]	SPA population size	Potential connectivity	Use of Project Envelope in qualifying season	Potential importance of Project Envelope to SPA population	Vulnerability to wave energy developments (Furness *et al.*, 2012)	Vulnerability to vessel activity (Jarrett *et al.*, 2018)	Potential for LSE
Calf of Eday SPA	Northern fulmar	I.I.B.A. component only	1,955 pairs	High	Very common	Low	Very low	Not included in study	No
	Great black-backed gull	I.I.B.A. component only	938 pairs	Moderate	Common	Very low	Very low	Not included in study	No
	Black-legged kittiwake	I.I.B.A. component only	1,717 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
	Common guillemot	I.I.B.A. component only	8,472 pairs	Moderate	Very common	Very low	Low	Not included in study	No
Rousay SPA	Northern fulmar	I.I.B.A. component only	1,240 pairs	High	Very common	Low	Very low	Not included in study	No
	Arctic skua	I.I.B.A. component only	130 pairs	Moderate	Uncommon	Low	Very low	Not included in study	No
	Black-legged kittiwake	I.I.B.A. component only	4,900 pairs	Moderate	Very common	Low	Very low	Not included in study	No
	Arctic tern	N.I.P. Annex 1 species	1,000 pairs	Moderate	Very common	Low	Low	Not included in study	No
	Common guillemot	I.I.B.A. component only	7,102 pairs	High	Very common	Low	Low	Not included in study	No

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SPA name	Qualifying species	Qualifying reason [1]	SPA population size	Potential connectivity	Use of Project Envelope in qualifying season	Potential importance of Project Envelope to SPA population	Vulnerability to wave energy developments (Furness *et al.*, 2012)	Vulnerability to vessel activity (Jarrett *et al.*, 2018)	Potential for LSE
West Westray SPA	Northern fulmar	I.I.B.A. component only	1,400 pairs	High	Very common	Low	Very low	Not included in study	No
	Arctic skua	I.M.P. non-Annex 1 species	78 pairs	Moderate	Uncommon	Low	Very low	Not included in study	No
	Black-legged kittiwake	I.I.B.A. component only	23,900 pairs	Moderate	Very common	Low	Very low	Not included in study	No
	Common guillemot	I.M.P. non-Annex 1 species	28,274 pairs	Moderate	Very common	Low	Low	Not included in study	No
	Razorbill	I.I.B.A. component only	1,304 pairs	Moderate	Common	Low	Low	Not included in study	No
Sule Skerry and Sule Stack SPA	Northern gannet	I.M.P. non-Annex 1 species	4,890 pairs	High	Very common	Low	Low	Not included in study	No
	European storm-petrel	N.I.P. Annex 1 species	1,000 pairs	High	Rare	Low	Very low	Not included in study	No
	Leach's storm-petrel	N.I.P. Annex 1 species	5 pairs	High	Rare	Low	Very low	Not included in study	No
	Common guillemot	I.I.B.A. component only	6,298 pairs	Moderate	Very common	Low	Low	Not included in study	No

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SPA name	Qualifying species	Qualifying reason [1]	SPA population size	Potential connectivity	Use of Project Envelope in qualifying season	Potential importance of Project Envelope to SPA population	Vulnerability to wave energy developments (Furness *et al.*, 2012)	Vulnerability to vessel activity (Jarrett *et al.*, 2018)	Potential for LSE
	Atlantic puffin	I.M.P. non-Annex 1 species	43,380 pairs	Moderate	Very common	Low	Low	Not included in study	No
Papa Westray SPA	Arctic skua	I.I.B.A. component only	135 pairs	Moderate	Uncommon	Very low	Very low	Not included in study	No
Cape Wrath SPA	Northern fulmar	I.I.B.A. component only	2,300 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
	Atlantic puffin	I.I.B.A. component only	5,900 pairs	Moderate	Very common	Very low	Low	Not included in study	No
Fair Isle SPA	Northern fulmar	I.I.B.A. component only	35,210 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
	Northern gannet	I.I.B.A. component only	1,166 pairs	Moderate	Very common	Very low	Low	Not included in study	No
Troup, Pennan and Lion`s Heads SPA	Northern fulmar	I.I.B.A. component only	4,400 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
Handa SPA	Northern fulmar	I.I.B.A. component only	3,500 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
North Rona and Sula Sgeir SPA	Northern fulmar	I.I.B.A. component only	11,500 pairs	Moderate	Very common	Very low	Very low	Not included in study	No

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SPA name	Qualifying species	Qualifying reason [1]	SPA population size	Potential connectivity	Use of Project Envelope in qualifying season	Potential importance of Project Envelope to SPA population	Vulnerability to wave energy developments (Furness *et al.*, 2012)	Vulnerability to vessel activity (Jarrett *et al.*, 2018)	Potential for LSE
	Northern gannet	I.M.P. non-Annex 1 species	9,000 pairs	Moderate	Very common	Very low	Low	Not included in study	No
Buchan Ness to Collieston Coast SPA	Northern fulmar	I.I.B.A. component only	1,765 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
Sumburgh Head SPA	Northern fulmar	I.I.B.A. component only	2,542 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
Foula SPA	Northern fulmar	I.I.B.A. component only	46,800 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
Noss SPA	Northern fulmar	I.I.B.A. component only	6,350 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
	Northern gannet	I.M.P. non-Annex 1 species	7,310 pairs	Moderate	Very common	Very low	Low	Not included in study	No
The Shiant Isles SPA	Northern fulmar	I.I.B.A. component only	6,820 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
Fowlsheugh SPA	Northern fulmar	I.I.B.A. component only	1,170 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
Fetlar SPA	Northern fulmar	I.I.B.A. component only	9,500 pairs	Moderate	Very common	Very low	Very low	Not included in study	No

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SPA name	Qualifying species	Qualifying reason [1]	SPA population size	Potential connectivity	Use of Project Envelope in qualifying season	Potential importance of Project Envelope to SPA population	Vulnerability to wave energy developments (Furness *et al.*, 2012)	Vulnerability to vessel activity (Jarrett *et al.*, 2018)	Potential for LSE
Flannan Isles SPA	Northern fulmar	I.I.B.A. component only	4,730 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
Hermaness, Saxa Vord and Valla Field SPA	Northern fulmar	I.I.B.A. component only	19,539 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
	Northern gannet	I.M.P. non-Annex 1 species	12,000 pairs	Moderate	Very common	Very low	Low	Not included in study	No
Rum SPA	Manx shearwater	I.M.P. non-Annex 1 species	61,000 pairs	Moderate	Uncommon	Very low	Very low	Not included in study	No
St Kilda SPA	Northern fulmar	I.I.B.A. component only	62,800 pairs	Moderate	Very common	Very low	Very low	Not included in study	No
	Manx shearwater	I.I.B.A. component only	5,000 pairs	Moderate	Uncommon	Very low	Very low	Not included in study	No
Mingulay and Berneray SPA	Northern fulmar	I.I.B.A. component only	10,450 pairs	Moderate	Very common	Very low	Very low	Not included in study	No

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Analysis of Table 10-4 and Table 10-5, indicates that for [redacted] that occur in the Billia Croo test site there is potential for SPA conservation objectives to be undermined. Specifically, the Hoy SPA breeding [redacted] qualifying interest and Scapa Flow pSPA breeding [redacted] qualifying interest. These two SPAs thus require further appraisal.

For all qualifying species other than [redacted] and despite in some cases potential for connectivity of moderate or high strength between the test site area and at least one or more SPA (Table 10-4), it is determined that that there is no potential for the SPA conservation objectives to be undermined. This conclusion is reached on the basis that all except one of these species are rated as having either very low (northern fulmar, Manx shearwater, European storm petrel, Arctic skua, great skua, great black-backed gull, herring gull, black-legged kittiwake and long-tailed duck) or low (northern gannet, European shag, Arctic tern, common guillemot, razorbill, Atlantic puffin and common eider) vulnerability to wave energy development activities (Furness *et al*., 2012). Thus, for all these species there is a lack of potential impact pathway that could give rise to adverse effects.

The one exception noted above is great northern diver, a species which is rated as having moderate vulnerability to wave energy developments (Furness *et al*., 2012). However, following consultation with SNH, it is considered that the potential connectivity between the test site and Scapa Flow pSPA for this species is likely to be too low to give rise to concern for LSE. For great northern diver (non-breeding), there is potential for connectivity if birds that form part of the wintering population within Scapa Flow pSPA also make use of other adjacent waters, such that impacts on these birds could ultimately impact the population using the SPA. The JNCC surveys supporting identification of marine SPAs found low densities of great northern divers near Billia Croo, contiguous with the higher densities observed within Scapa Flow. However, while great northern divers are noted as making relatively short distance swimming movements within wintering locations, we have no information on specific movements within and in vicinity of Scapa Flow. Given absence of site-specific or more general behavioural evidence of connectivity between Billia Croo and Scapa Flow pSPA for (non-breeding) great northern diver, and the very low numbers at Billia Croo relative to the pSPA population (see Tables 10-4 and 10-5), we conclude no LSE for this feature.

Considering the potential for impact pathway and connectivity, and the relatively low abundance of the species at the test site (in the context of SPA and wider population sizes) leads to the conclusion that there is no LSE to for all qualifying species other than [redacted] at any SPA.

Conclusion: There is potential for the test site to have a likely significant effect on the breeding [redacted] qualifying interest of Hoy SPA the [redacted] qualifying interests of Scapa Flow pSPA.

The information in the following section summarises the potential issues relevant to Appropriate Assessment.

Step 3: Can it be ascertained that the test site will not adversely affect the integrity of the SPA, either alone or in-combination with other plans or projects?

This stage of HRA is termed the **Appropriate Assessment**. This stage is undertaken by the competent authority with advice provided by SNH. Appropriate Assessment considers the implications of the proposed development for the conservation objectives of the qualifying interests for which a likely significant effect has been determined. The outcomes of this appraisal are detailed in Section 10.7 Natural Appraisal and summarised below.

At this stage the assessment is required to ascertain whether there would be Adverse Effects on Site Integrity (AESI) because of the plan or project in view of the sites conservation objectives

The key question in any Appropriate Assessment for the testing of wave energy devices and other infrastructure at the Billia Croo test site is whether it can be ascertained that this proposal, alone or in-combination, will not have Adverse Effects on Site Integrity (AESI) for any Natura sites, where it has been advised that there is a likely significant effect.

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The Hoy SPA conservation objectives are:

- To avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
    - population of the species as a viable component of the site;
    - distribution of the species within site;
    - distribution and extent of habitats supporting the species;
    - structure, function and supporting processes of habitats supporting the species; and
    - no significant disturbance of the species.

The Scapa Flow pSPA draft conservation objectives are:

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

As the test site does not overlap with either SPA, the conservation objectives relevant to the Appropriate Assessment are limited to those concerning impacts on qualifying species when they are outwith the SPA. These are to maintain in the long term the following:

- No significant disturbance to the qualifying species (relevant to both Hoy SPA and Scapa Flow pSPA); and
- Population of the species as a viable component of the SPA (relevant to Hoy SPA only).

This appraisal should help inform the Appropriate Assessment, however as stated above any deviation from the Project Envelope description (Section 2) may require further information and subsequent appraisal.

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Table 10-6 Summary of Natura assessment for SPA qualifying features for which Likely Significant Effect is not ruled by HRA screening process. The information in this table is compiled to inform Appropriate Assessment

Activity/potential impact pathway	Qualifying interest: Installation and decommissioning phases	Qualifying interest: Operation/ maintenance phase	Summary of appraisal assessment
Vessel transits and activity (including noise) leading to temporary disturbance	[redacted]	[redacted] (breeding)	There is potential for disturbance of [redacted] from vessel activity. However, the low use of the test site by this species and the wide local availability of alternative habitat in relation to the small scale of the Billia Croo test site and the activities included in the Project Envelope is such that it is considered that any disturbance would not negatively impact on the conservation objective for either of the two connected SPAs. For Hoy SPA, disturbance in the breeding season could lead to the occasional displacement from foraging areas of very low numbers of individual which may be part of the Hoy SPA breeding [redacted] qualifying feature. The birds affected could incur minor losses in foraging time leading to minor reductions in provisioning rates during chick-rearing and could therefore potentially compromise the SPAs conservation objectives relating to disturbance and population sustainability. However, given that only a small proportion of the SPA population could plausibly be affected (the test sites lies beyond the foraging range of most Hoy SPA breeding pairs), the expected small magnitude of the effects on individuals affected and the wide local availability of alternative habitat it is concluded that the disturbance would not be significant and therefore would not compromise the Hoy SPA conservation objectives and therefore there would be no AESI. For Scapa Flow pSPA, following the same reasons detailed above for Hoy SPA, and bearing in mind it is essentially the same [redacted] that are of concern, it is also concluded that that the disturbance from the Project would not be significant and therefore would not compromise the Scapa Flow pSPA (draft) conservation objectives and therefore there would be no AESI.
Loss of and alteration to foraging habitat	[redacted]	[redacted]	Changes to the characteristics of seabed at Billia Croo as a result of the installation and operation of wave energy devices and other infrastructure are

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Activity/potential impact pathway	Qualifying interest: Installation and decommissioning phases	Qualifying interest: Operation/ maintenance phase	Summary of appraisal assessment
(includes indirect effects)			not considered to be important at the scale of the test site and as such it is unlikely there would be significant impacts on diver prey species. Thus, it is unlikely there would be a negative effect on SPA conservation objectives.
Presence of and noise from wave energy device and associated infrastructure leading to displacement	Not applicable to installation phase.	[redacted]	Based on the observed response by breeding [redacted] in Scotland to other fixed man-made structures in the marine environment (such as fish farm cages and navigation buoys) [redacted] it is considered likely that any response to wave energy devices (and other fixed infrastructure) will be spatially limited to their close proximity (approximately <250 m). [redacted] is categorised as having a medium strength vulnerability to displacement from fixed structures in the Scottish marine environment [redacted] There is evidence that [redacted] wintering offshore in the southern North Sea show a much stronger displacement response to large offshore wind farms [redacted] suggesting that the nature of the displacement response shown by this species may vary geographically, seasonally and according to the type of structure involved. Even were the spatial scale of the displacement response to be somewhat greater than predicted (<250m), the size of the area potentially affected would be trivial in the context of the extent of foraging areas locally available. It is concluded there would be no significant impacts on the populations of [redacted] and therefore no negative impact on the conservation objectives of the SPAs.
Accidental release of contaminants	[redacted] (breeding)	[redacted] r (breeding)	[redacted] have high vulnerability to oil and other marine contaminants; plumage soiling and contaminants ingestion is likely to lead to mortality. However, the test facility has multiple embedded mitigation measures to prevent incidents occurring, and in the unlikely event of an incident there will be specialist equipment and trained personnel on hand to rapidly contain and clean up any contamination. The very exposed location would mean that any residual contaminants are quickly dispersed and broken down. Provided protocols designed to avoid and deal with incidents are rigorously observed, it is concluded there would be no significant impacts on the populations of [redacted] species and therefore no negative impact on the conservation objectives of the SPA.

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10.4.2 Appraisal of notified ornithology features of SSSI

SSSIs are designated under the Nature Conservation (Scotland) Act 2004 (as amended) and it is an offence for any person to intentionally or recklessly damage the protected natural features of an SSSI. More information can be found on the SNH website, including SSSI citations and Site Management Statements. Assessment of impacts to SSSIs should consider the likelihood of adverse impacts to the integrity of the area or damage to the natural features for which the site is notified.

The 14 km coastline from Point of Ness near Stromness to Bay Skaill and adjacent to the test site area is designated as the Stromness Heaths and Coasts SSSI. However, no notified ornithology features are associated with this SSSI.

The landward extents of the breeding seabird SPAs considered in Section 10.3.1 are also designated as SSSIs, with breeding seabirds as notified features. The closest of these to the Billia Croo test site are Hoy SSSI and Marwick Head SSSI. The conclusions regarding the potential for the test facility to affect the integrity of these SPAs (see Section 10.3.1) equally applies to the notified ornithology features of the SSSI designations.

In addition to the same breeding seabird species and breeding seabird assemblage cited as SPA qualifying interests for the Marwick Head SPA, the Marwick Head SSSI citation lists breeding jackdaw (not a seabird) as a component of the nationally important seabird colony. Jackdaw is a terrestrial species that makes no use of offshore habitats and therefore it is not plausible that this species would be adversely affected by the Project Envelope.

In addition to the same breeding seabird species and breeding seabird assemblage cited as SPA qualifying interests for the Hoy SPA, the Hoy SSSI citation includes nationally important moorland breeding bird assemblage and breeding peregrine as notified features. The moorland breeding assemblage includes hen harrier, buzzard, merlin, red grouse, golden plover, dunlin, snipe, curlew, redshank, common sandpiper, short-eared owl, stonechat, wheatear, raven and twite. All these species are terrestrial birds that make no use of offshore habitats (peregrine may occasionally hunt over inshore waters) and therefore it is not plausible that any of these species would be adversely affected by the Project Envelope.

10.4.3 Appraisal of other features

Bird species that commonly use the Billia Croo test site in at least moderate numbers and that are either not qualifying interests or features of the above-mentioned SPAs or SSSIs, respectively, or also have substantial regional (Orkney) populations outside of these sites that are relevant for appraisal of potential impacts from the project are black guillemot and European shag. The appraisals below examine the potential for the project to have impacts on the regional populations of these species.

10.4.3.1 European shag (breeding)

This appraisal concerns the potential for the project to affect the European shag Orkney breeding population. Orkney supports approximately 1,900 pairs of breeding European shag, approximately 9% of the Scottish population (Mitchell *et al*., 2004). However, the majority of Orkney shag breeding sites are not part of the qualifying interests or features of SPAs or SSSIs. In contrast, outside the breeding season the majority of shags wintering in Orkney are part of the non-breeding European shag qualifying interest for either the Scapa Flow pSPA or the North Orkney pSPA. As such it is considered that the potential for the project to impact on wintering European shag populations is adequately covered by the appraisal of SPA qualifying features (see Section 10.3.1).

Low to moderate numbers of European shag were frequently observed using the test site during the breeding season; typically, up to 50 birds were present, but exceptionally up to approximately 200 were counted. Were all these to be breeding birds (it is likely that some were non-breeding immature individuals), then they would represent up to approximately 5% of the Orkney breeding population. Additionally, moderate to large numbers (100 to 700 individuals) of shag were often present in the breeding season immediately to the south of the test site in the western parts of Hoy Sound and off Breckness Headland. It is concluded that parts of Billia Croo

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and its immediate vicinity has high importance for the regional (Orkney) population of shags in the breeding season.

However, European shags' preference for feeding on the seabed in relatively shallow water (<30 m deep) means that the immediate vicinity of the five offshore berths (Berths 1 to 5) is likely to be have low importance as foraging habitat for this species compared to the shallower parts of the test site closer to the coast and including the vicinity of the two inner device berths (Berths 6 and 7).

The project would potentially expose European shag to vessel disturbance, localised changes to seabed foraging habitat and the accidental contamination of the local marine environment. However, European shag is rated as having low vulnerability to effects of WECs, other infrastructure and associated vessel activity (Furness *et al*., 2012) and the risks of accidental contamination are low due to the project's embedded mitigation. Therefore, it is considered unlikely that these effects would lead to significant adverse impacts to this species, even at a local level. This species will potentially experience positive effects from the project emanating from creation of artificial reef foraging habitat that develops on fixed structures such as foundations and the use of surface piercing infrastructure for perching.

Appraisal conclusion for European shag (breeding): Any potential impacts are not regarded as important at an Orkney regional level.

10.4.3.2 Black guillemot

Black guillemots were frequently observed year-round in low numbers (maximum count 29) during the surveys of the test site. The numbers seen represent a very small proportion (well below 1%) of the Orkney population estimated to be approximately 6,000 breeding birds (Mitchell *et al.,* 2004).

Black guillemots' preference for feeding on the seabed in relatively shallow water (<40 m deep) means that the immediate vicinity of five offshore berths (Berths 1 to 5) is likely to be have low importance as foraging habitat for this species compared to the shallower parts of the test site closer to the coast and including the vicinity of the two inner device berths (Berths 6 and 7).

The project would potentially expose black guillemot to vessel disturbance, localised changes to seabed foraging habitat and the accidental contamination of the local marine environment. However, black guillemot is rated as having low vulnerability to wave energy devices and associated vessel activity (Furness *et al*., 2012) and the risks of accidental contamination are low due to the project's embedded. Therefore, it is very unlikely that these effects would lead to significant adverse impacts to this species, even at a local level. Indeed, this species will potentially experience positive effects from the project emanating from creation of artificial reef foraging habitat that develops on fixed structures such as foundations and the use of surface piercing infrastructure for perching. The multiple observations during the surveys of black guillemot perched on and gathering around the offshore lease area cardinal buoys provides evidence of such positive effects.

Black guillemot is the sole biodiversity feature of interest for Papa Westray MPA. This MPA is located approximately 53 km north-east of the test site. However, it is unlikely that there is more than negligible connectivity between this site and the test site as black guillemots travel up to only a few kilometres from colonies to forage (Johnstone *et al*., 2018) Furthermore, ringing studies indicate that natal dispersal movements are also relatively short, averaging only 10.5 km (Wernham *et al.*, 2002).

Appraisal conclusion for black guillemots: Any potential impacts are not regarded as important at an Orkney regional level.

A summary of the appraisal for each of the receptors is provided in Table 10.8. Note that, even where no important impacts are identified, in some cases there may still be a recommendation for some mitigation or monitoring. Under these circumstances, mitigation would be regarded as good-practice rather than a necessity, while monitoring may serve to improve generic understanding of the relationships between stressors and receptors.

Given uncertainties regarding some potential impacts and the opportunity to learn from test deployments, some potential mitigation and monitoring measures are presented in Table 10-9.

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10.5 Appraisal of cumulative Impacts

The same seabird receptors that could potentially be affected by the Billia Croo test site may also be potentially affected by other developments and activities (either existing, planned or that are reasonably foreseeable) in the geographic area used by a particular receptor, and thus potentially give rise to a cumulative effect. Whilst recognising that the areas used by some bird species receptors extends further (for example for species that have very large foraging ranges or winter and breed in different areas), for practical purposes the consideration of the potential cumulative effects is limited to other projects and activities in Orkney waters (see Table 3-2).

With the exception of the [redacted] it is concluded that the Billia Croo test site activities would have either no important impacts on seabird species. Therefore, the further consideration of cumulative effects is limited to the breeding [redacted]. Based on observation of non-breeding (wintering) birds, this species is considered to have a high sensitivity to disturbance from vessels (Furness *et al*., 2012; Jarrett *et al*., 2018; Mendel *et al*., 2019). However, there have been no studies of the response of breeding birds to vessel activity. Incidental observations of foraging [redacted] in the breeding season in Shetland suggest a greater tolerance to vessel activity (D Jackson, personal observation).

Any development or activity that includes vessels operating in Orkney inshore waters between April and September [redacted] will potentially contribute to a cumulative disturbance effect to the [redacted]. Developments or activities that involve operating vessels within the Scapa Flow pSPA will potentially contribute to a cumulative disturbance effect on [redacted] qualifying interests of Scapa Flow pSPA and Hoy SPA. In this regard, vessel activity associated with fishing, shell-fish harvesting (e.g. scallop dredging and pot-fishing), fish-farming, Flotta Oil Terminal, ferry services and recreational diving are all likely to be relevant. The amount of vessel activity associated with the test site is likely to be a small but possibly significant addition to the total amount of vessel activity potentially causing disturbance to [redacted]

In the absence of baseline studies on the breeding season vessel activity around Orkney, the response by breeding [redacted] to this activity and the impacts this may have on their population processes (in particular productivity), it is concluded that it is not possible to undertake a quantitative cumulative impact assessment for vessel disturbance. The implication of this conclusion is that such studies are required. Furthermore, examining the list of vessel activities identified above, it seems likely that there has been a gradual increase in vessel activity in Orkney waters over recent decades, particularly in Scapa Flow.

Table 10-7 Summary of appraisal conclusions for seabirds.

Species	Designated sites where significant impact not ruled out (qualifying interest)	Conclusion	Mitigation and/or monitoring
All species	None	Accidental release of contaminants into the marine environment, oil, poses a potentially lethal hazard to all seabird species. Due to the project's embedded mitigation the potential risks to seabirds are concluded to be very low.	Yes see Table 10-8
[redacted] (breeding)	Hoy SPA, Scapa Flow pSPA	[redacted] at moderate to high risk of temporary disturbance by vessel activity and displacement from the presence and operation of infrastructure as per the Project Envelope.	Yes see Table 10-8
Auk and seaduck species,	None	Small numbers of these species are at low to moderate risk of localised and temporary disturbance by vessel.	Yes see Table 10-8

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Species	Designated sites where significant impact not ruled out (qualifying interest)	Conclusion	Mitigation and/or monitoring
European shag, great northern diver		Shag, eider and black guillemot may use project's surface-piercing infrastructure as platforms for roosting and resting.	
Northern gannet, northern fulmar, Manx shearwater, gull species, Arctic tern, skua species.	None	These species are at very low to low risk of localised and temporary disturbance from vessel activity. Gull and tern species may use project's surface-piercing infrastructure as platforms for roosting and resting.	Yes see Table 10-8
European storm petrel	None	The only important impact pathway identified was attraction to lighting above-sea-surface structures. The type of structures present, low potential use of the area by this species and large distance from the nearest breeding colonies indicates that this effect will not cause significant impact.	Yes see Table 10-8
All species	Hoy SPA, Scapa Flow pSPA	No important cumulative impacts are anticipated.	Yes see Table 10-8

Although the test site and its immediate vicinity are used by a wide variety of seabirds and other waterbirds, in an Orkney-wide context the site generally has low or very low importance for these species, mainly as a foraging site. Exceptions are European shag, black-legged kittiwake and northern fulmar, all of which are sometimes present in relatively large numbers; the site is therefore considered to have low to moderate importance for these species. HRA screening in the appraisal shows that many of the birds using the site are likely to be from SPA breeding populations, in particular Hoy SPA and Marwick Head SPA, for example black-legged kittiwake, guillemot, great skua and [redacted]

The appraisal identifies the potential for disturbance from project vessels and displacement from fixed marine infrastructure (e.g. WEC devices) as the most important potential impacts on birds, though for most species any affects would be highly localised. Accidental release of contaminants (in particular oil pollution) and disturbance by lighting are also identified as potential issues for birds but project mitigation measures mean that neither of these are likely to materially impact on bird receptors. Surface-piercing infrastructure (e.g. WEC devices) and their wakes are likely to attract some bird species (e.g. gulls, terns, black guillemot and European shag) through providing perches for roosting and enhanced feeding opportunities; such attraction could lead to localised and small beneficial affects to these species.

Particular attention is drawn to the potential for the project vessel activity to cause disturbance to breeding [redacted] in the test site and its immediate vicinity. There is some uncertainty concerning this species' response to vessel activity during the breeding season and whether the breeding sites of individuals using the test site are within Hoy SPA; monitoring to address these knowledge gaps is suggested.

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Table 10-8 Suggested mitigation and monitoring

Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licence requirement / Likely condition of consent	Explanation
Injury/death	All birds species	Accidental release of contaminants into the marine environment.	Adherence to embedded mitigation in relation to pollution and reporting of incidents of leakage and contamination immediately to the regulator.	Yes	The conclusion of very low risk to birds is dependent on the rigorous adherence to the project's embedded mitigation measures. These are aimed at avoiding contamination events occurring and having protocols and equipment ready to deal with any incidents should they occur. Incidents should be reported immediately to the Regulator, as appropriate, and if required, boat-based and beach surveys organised to assess if any birds are at risk or have become contaminated.
Disturbance and displacement	[redacted]	Vessel activity, response to fixed marine structures	The test site and an appropriate sized buffer should be monitored to determine, frequency, duration and nature of project vessel activity, [redacted] response to devices and vessel activity, and evidence of habituation with time. Breeding season [redacted] flight lines should be mapped to determine breeding sites, and whether they are within the Hoy SPA. Project vessel activity should avoid area used by foraging [redacted] as far as possible.	No	Although this will not be a Licence condition, the information which would result from such monitoring would be very informative for determining the usage of the test site by qualifying species of the Hoy SPA [redacted]

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Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licence requirement / Likely condition of consent	Explanation
Disturbance and displacement/ attraction	Auk species, seaduck species, great northern diver and European shag	Vessel activity, response to fixed marine structures	The test site and an appropriate sized buffer should be monitored to determine any behavioural changes – including habituation and attraction to devices. Frequency, duration and nature of project vessel activity should be monitored to provide context. Project vessel activity should avoid area used by foraging auks, sea duck and shag as far as possible. When not, possible vessels should reduce speeds to <10 knots when diving birds are present.	No	Increased knowledge on the behaviour of bird species near WECs and other infrastructure deployed at the site will serve to inform any appropriate mitigation measures and potentially future WEC designs. Severity of disturbance response is reduced with vessel speed.
Disturbance and displacement/ attraction	Northern gannet, Northern fulmar, Manx shearwater, gull & skua species, Arctic tern	Vessel activity, response to fixed marine structures	The use by tern and gull species of above surface marine structures for resting should be recorded as part of monitoring of devices and components installed at the site.	No	This kind of monitoring will provide an insight into how bird species utilise WECs and other infrastructure deployed at the test site. This may be influenced by different technologies, seasonality and species.
Disturbance because of lighting	European storm petrel	Lighting	Lighting of above surface structures should be designed to provide sufficient light for purpose but avoid excessive bright lights. Flashing or coloured lights may decrease attraction and impact of any statutory lighting.	Yes	All devices, equipment and infrastructure deployed at the test site will be marked and lit in accordance with marine safety standards and as specified by the Northern Lighthouse Board and Maritime and Coastguard Agency. It is anticipated

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Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licence requirement / Likely condition of consent	Explanation
					that all infrastructure protruding above the water surface will be predominantly yellow in colour and, where required, be fitted with flashing lights of a similar brightness to those required on the site's cardinal buoys.

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10.6 Natura Appraisal: Special Protection Areas (Seabirds)

10.6.1 Site details

1(a) Name of Natura site affected & current status

1. From the earlier screening exercise (see Section 10.5), the following SPA were identified as requiring further appraisal based on foraging range, impact pathway and consideration of bird usage of the site using the EMEC Wildlife Observation data:

SPA Name	Current status
Hoy SPA	Classified
Scapa Flow SPA	Proposed

1(b) Name of component SSSI if relevant

Hoy SSSI	Component of Hoy SPA

1(c) European qualifying interest(s) & whether carried forward for further assessment:

Name of SPA	Qualifying interest	Comments
Hoy SPA	Seabird assemblage, breeding	See individual qualifiers
	Arctic skua, breeding	No impact pathway – not carried forward
	Northern fulmar, breeding	No impact pathway – not carried forward
	Great skua, breeding	No impact pathway – not carried forward
	Great black-backed gull, breeding	No impact pathway – not carried forward
	Common guillemot, breeding	No impact pathway – not carried forward
	Black-legged kittiwake, breeding	No impact pathway – not carried forward
	Peregrine falcon, breeding	No impact pathway – not carried forward
	Atlantic puffin, breeding	No impact pathway – not carried forward
	[redacted]	Requires further assessment - see below
Scapa Flow pSPA	[redacted]	Requires further assessment - see below
	Great northern diver, non-breeding	No impact pathway – not carried forward
	[redacted] non-breeding	No impact pathway – not carried forward
	Slavonian grebe, non-breeding	No impact pathway – not carried forward
	European shag, non-breeding	No impact pathway – not carried forward
	Common eider, non-breeding	No impact pathway – not carried forward
	Long-tailed duck, non-breeding	No impact pathway – not carried forward
	[redacted], non-breeding	No impact pathway – not carried forward

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1(d) Conservation objectives for qualifying interests

The conservation objectives for Hoy SPA are:

To avoid deterioration of the habitats of the qualifying species (listed above) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and

To ensure for the qualifying species that the following are maintained in the long term:

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

The draft conservation objectives for Scapa Flow pSPA are:

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

10.6.2 Proposal details

2(a) Proposal title: EMEC Billia Croo Test Site – Environmental Appraisal

2(b) Date consultation sent: N/A

2(c) Date consultation received: N/A

2(d) Name of consultee: SNH

2(e) Name of competent authority: Marine Scotland

2(f) Details of proposed operation

This appraisal is being carried out in response to the development of the environmental documentation used by developers at EMEC in order to assist in streamlining the appraisal process required to inform the Marine Licence/S36 consenting process for deployments (wave energy devices and other infrastructure) at the test site at Billia Croo. For further details please see the Introduction (Section 1) and the Project Envelope description (Section 2) which will explain the parameters included within this appraisal.

The test site at Billia Croo has been in existence since 2003. There are currently (as of February 2019) five cabled offshore berths and two inshore berths, assigned to different developers, some of whom hold a Marine Licence for their projects. The Project Envelope description (Section 2) describes the maximum parameters used in this appraisal.

10.6.3 Appraisal in relation to Regulation 48

3(a) Is the operation directly connected with or necessary to conservation management of the site? (Yes or No)

Answer: No

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3(b) Is the operation likely to have a significant effect on the qualifying interest? Consider each qualifying interest in relation to the conservation objectives.

Hoy SPA – [redacted]

[redacted] Therefore, there is potential for the test site, through disturbance and displacement effects, to have a likely significant effect on the Hoy SPA [redacted] ualifying feature. This qualifying feature is in favourable maintained condition, it was last assessed in 2007.

Scapa Flow pSPA – [redacted]

At its closest the landward extent of Scapa Flow pSPA is 2 km away from the Billia Croo test site.

[redacted] Therefore, there is potential for the test site, through disturbance and displacement effects, to have a likely significant effect on the Scapa Flow pSPA breeding [redacted] qualifying feature.

Summary of potential impacts pathways from the installation, decommissioning, operation and maintenance of wave energy devices and other infrastructure at Billia Croo test site:

The table below provides as summary of the potential impact pathways identified for each species according to those activities likely to occur through the installation, decommissioning, operation and maintenance of wave devices and other infrastructure at the Billia Croo test site. Impact pathways anticipated not to potentially give rise to a LSE to any SPA qualifying species are excluded from the table. Further commentary on these impact pathways is provided in Table 10.1 and 10.2.

Impact pathway	Installation and decommissioning	Operation or maintenance
Installation and maintenance vessel(s) transits, manoeuvring and activity (includes noise) leading to disturbance*	[redacted]	[redacted]

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Presence of wave device and associated infrastructure leading to displacement (including underwater noise	Not applicable to installation – see operation or maintenance column	[redacted]

* The term 'disturbance' includes all behavioural responses of biological consequence, including displacement from the vicinity of the activity.

3(c) Appraisal of the implications for the site in view of the site's conservation objectives

Overview of existing information

The results of the EMEC Wildlife Observation survey programme undertaken between 2008 and 2015 (EMEC unpublished bird survey data, Robbins, 2012; Long, 2017) provide detailed information on the occurrence of birds in the test site (see Section 10.3). Definitive information for SPAs relating to qualifying interests, location, conservation objectives and site condition is held on SNH SiteLink database.

Appraisal of impacts

IMPACTS FROM INSTALLATION, DECOMMISSIONING, OPERATION & MAINTENANCE ACTIVITIES

Section 2 (Project Envelope) summarises the anticipated marine works associated with installation, operation and maintenance activities. The response of seabirds to vessel traffic and the presence of fixed structures in the marine environment varies between species (Ronconi and St Clair, 2002; Jarret *et al*., 2018, Furness *et al*, 2012). Langton *et al*. (2011) suggested that some species may habituate to regular predictable stimuli better than unpredictable irregular ones and the magnitude of behavioural change may decrease over time (Schwemmer *et al*., 2011). Seabirds also differ in their susceptibility to the adverse effects of surface pollutants such as oil spills (Williams *et al*., 1995). [redacted]

Impact pathway:	**Vessel activity leading to disturbance**

[redacted] **(breeding)**	**Hoy SPA**
	Scapa Flow pSPA

A variety of types and sizes of vessels are used at the Billia Croo test site by developers depending on the activity being undertaken and the availability of vessels at that time. The Project Envelope description (Section 2) provides an outline of typical activities.

The test site standard operating procedure allows multiple developers to perform operations within the test site simultaneously and this could result in several vessels (very unlikely to exceed ten vessels) operating within the test site at any one time. Nevertheless, the duration of multiple vessel activity is likely to be relatively focused and short. Indeed, for much of the time there would be no project vessel activity in the test site.

It is considered likely that there is potential for disturbance from single or multiple vessel activity (noise and or presence) to affect [redacted]. Survey results indicate that it is very unusual for more than single or two [redacted] to be present in the test site, thus a greater number of vessels present would not necessarily mean that a greater number of individual [redacted] would be at risk of disturbance.

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Given the low use of the test-site by [redacted] and the expected long periods of low or no vessel activity it is anticipated that the frequency of incidents of [redacted] vessel disturbance will be relatively low. Furthermore, it is considered that the extensive availability of alternative foraging habitat for [redacted] in relation to the scale of the Billia Croo test site is such that any disturbance would not negatively impact on the conservation objectives for either of the two potentially connected SPAs, specifically the maintenance of the populations of these species as a viable component of the SPA.

Impact pathway:	**Displacement from fixed structures**

[redacted] (breeding)	**Hoy SPA**
	Scapa Flow pSPA

On the basis of observation of Scottish breeding [redacted] It is considered that the extensive availability of alternative foraging habitat for [redacted] in relation to the scale of the Billia Croo test site is such that any displacement would not negatively impact on the conservation objectives for either of the two potentially connected SPAs, specifically the maintenance of the populations of these species as a viable component of the SPA.

Impact pathway:	**Accidental release of contaminants**

[redacted] (breeding)	**Hoy SPA**
	Scapa Flow pSPA

Provided there is rigorous adherence to embedded mitigation measures, it is considered that there is a very low risk that accidental release of contaminants, such as oil, will negatively impact [redacted] using the test site. These embedded mitigation measures are aimed at avoiding contamination events occurring and having protocols and equipment ready to deal with any incidents should they occur. Even were a contamination event to occur it is anticipated that it would be of small scale and short duration and at worst lead to the death of a very small number of [redacted] constituting a very small proportion of the SPA populations potentially affected. It is thus considered that accidental release of contaminants would not negatively impact on the conservation objectives for either of the two potentially connected SPAs, specifically the maintenance of the populations of these species as a viable component of the SPA.

Impact pathway conclusions

It is concluded that none of the three impact pathways identified as having potential to affect [redacted] would negatively impact on the conservation objectives of the two SPAs where this species is a qualifying interest, specifically the maintenance of the populations of these species as a viable component of the Hoy SPA and Scapa Flow pSPA.

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Mitigation

Adherence to the principles set out in the Scottish Marine Wildlife Watching Code will help reduce the potential for disturbance effects from vessel activity, in particular vessel limiting speeds to below 10 knots when divers, auks and seaduck are present nearby. The development of an appropriate vessel management plan that co-ordinates vessel activities across individual projects/developers and that takes into consideration the management of multiple simultaneous operations with the aim of mitigating vessel disturbance impacts at the test site and during transits outwith the site.

As already mentioned, it is imperative that the project's embedded mitigation to avoid and deal with accidental release of contaminants is adhered to. Any contamination incidents should be reported immediately to the Regulator, as appropriate, and if required, boat-based and beach surveys organised to assess if [redacted] and other seabirds are at risk or have become contaminated.

Monitoring

Monitoring of the nature, frequency and duration of project vessel activity and the routes taken by project vessels. Complimentary monitoring of the response by (breeding) [redacted] (and other potentially sensitive species) to project vessel activity and collecting of evidence of behavioural habituation with time.

Monitoring of the occurrence of [redacted] (and other potentially sensitive species) relative to proximity from test-site berths and complimentary information on the presence and operational status of WEC devices installed there.

Studies to map [redacted] flight lines to provide empirical evidence as to whether breeding birds from Hoy SPA are regularly feeding in the Billia Croo test site.

Conclusion:

It is considered that the Billia Croo test site will not adversely affect the integrity of any of the aforementioned SPAs.

10.6.4 Conditions or modifications required

Condition:	**Reason: N/A**
No conditions are required for HRA purposes however recommendations for monitoring and or mitigation to be incorporated into the PEMP.	

10.6.5 Conclusion

Conclusion:

Likely significant effect but the appraisal carried out demonstrates that there would no Adverse Effects on Site Integrity (AESI) of any of the aforementioned SPAs.

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11 OTTERS

Stage 1 of this appraisal defined the categories of potential effects as presented in Table 3-1. The appraisal now picks up at Stage 2 of the methodology where effect pathways and importance are identified as described in Section 3.

11.1 Potential effects

For otter receptors, the defined potential effect categories are applied to activities/effect pathways relevant to activities as described in the Project Envelope. First, potential effects are considered in broad-principles. Deployment, installation and decommissioning effects (Table 11-1) are addressed separately from those during the operational and maintenance phases (Table 11-2).

Note that details specific to Billia Croo, both environmental and relating to project-specifications, are not considered until the detailed appraisal later in this section.

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Table 11-1 Potential effects on otter receptors during deployment, installation and decommissioning of infrastructure

Potential effects from device installation and deployment
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels (e.g. jack-up barge; multi cat; workboat; DP vessel; dive-support vessel; crane-barge; tug; specialist cable-laying vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices)

Activity/potential effect pathway	Natural heritage feature	Potential importance and reasoning
Installation and decommissioning vessel(s) presence, transiting and manoeuvring leading to disturbance	Otters	**Potentially important** – otters may be sensitive to vessel presence and associated activities taking place in the nearshore environment. Importance will depend upon the duration and intensity of vessel activity, the location in which it takes place (including distance from shore), habitat use by otters in the area, and the opportunity for those animals to avoid areas of disturbance. The need for a licence to disturb EPS should be considered.
Underwater noise from foundation/mooring installation methods and vessels leading to disturbance, auditory injury, or death	Otters	**Not important** – hearing sensitivity in this species is greatly reduced compared to marine mammals (e.g. dolphins, whales and seals). Non-percussive foundation drilling or pile-driving operations have the potential to produce low-frequency continuous underwater sounds which range between 0.01 Hz – 100 Hz (Kvaerner Cementation Foundations, Ltd., 2002; Rice, 1983). Whilst in-water hearing by Eurasian otters is not yet fully understood, studies on the hearing ability of another semi-aquatic carnivore, the sea otter (*Enhydra lutris*), have shown that hearing levels peak at high frequencies around 8 kHz (NMFS, 2018; Ghoul and Reichmuth, 2014; Au *et al.*, 2000). Evidence also suggests that sea otters, which are likely to have adapted better in-water hearing than Eurasian otters which spend 4.5 times more time on land (Nolet and Kruuk, 1989), are poorly equipped at separating acoustic signals from background noise if frequencies are below 2 kHz (Ghoul and Reichmuth, 2014). As foundation and mooring installation will emit sound at low frequencies which are likely be inaudible to Eurasian otters, and which will take place beyond the range of marine habitat use for this species, it

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Activity/potential effect pathway	Natural heritage feature	Potential importance and reasoning
		is unlikely that installation activities will cause a disturbance offence to otters under the Habitats Directive or per the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).
Underwater noise from active acoustic equipment leading to disturbance	Otters	**Not important** – whilst active acoustic monitoring equipment may generate some underwater noise at frequencies which overlap with the hearing abilities of otters, otters are not likely to occur within the vicinity of these monitoring devices. Monitoring devices are likely to be deployed in the immediate vicinity of WECs and other infrastructure, or as a part of their infrastructure, more than 0.5 km from shore. Given marine habitat use by otters is limited to shallow nearshore environments where they target small subtidal fishes and coastal crustaceans (Carss, 1995), the deep waters of the test site extension do not constitute marine habitat which is generally used by this species. Thus, this impact pathway is unlikely to cause a disturbance offence disturbance offence to otters under the Habitats Directive or per the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).
Habitat loss/damage	Otters	**Not important** – damage to or loss of subtidal foraging habitat by device foundation or cable/infrastructure installation and deployment is unlikely to result in a significant loss of important marine habitat for a predominantly terrestrial species. Installation activities will take place outwith the range of marine habitat use for Eurasian otters, which predominantly forage for short periods adjacent coastlines (Nolet and Kruuk, 1989). Moreover, vessels employed for installation activities within the test site are unlikely to utilise the shallow water habitat targeted by this species, due to limitations from the draft of the vessel. As such, no loss or damage to marine habitats are anticipated from activities taking place at Billia Croo. *Note: this appraisal does not address loss or damage of onshore habitats, of which none are anticipated from activities defined by the Project Envelope.*

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Table 11-2 Potential effects on otter receptors during operations and maintenance of infrastructure

Potential effects from device operation and maintenance
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Physical presence of device(s), foundations, moorings, buoys and other infrastructure on the seabed, in the water column or above the surface > Operation of device(s)/power generation > Repeat removal and redeployment of equipment for maintenance (e.g. device removed from water or floating structure removed from berth; replacement of mooring system) > Other maintenance activities (e.g. biofouling removal; ROV/diver inspection or repairs) > Use of vessels (e.g. DP vessel; jack-up barge; multi cat; workboat; dive-support vessel; crane-barge; tug) > Use of equipment to monitor devices in situ or other environmental parameters (e.g. ROV, cameras or acoustic devices)

Activity/potential effect pathway	Natural heritage feature	Potential importance and reasoning
Maintenance vessel(s) presence transiting and manoeuvring leading to disturbance	Otters	**Potentially important** – some operations occurring in proximity to the shoreline may cause disturbance of otters at holts[32] or resting sites and may require a licence to disturb EPS. The degree of effect and need for any licence conditions will depend upon vessel types and activities, distance to shore and the presence and usage of any known otter holts.
Underwater noise from device operation leading to disturbance	Otters	**Not important** – hearing sensitivity in this species is greatly reduced compared to marine mammals (e.g. dolphins, whales, and seals). Whilst in-water hearing by Eurasian otters is not yet fully understood, studies on the hearing ability of another semi-aquatic carnivore, the sea otter (*Enhydra lutris*), have shown that hearing levels peak at frequencies around 8 kHz (NMFS, 2018; Ghoul and Reichmuth, 2014; Au *et al.*, 2000). Evidence also suggests that sea otters are likely to have adapted better in-water hearing than Eurasian otters,

[32] Holt: the den of an otter.

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Activity/potential effect pathway	Natural heritage feature	Potential importance and reasoning
		which spend 4.5 times more time on land (Nolet and Kruuk, 1989), yet are still are poorly equipped at separating acoustic signals from background noise if frequencies are below 2 kHz (Ghoul and Reichmuth, 2014). Device operations are not anticipated to emit high frequency sounds which are likely be inaudible to Eurasian otters. Moreover, WECs are likely to be deployed more than 0.5 km from shore. Given marine habitat use by otters is limited to shallow nearshore environments where they target small subtidal fishes and coastal crustaceans (Carss, 1995), the deep waters of the test site extension do not constitute marine habitat which is generally used by this species. Thus, this impact pathway is unlikely to cause a disturbance offence to otters under the Habitats Directive or per the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).
Underwater noise from active acoustic equipment leading to disturbance.	Otters	**Not important** – whilst active acoustic monitoring equipment may generate some underwater noise at frequencies which overlap with the hearing abilities of otters, otters are not likely to occur within the vicinity of these monitoring devices. Monitoring devices are likely to be deployed in the immediate vicinity of WECs, or as a part of their infrastructure, more than 0.5 km from shore. Given marine habitat use by otters is limited to shallow nearshore environments where they target small subtidal fishes and coastal crustaceans (Carss, 1995), the deep waters of the test site extension do not constitute marine habitat which is generally used by this species. Thus, this impact pathway is unlikely to cause a disturbance offence disturbance offence to otters under the Habitats Directive or per the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).
Other maintenance activities (non-vessel based) leading to disturbance	Otters	**Not important** – maintenance activities include inspection (e.g. divers/ROV), repairs or temporary retrieval or replacement of nacelles by winch. In all cases it is the presence of the accompanying vessel that presents the disturbance risk, which is appraised separately.
Habitat loss/damage	Otters	**Not important** – damage to or loss of subtidal foraging habitat by device operation is unlikely to result in a significant loss of important marine habitat for a predominantly terrestrial species. Installation activities will take place outwith the range of marine habitat use for Eurasian otters, which predominantly forage for short periods adjacent coastlines (Nolet and Kruuk, 1989). Moreover, vessels employed for maintenance activities within the test site are unlikely to utilise the shallow water habitat targeted by this species, due to limitations from the draft of the vessel. As such, no loss or damage to marine habitats are anticipated from activities taking place at Billia Croo. *Note: this appraisal does not address loss or damage of onshore habitats, of which none are anticipated from activities defined by the Project Envelope.*

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11.2 Natural heritage context

Eurasian otters (*Lutra lutra*; also known as the European otter) are listed as species of European Community interest in Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Appendix II of the Bern Convention, and in Annex II and IV of the European Commission (EC) Habitats Directive, as ratified through the Wildlife and Countryside Act 1981 (as amended), and therefore requiring strict protection in UK territorial waters. Those species which are listed in Annex IV of the Habitats Directive are termed EPS. Eurasian otters are additionally protected within the UK through their inclusion as a priority species in the Biodiversity Action Plan (BAP) 1995 and as Scottish Priority Marine Features (PMFs) (Tyler-Walters *et al.*, 2016).

Eurasian otters have the widest geographical range of any otter species and constitute the only native otter in the UK. Following historic population lows from decades of population loss, otter populations have shown strong recovery of population estimates in recent years (SNH, 2015; Strachan, 2007). Population trend data indicates a population increase with projections of long-term stability of this species and maintenance of its 'favourable' conservation status, pending continued conservation of its natural habitats (SNH, 2015; JNCC, 2007). Threats to otters include but are not limited to: pesticide use; hunting; pollution; static gear fishing; drainage management, modification of hydrographic function, inland water courses, and water levels; and infilling of freshwater sources, such as ponds, pools, marshes or potential freshwater sources, such as pits, dykes, and ditches (JNCC, 2007).

As semi-aquatic mammals, otters use both marine and freshwater habitats for foraging purposes, but terrestrial habitats for all other biological functions (DECC, 2016). Habitat use by otters predominantly takes place on land, where they socialise, rest and shelter. Eurasian otters are thought to spend nearly two-thirds of the day at rest-sites (Beja, 1996) and 25% more time resting than hunting, indicating the importance of their terrestrial shelters (i.e. holts) to their biological functions (Nolet and Kruuk, 1989). Short duration, nocturnal aqueous hunting bouts (approximately 13.7 min on average) are followed by extended periods of grooming and sleeping on land, particularly for coastal otters which have to remove salt from their fur after foraging in the sea (Carss, 1995; Nolet and Kruuk, 1989). Otters are thought to primarily utilise shallow waters (i.e. within the 10 m depth contour) for foraging activities, wherein they hunt for subtidal crustaceans and other shellfish species (Carrs, 1995).

Coastlines which have ample peat-cover, rich seaweed communities and a freshwater supply constitute optimal coastal marine habitat for otters (DECC, 2016). Unsurprisingly, the coastlines of Scotland form important habitat for this species (JNCC, 2018b). Approximately 50% of Scottish otters are coastally dwelling and thought to forage almost solely on marine prey, particularly in the west coast (SNH, 2015). Coastal otters are thought to have reduced home ranges (i.e. up to approximately 5 km of coastline) in comparison to their freshwater counterparts (SNH, 2015; Carrs, 1995).

The Orkney Islands constitute important habitat to UK otters, though the distribution of this species varies across the islands (DECC, 2016). The small uninhabited island of Switha, located 2 km south of Flotta, and the area comprising Northwall, on northeast Sanday Island have been identified as coastal areas which regularly support otters (Orkney Islands Council, 2019). These locations, which are also SSSIs, are more than 20 km and 60 km from Billia Croo, respectively. There are also reports of regularly occurring otters at Brig O'Waith, near the mouth of the Loch of Stenness, which is a little more than 6 km from Billia Croo (Northlink Ferries, 2019). However, the otters have not been observed in this area to such a degree as to be included as a qualifying feature for the Loch of Stenness SAC (JNCC, 2015c). EMEC wildlife observations collected between 2009 and 2015 only include two otter recordings within the marine environment (EMEC wildlife observations data 2009 - 2015), indicating that the coastline near Billia Croo does not constitute important habitat to this species. This conclusion was additionally supported by a dedicated otter survey which determined the Billia Croo area was not regularly used by otters, though evidence of occasional use was collected (Booth, 2010).

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11.2.1 Protected sites with otter features

There are several sites with otter features located in Orkney, including: the Loch of Isbister SAC (8 km north-north-east), Switha SSSI (23.5 km southeast), and Northwall SSSI (60 km northeast). Otters form a qualifying, but not primary feature of the Loch of Isbister SAC, which offers freshwater habitat for this species. The Switha and Northwall SSSIs protect coastal otters in Orkney, which occur with less regularity than in Shetland (Kruuk *et al.,* 1989). However, unlike the Loch of Isbister SAC, these sites are located on separate islands from the Orkney mainland, with vast marine waterways to traverse. Given relevant knowledge of habitat use by coastal otters being particularly spatially constrained (SNH, 2015; Carrs, 1995), it is unlikely that the otter features at either the Switha or Northwall SSSIs would travel to the Billia Croo area, and as such the otter features protected at these two sites are considered beyond the range of connectivity with Billia Croo.

11.3 Summary of impact appraisal for Billia Croo

This impact appraisal takes account of a maximum-case scenario based on the Project Envelope where all available berths within the test site are developed and operating at capacity. It addresses the differing consenting and licensing regimes. This appraisal will inform the consenting process for both Marine Licence and S36 applications. However, it should be noted that if there are key deviations in the device design or in any activity (deployment, installation, decommissioning, operations and maintenance), further appraisal work may be required. Any additional appraisal work required will be undertaken by the individual developer (further advice should be sought from EMEC in the first instance).

Table 11-3Table 4-5 presents the relevant legislation and the reasons for undertaking an appraisal for several features in the test site area.

Table 11-3 Appraisal mechanism for otter species and habitats

Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
Qualifying features of European sites	The Conservation of Habitats and Species Regulations 2017 (Note: these regulations apply in Scotland in relation to certain specific activities (reserved matters), including consents granted under Sections 36) Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	Yes	Connectivity with the Loch of Isbister SAC is considered in Section 11.4
European Protected Species	The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	Yes	Otters are listed as EPS.
Notified features of SSSIs	Nature Conservation (Scotland) Act 2004 (as amended)	No	SSSIs with otter features in Orkney are located on other islands beyond mainland Orkney and therefore considered beyond the range for connectivity with Billia Croo.
Protected features of MPAs	Marine (Scotland) Act 2010	No	Not capable of affecting protected otter features of any MPAs.
PMFs	Marine (Scotland) Act 2010	Yes	Otters are PMFs.

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Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
Other sensitive natural heritage features	Appraisal of other features under: > The Wildlife and Countryside Act 1981 > The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (relevant to projects located 0-12 nm from shore) > The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 > Marine (Scotland) Act 2010	No	captures assessment of all other sensitive otter features at a population scale of concern.

11.4 Qualifying features of protected sites

Whilst many SACs have been designated for the protection of otters in the UK, the vast majority of these sites encompass terrestrial or freshwater habitats. The only SAC designated for the protection of otters in Orkney is the Loch of Isbister SAC, located approximately 11.8 km north-north-east from the Billia Croo test site (JNCC, 2015d). The Loch of Isbister SAC protects a shallow eutrophic lake which supports a variety of native flora. Otters constitute a qualifying feature of this site but are not a primary reason for its selection (JNCC, 2018c).

Given the distance of the Loch of Isbister SAC from the Billia Croo test site, and the limited observations of otters near the test site (n=2; EMEC wildlife observations data 2009 - 2015), it is considered that there is no connectivity with this site or its otter qualifying features. Therefore, it is anticipated that there will be no Likely Significant Effect (LSE) to the Lock of Isbister SAC from activities taking place at the Billia Croo test site and no further assessment under HRA is required.

Appraisal conclusion for qualifying features of protected sites: The Project Envelope area is not overlapping or directly adjacent to any designated protected sites for otter. The Billia Croo test site is not directly connected with, or necessary to site or conservation management of, any SAC in the UK and it is concluded that there is no connectivity and no impact pathway to the otter qualifying features at the Loch of Isbister SAC or any other European sites.

11.5 Appraisal of EPS

EPS include those species listed under Annex IV of the Habitats Directive as species of European Community Interest, and therefore, in need of strict protection. Articles 12 and 16 of the Directive outline the protective measures required under this international policy. EPS in the UK are defined as those species listed on Annex IV of the Habitats Directive whose natural range includes any area within the UK and UKCS.

This legislation is transposed in the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended; also, referred to as the 'Habitats Regulations' to cover the protection of EPS within Scottish territorial waters (to 12 nm). SNH is the statutory nature conservation body which advises on the protection of EPS and acts as the licensing authority in Scotland (including Scottish waters) under the Habitats Regulations. It is worth noting that where works may disturb otters, no consideration will be given to a licence application unless an otter survey has been carried out.

11.5.1 Summary of the legal requirements for EPS

The Habitats Regulations provide protections for species of conservation importance, as listed in Schedules 2 & 4 therein and in Annex IV of the Habitats Directive, through the introduction of offences against disturbing, injuring or killing EPS. Refer to Section 8.6.1 for detailed information on legal requirements.

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An EPS licence is likely to be required for any activities with the potential to cause disturbance, injury or death of otters, or destruction or damage to their breeding or resting places (i.e. holts).

11.5.1.1 Licence requirements

Impacts to otters at the Billia Croo test site may arise from noise emissions from: vessel activities during the installation and decommissioning, and operation and maintenance stages. These potential disturbance pathways necessitate consideration of EPS licensing and its regulatory requirements. The appraisals below are informed by knowledge of otter distributions at the time of writing. Proposal modifications may require further assessment if there is any change in the conservation status of otters, as these may have implications for the requirement of a licence to disturb EPS or the appropriate mitigation for those proposals. Mitigation may negate the need for a licence to disturb EPS or may be included as a condition of the licence.

Licences may be granted to authorise activities that could affect EPS which would otherwise be illegal under the Habitats Regulations. Three tests must be satisfied before the licensing authority can issue a licence under Regulation 44(2) of the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) to permit otherwise prohibited acts. Appendix 1 outlines the three tests which must be satisfied in application for an EPS licence to disturb; such an application may be rejected unless these tests are satisfied. **The following appraisal first considers impacts in relation to whether an offence is likely under the protection afforded to otters under the Habitats Regulations. It then considers whether a licence to disturb EPS is required to address this and if so, provides commentary in relation to impacts upon Favourable Conservation Status (i.e. Test 3).**

Further appraisal may be required if (a) a proposal is outside of the Project Envelope description, (b) if knowledge/data on the status of cetaceans at the test site or in their natural range changes, or (c) if knowledge regarding potential impact pathway changes. These scenarios aside, the appraisal below should be adequate to inform licensing and consenting decisions. Current knowledge on the conservation status of otters is summarised in Section 11.2 above.

11.5.2 Disturbance impacts

Marine Scotland (2014) defines disturbance as any activity which is likely "to significantly affect the local distribution or abundance of the species to which it belongs". Guidance from the European Commission (2007) states that a disturbance has a significant impact to a species localised distribution or abundance which may be long-term or temporary. These interpretations of disturbance can be summarised as any activity which may adversely impact the Favourable Conservation Status (FCS) of a population.

Whilst disturbances to otters at or near their holts are not expected to result from any activities described in the Project Envelope, the presence of installation, decommissioning and maintenance vessels, including transiting and manoeuvring of those vessels, forms a potential source of disturbance in the marine environment. This pathway has been reviewed for its potential to cause an offence under the Habitats Regulations, including an assessment of potential impacts to the FCS of otter populations. The appraisal then provides recommendations on the requirement of an EPS licence to address these impacts.

11.5.2.1 Installation, decommissioning and maintenance vessel(s) presence, transiting and manoeuvring leading to disturbance

Vessel disturbance to otters is likely to be limited, due to minimal spatial and temporal overlap between otters and vessel presence in the Billia Croo area. A range of vessels of varying sizes and draughts will be employed at the Billia Croo test site. The majority of vessel activity, particularly during the installation and decommissioning phases, will take place near the WECs and other infrastructure, which are predominantly located more than 2 km offshore and outwith the 10 m depth contour targeted by otters for foraging purposes. Area use by vessels in the inshore lease area (Figure 1-1) will be limited by vessel draft and most sheltered, shallow water environments targeted by otters (Booth, 2010) are likely to be too shallow for vessels travel through safely. Otter survey data collected for EMEC suggests that the steep, exposed beach at Billia Croo does not constitute ideal habitat for this species and there is limited evidence of their habitat use in the Billia Croo area (Booth, 2010; EMEC, 2016). Given marine habitat use by otters is limited to the nearshore environment where they can target shallow water prey and maintain proximity to their holts (Carss, 1995), it is

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unlikely that otters will overlap spatially with installation, decommissioning or maintenance vessels. Moreover, as otters are considered nocturnal hunters which forage in the aquatic environment at night (Carss, 1995), there is little scope for otters and vessels to coincide temporally. Whilst the majority of vessel use at Billia Croo will largely take place during daylight hours for safety and practicality purposes, work will occur during the hours of darkness. However, procedures are in place to reduce the potential for vessel disturbance by limiting lighting to navigational lighting and lighting for the deck space only. As such, any disturbance to otters would be limited to a very few number of individuals and will not have population-level repercussions or alter the FCS of this species.

Potential disturbance to marine species from vessel presence is anticipated to increase with increased vessel numbers. The potential disturbance generated by the use of multiple vessels across the site will be managed via the use EMEC SOPs. The Control of Work SOP controls developer access and use of the test site under a permitting scheme to ensure any risks to health and safety are minimised across Billia Croo. Under this operating plan, a maximum of 12 vessels are permitted to operate on-site simultaneously. However, the prospect of this maximum being reached is small due to the low likelihood that the operating schedules of all permitted vessels will overlap. Those vessels which do overlap in operating time are likely to do so for a short-period. As the Billia Croo area does not appear to constitute important habitat to Eurasian otters, it is considered unlikely that installation, decommissioning and maintenance vessel presence will lead to disturbance events.

For the reasons above, vessel activities at Billia Croo are not anticipated to negatively impact otters or compromise the FCS of this species across its natural range.

Appraisal Conclusion for disturbance impacts to otters as EPS: Within the bounds of the Project Envelope, it is considered that disturbance impacts from installation, decommissioning and maintenance vessel presence are unlikely and will not be detrimental to the maintenance of otter populations or the FCS of this species across its natural range.

11.6 Appraisal of PMF and other natural heritage interests

Otter are listed on the Scottish Biodiversity List and are also listed as PMFs. Under the legal requirements as an EPS considered in Section 11.5.1, it is considered that potential impacts to the species in relation to its status as a PMF and presence on the Scottish Biodiversity List have been sufficiently addressed and therefore no further consideration is required.

11.7 Appraisal of cumulative impacts

Cumulative impacts are those generated by intersecting projects or activities which have the potential to intensify impacts of the Project Envelope activities on sensitive receptors. For impacts to otters, the relevant cumulative impact pathways include other sea users which have the potential to interact with otters in the nearshore marine environment, such as recreational vessels, as well as transiting vessels passing nearby.

Vessel activity by other sea users will be limited within the Billia Croo test site area. The region is not targeted by recreational sea users, for example for fishing or wildlife watching activities. The 2019 NRA reports that most recreational crafts encountered in the vicinity of the Project Envelope tend to be on passage past Billia Croo and that most choose to pass either inshore or offshore of the test site (Marine Risk Consultants Ltd, 2019). Boating intensity for recreational crafts in the Project Envelope is classed as low, with less than 400 recreational boats passing within 500 m of the Project Envelope annually (Marine Risk Consultants Ltd, 2019).

There is some commercial vessel activity which has the potential to introduce cumulative impacts with Project vessel activities. This includes ferry vessels and vessels used for operations and maintenance at nearby aquaculture sites. The nearest ferry vessel transit lanes are those of the Stromness-Scrabster, Stromness-Graemsay, and Stromness-North Hoy ferry routes, located 6 km south of Billia Croo (Figure 3-2). Although ferry vessels may be large and introduce a greater disturbance than some of the vessels described in the Project Envelope, these commercial vessels will be limited by their draught, which inhibits travel in the shallow

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nearshore environment, and they are not anticipated to dramatically deviate from their set routes. For this reason, potential overlap with these vessels will be limited and are not anticipated to generate cumulative disturbance impacts to otters.

The nearest fin fish site to Billia Croo is located approximately 9 km south at Bring Head. Given its location (Figure 3-2), vessels servicing the site are unlikely to transit very close to the test site. Operational aquaculture vessels are likely to be limited to a few, small vessels which are not anticipated to occupy nearshore otter habitat for extended periods of time. Rather, these vessels are more likely to rapidly transit to the waters directly adjacent the aquaculture site to undertake works. Finally, as described in Section 11.5.2.1, the potential for vessel-related disturbance to otters are considered unlikely, because the nearshore region of Billia Croo does not constitute key habitat to the species.

For these reasons, cumulative impacts to otters from other sea users are not anticipated to negatively impact otters or compromise the FCS of this species across its natural range.

Appraisal Conclusion for cumulative impacts to otters: In review of activities undertaken by other sea users, it is considered that cumulative disturbance impacts from commercial or recreational vessel presence in the test site and surrounding waters is unlikely and will not be detrimental to the maintenance of otter populations or the FCS of this species across its natural range.

11.8 Receptor conclusion

A summary of the appraisal for each of the receptors is provided in Table 11-4 below. Note that, even where no important impacts on the development site are identified, in some cases there may still be a recommendation for mitigation or monitoring. Under these circumstances, mitigation is regarded as good-practice, while monitoring may serve to improve generic understanding of the relationships between stressors and receptors. Where mitigation or monitoring is considered to be a likely licence or condition of consent this is highlighted in able 11-5

Table 11-4 Summary of otter appraisal conclusions

Receptor	Appraisal conclusion	Mitigation/Monitoring applicable?
Otters	No important impacts predicted for EPS, PMF or other natural heritage	Yes, see Table 11-5
	No important impacts predicted as a result of cumulative impacts	Yes, see Table 11-5

Recommendations to ensure that this impact pathway remains not important have been captured in the mitigation and monitoring strategies outlined in Table 11-5 below. Site-wide monitoring and research ideas may be more effectively pursued at a strategic level (by EMEC/Crown Estate Scotland/Marine Scotland/developer consortium), but developer input or ideas are welcomed.

Where beach excavation work is required as part of cable installation, the requirement for an otter survey, licensing and specific mitigation will be determined through consultation with SNH. It should be noted that any EPS licence applications will require the support of an otter survey.

No important impacts are predicted because of the Project Envelope. Potential disturbance impacts from vessel presence are considered unlikely and will not be detrimental to the maintenance of any otter populations or the FCS of this species across its natural range.

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Table 11-5 Suggested mitigation and monitoring

Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licensing condition / Likely condition of consent	Explanation
Disturbance	Otters	Installation, decommissioning and maintenance vessel presence, transiting and manoeuvring	Vessel movements and occupancy within the Billia Croo test site will be managed through EMEC's SOPs. The SOPs limit the number and size of vessels which can utilise the test site simultaneously. Monitoring by shipboard personnel trained on the SMWWC will enable identification of otters from at-sea vantage points.	No	Based on available survey data, otters are unlikely to be found onshore near Billia Croo or within the test site. As such, there is limited scope for disturbance of otters. The proposed mitigation measures will further limit the scope for vessel-related disturbance to any otters which may be near the Test Site.
			A VMP, which includes a traffic management scheme, will be included as a part of the PEMP.	Yes	Implementation of the VMP will minimise vessel overlap and provide further mitigation against potential disturbance to otters in the nearshore environment. The Vessel Management Plan is required as part of the PEMP.
			An EPS licence may be required where there is the potential to disturb otters.	Possible	The requirement for EPS in relation to otters will be determined on a case by case basis.

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12 COMMERCIAL FISHERIES

Stage 1 of this appraisal defined the categories as presented in Table 3-1. The appraisal now picks up at Stage 2 of the methodology where effect pathways and importance are identified as described in Section 3.

12.1 Potential effects

For commercial fish receptors, the defined potential effect categories are applied to activities/effect pathways relevant to activities as described in the Project Envelope. First, potential effects are considered in broad-principles. Deployment, installation and decommissioning effects (Table 11-1) are addressed separately from those during the operational and maintenance phases (Table 11-2).

Note that details specific to Billia Croo, both environmental and relating to project-specifications, are not considered until the detailed appraisal later in this section.

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Table 12-1 Potential effects on commercial receptors during deployment, installation and decommissioning of infrastructure

Potential effects from device installation and deployment
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels (e.g. jack-up barge; multi cat; workboat; DP vessel; dive-support vessel; crane-barge; tug; specialist cable-laying vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Commercial fisheries feature	Potential importance and reasoning
Increased suspended sediment	Aquaculture	**Potentially important** – If aquaculture developments are located in close proximity to a WEC/infrastructure deployment, there is the potential for increased suspended sediment as a result of installation activities to impact upon a fish farm site.
Exclusion from fishing grounds	Commercial fisheries	**Potentially important –** During installation activities there may be exclusion zones which restrict areas available for fishing or vessel transiting.
Snagging risk	Commercial fisheries	**Potentially important –** When a project ceases, there is the risk of fishing operators snagging gear on any decommissioning relics which may remain on the seabed, this could cost costly damage to gear and also result in a loss of fishing time.

Table 12-2 Potential effects on commercial fisheries receptors during operations and maintenance of infrastructure

Potential effects from device operation and maintenance
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Physical presence of device(s), foundations, moorings, buoys and other infrastructure on the seabed, in the water column or above the surface > Operation of device(s)/power generation > Repeat removal and redeployment of equipment for maintenance (e.g. device removed from water or floating structure removed from berth; replacement of mooring system) > Other maintenance activities (e.g. biofouling removal; ROV/diver inspection or repairs) > Use of vessels (e.g. DP vessel; jack-up barge; multi cat; workboat; dive-support vessel; crane-barge; tug)

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- Use of equipment to monitor devices in situ or other environmental parameters (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Natural heritage feature	Potential importance and reasoning
Increased suspended sediment	Aquaculture	**Not important –** It is not considered that the levels of sediment produced in the water column as a result of the operation of infrastructure would be sufficient to have an important impact on any aquaculture developments in the vicinity**.**
Exclusion from fishing grounds	Commercial fisheries	**Potentially important -** For both static and mobile gear operators there is a risk of exclusion from favoured fishing grounds depending on the nature and extent of activities.
Increased vessel transit time because of infrastructure	Commercial fisheries	**Potentially important –** If a WEC or other infrastructure deployment occurs on a route utilised by fishing operators to transit to fishing grounds, this may increase transit time to said location as there will be a requirement to reroute to take account of the infrastructure.
Snagging risk	Commercial fisheries	**Potentially important –** There is a risk of fishing operators snagging gear on operational infrastructure within an area of deployment of wave technology or on any other infrastructure introduced to the seabed. This could cost costly damage to gear and also result in a loss of fishing time.

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12.2 Commercial fisheries context

The Billia Croo test site has been in operation since 2003. The wave test site is clearly marked by cardinal buoys (which will also be the case for the extension area). The area is recorded as a chartered area and is marked in accordance with IMO and IALA standards. The offshore lease area, within the cardinal buoys is not an exclusion zone, but is an area to be avoided by vessels not actively involved in works onsite. The site is marked on charts and includes a note. Chart 2249 states that "*Mariners should avoid passing within the test area marked by cardinal buoys. Experimental devices usually marked by yellow buoys and lights with daymarks, are temporarily established in the area. Devices marked by buoys may also be deployed between this area the coast*." All significant work undertaken is and will be displayed by Notices to Mariners. An Awareness Chart for Billia Croo has been produced by EMEC and serves to provide an overview to mariners of the key areas within the inshore and offshore lease areas (EMEC, 2018). Given the established nature of the site, local commercial fisheries interests are well aware of the existence of the site and have adapted practices accordingly.

The sea area adjacent to Billia Croo is mainly used by trawlers passing through on the way to their preferred fishing grounds. The preferred fishing grounds tend to be further north and west of the test site, although in bad weather there maybe trawling closer inshore (Carl Bro, 2002). Fishing along the west coast of the Orkney mainland takes place in water depths of approximately 58 m (192 ft) (Carl Bro, 2002). Inshore fishing takes place in the vicinity of Billia Croo targeting lobster, edible crab, green crab and velvet crabs. These species are fished in water depths of approximately 33 - 38 m all year round depending on the weather (Carl Bro, 2002; EMEC, 2009). Inshore fishing vessels also utilise a passage through the inshore area of the Project Envelope area to more productive fishing grounds further north.

Billia Croo is located within International Council for the Exploration of the Seas (ICES) rectangle 46E6[33]. From the years 2013 to 2017, over 30 species were recorded in the landings data for this rectangle from vessels under 10 m (Table 12-3 and Figure 12-1). Brown crab is the dominant species in terms of landings value for vessels under and over 10 m in length in the years 2013 to 2017, shellfish dominate landings with other key species including lobster and velvet crab. Although potting could take place within the lease area (including the proposed lease extension area), it generally doesn't (EMEC, per comm). Finfish species which contribute to the landings include haddock, monkish and angler fish (Scottish Government, 2018c; ScotMap, 2014). However, Billia Croo is not fished for finfish species (EMEC, pers comm) although a number of vessels will transit past the site to reach fishing grounds further north.

The inshore area is also known to be used for storage of static gear. This is moved from the area in inclement weather to prevent damage on inshore rocky areas (Marine Risk Consultants Ltd, 2019).

Table 12-3 Value and live weight of species by vessels under 10 m (average 2013 - 2017) in ICES rectangle 46E6 (Scottish Government, 2018c)

Species	Value		Liveweight	
	£	%	Tonnes	%
Brown crab	443,172.67	44.27	320.97	66.72
Crabs - velvet (swim)	170,101.39	16.99	57.49	11.95
Crawfish	15,338.92	1.53	0.40	0.08
Green crab	12,742.55	1.27	18.75	3.90
Lobsters	248,822.49	24.86	21.98	4.57
Nephrops	2,658.18	0.27	0.76	0.16
Other crustaceans	38.06	0.00	0.00	0.00
Mixed clams	21.30	0.00	0.01	0.00

[33] ICES statistical rectangles are used for the gridding of data including fisheries landings to make simplified analysis and visualisation.

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Species	Value		Liveweight	
	£	%	Tonnes	%
Periwinkles	63,514.36	6.34	28.93	6.01
Queen scallops	6,518.30	0.65	5.75	1.20
Razor clam	1,212.12	0.12	0.37	0.08
Scallops	19,952.45	1.99	7.89	1.64
Sea urchin	48.00	0.00	0.02	0.00
Squid	511.67	0.05	0.16	0.03
Whelks	1,908.27	0.19	2.15	0.45
Mackerel	10,510.66	1.05	13.55	2.82
Pollack	3,201.55	0.32	1.24	0.26
Saithe	73.56	0.01	0.11	0.02
Cockles	9.37	0.00	0.01	0.00
Cod	478.26	0.05	0.29	0.06
Common skate	2.40	0.00	0.00	0.00
Haddock	156.93	0.02	0.17	0.03
Ling	1.61	0.00	0.00	0.00
Long rough dabs	5.60	0.00	0.01	0.00
Megrim	6.76	0.00	0.00	0.00
Monks or anglers	2.24	0.00	0.00	0.00
Plaice	1.38	0.00	0.00	0.00
Thornback ray	5.00	0.00	0.01	0.00
Witch	4.99	0.00	0.00	0.00
Mussels	19.20	0.00	0.00	0.00
Horse mackerel	0.00	0.00	0.01	0.00

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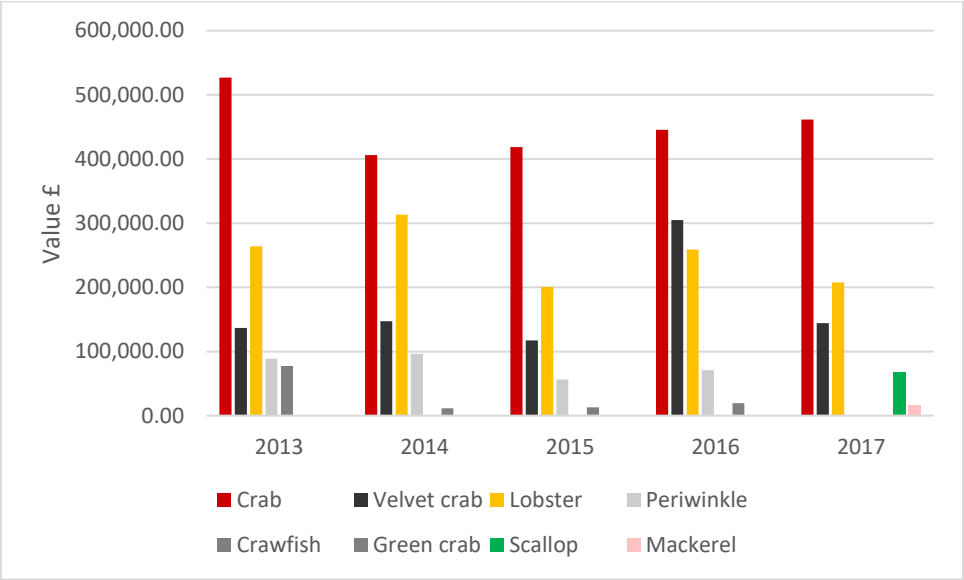
Figure 12-1 Top species by value landed by vessels under 10 m in ICES rectangle 46E6 (Scottish Government, 2018c)



The dominant gear types for vessels of all sizes are pots, the level of effort with this gear type has remained relatively constant over the years from 2013 to 2017 (Scottish Government, 2018c).

Figure 12-2 shows the average number of days spent fishing by vessels over 10 m in length and under 10 m in length from 2013 to 2017 in ICES rectangle 46E6 (area incorporating and surrounding the Project Envelope area, although fishing does not generally take place within the Project Envelope). Fishing effort is consistent throughout the year, with a slight increase during summer months, fishing effort is lowest in January.

There are several aquaculture sites in Orkney waters, however none occur in the vicinity of the Billia Croo test site. The closest sites are a shellfish site located approximately 7 km away and a fin fish site at Bring Head located approximately 9 km south (Figure 3-2).

In support of the S36 application, a separate NRA for the Billia Croo site has been conducted (Marine and Risk Consultants, 2019). As part of this, fishing vessel tracks from 2017 to 2018 were recorded (Figure 12-3). Stromness is an active fishing harbour and a significant number of transits are recorded passing through Hoy Mouth and then passing to the east or west of the Billia Croo test site. An offshore route of vessels passing to the west of Orkney mainland passes clear of the Billia Croo test site boundary (Figure 12-3). A number of fishing vessel tracks can however be seen transiting the north-east corner of the lease extension area. A proximity analysis was also undertaken as part of the NRA, this reported that a significant number of fishing vessels pass within 2 nm of the test site boundary (Marine and Risk Consultants Ltd, 2019).

As part of wildlife observations carried out from 2009 to 2015 observers recorded vessel traffic. The assessment was carried out on AIS data and then observation data used to extrapolate for vessels not carrying AIS. The data recorded a small decline in fishing vessels recorded in the area from 2013 to 2015 and the approximate locations of fishing vessel sightings were concentrated in the inshore area of the test site, in a corridor along the coastal area of Billia Croo (EMEC, 2016).

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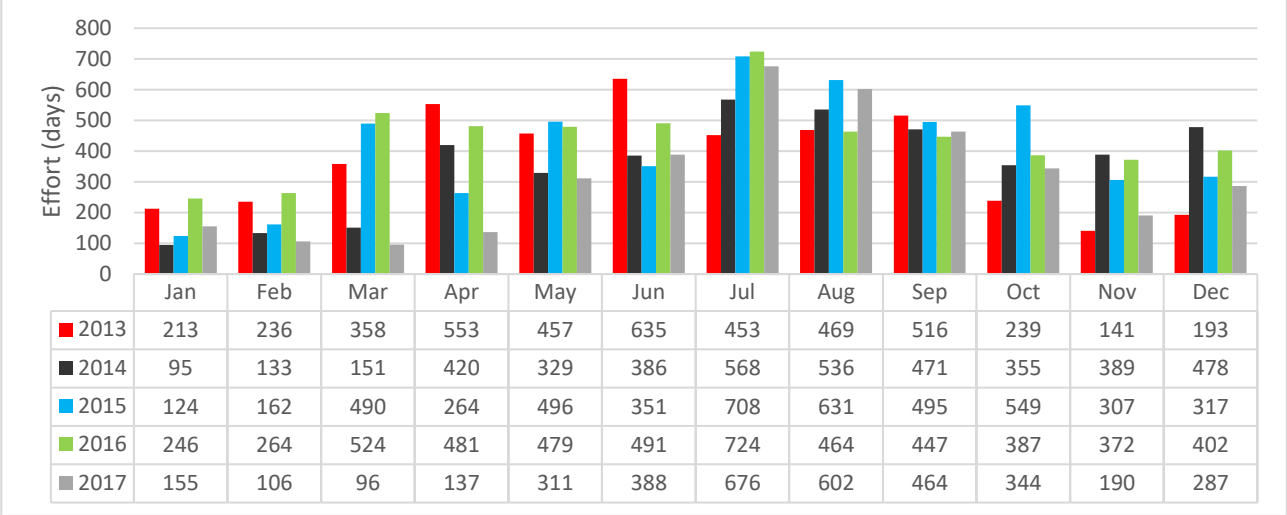
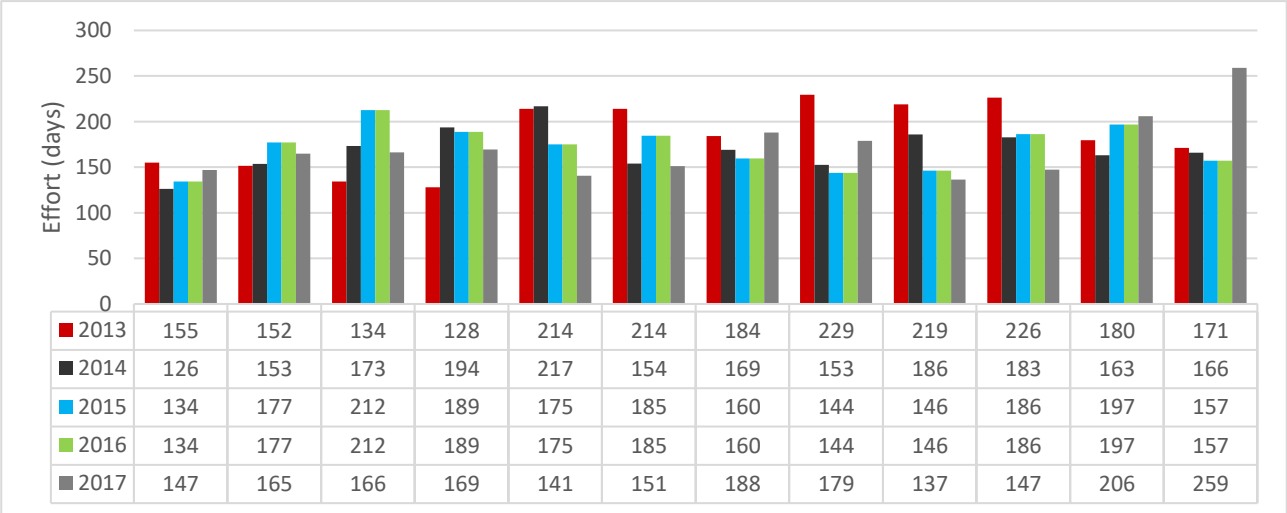
Figure 12-2 Monthly effort in ICES Rectangle 46E6 by vessels under 10 m (top) and over 10 m (bottom) (average 2013-2017) (Scottish Government, 2018c)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013	213	236	358	553	457	635	453	469	516	239	141	193
2014	95	133	151	420	329	386	568	536	471	355	389	478
2015	124	162	490	264	496	351	708	631	495	549	307	317
2016	246	264	524	481	479	491	724	464	447	387	372	402
2017	155	106	96	137	311	388	676	602	464	344	190	287



2013	155	152	134	128	214	214	184	229	219	226	180	171
2014	126	153	173	194	217	154	169	153	186	183	163	166
2015	134	177	212	189	175	185	160	144	146	186	197	157
2016	134	177	212	189	175	185	160	144	146	186	197	157
2017	147	165	166	169	141	151	188	179	137	147	206	259

A number of fisheries restrictions and management areas are applicable to the Billia Croo area. Under Council Regulation (EC) No 850/98 and Commission Regulation (EC) 494_2002, a restriction on fishing for sandeel using towed gear with mesh of less than 32 mm is applicable year-round in ICES area IVa (which Billia Croo lies within). Under the Inshore Fishing (Prohibition of Fishing for Cockles) (Scotland) (No. 3) Order 2006, all inshore Scottish waters are subject to a restriction for cockle harvesting. It is prohibited to collect cockles by any means in Scottish inshore waters at any time of the year.

Landing controls for the Scottish crab and lobster fisheries came into effect on 25th February 2018 (Marine Scotland, 2018e) under the Specified Crustaceans (Prohibition on Landing, Sale and Carriage) (Scotland) Order 2017. Landing controls are applicable to several species landed from the Billia Croo area (brown crab, velvet crab and lobster).

Under the Common Fisheries Policy, fishing by non-UK vessels between 6 and 12 nm is restricted to countries with historic rights relating to specific fisheries. Marine Scotland issue annual fishing quotas, the purpose of quota management arrangements is to enable the fishing industry to make full use of annual fishing opportunities while ensuring that quotas are not exceeded. Marine Scotland may also grant responsibility for sectoral quota management. Sectoral management has been granted to ten Scottish Fish Producer Organisations (FPO), the Orkney FPO is relevant to the Billia Croo test site (Marine Scotland, 2017c).

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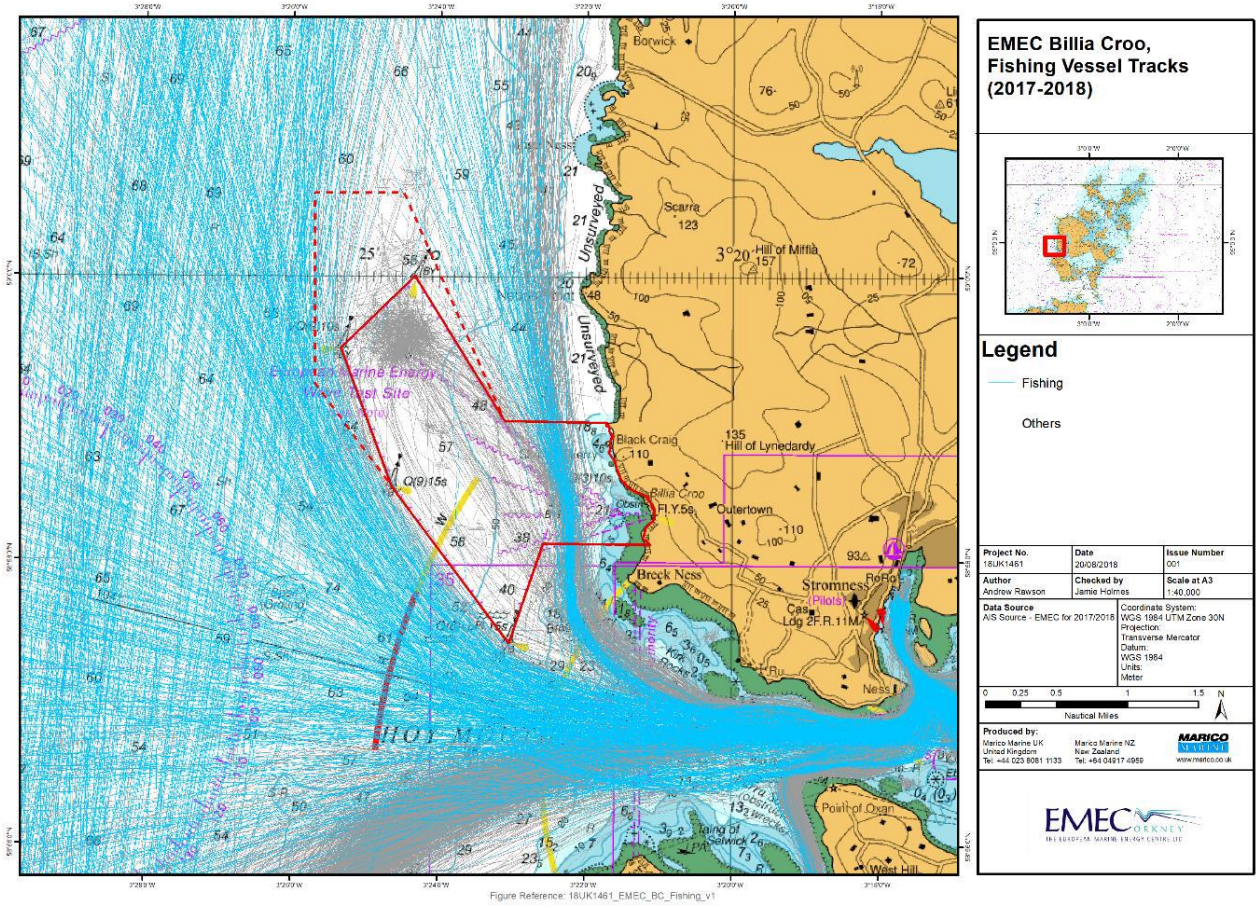
In 2018 SNH were commissioned to identify locations where there is a need to consider additional management for bottom contacting mobile fishing gears to ensure there is no significant impact on the national status of PMFs within the 6 nm limit. Prioritisation was undertaken which identified 11 habitats which are particularly sensitive to impact from bottom contacting mobile fishing gears (Scottish Government, 2018c). Consultation on the scope of the SNH study closed on the 31st August 2018. The next stage will be a Sustainability Appraisal which will assess potential social, economic and environmental impacts of any proposed management measures. Billia Croo overlaps with areas being considered for the management of several of the sensitive habitats identified (Marine Scotland, 2018f). Although the results of consultation and Sustainability Assessments are yet to be published, it is considered probable that the SNH study will lead to increased management for fisheries using bottom contacting methods.

Figure 12-3 Fishing vessel transits in the vicinity of Billia Croo (Marine and Risk Consultants Ltd, 2019)



12.3 Summary of impact appraisal for Billia Croo

This impact appraisal takes account of a maximum-case scenario based on the Project Envelope where all available berths within the test site are developed and operating at capacity. It addresses the differing consenting and licensing regimes. This appraisal will inform the consenting process for both Marine Licence and S36 applications. However, it should be noted that, if there are key deviations in the device design or in any activity (deployment, installation, decommissioning, operations and maintenance), further appraisal work may be required. Any additional appraisal work required will be undertaken by the individual developer (further advice should be sought from EMEC in the first instance).

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Table 12-4 Appraisal mechanism for commercial fisheries

Feature type	Appraisal mechanism	Applicable	Reasoning
Aquaculture	Presence of active aquaculture sites in the vicinity of the Billia Croo test site.	No	It is not considered that any aquaculture developments will be impacted as a result of any activities within the Project Envelope, therefore no further assessment is deemed necessary. The potential for cumulative impacts will be considered in Section 12.4.
Static gear fisheries	Presence of active static fishing in the area and or use of the area to transit to other fishing grounds.	Yes	The Billia Croo inshore area is known to be utilised for static gear fisheries and for transiting of vessels to other fishing grounds further north. The inshore area of the lease area is also used for storage of static gear (moved offshore in periods of bad weather to avoid damage from rocks). The potential for cumulative impacts will be considered in Section 12.4.
Mobile gear fisheries	Presence of active mobile fishing in the area and or use of the area to transit to other fishing grounds.	No	The Billia Croo area is known to be used to a certain extent for mobile fisheries but is also known as an area of transit for mobile fishing gear vessels to fishing grounds further north. The potential for cumulative impacts will be considered in Section 12.4.

12.3.1 Mobile and static gear fisheries

The most utilised gear type in ICES rectangle 46E6 was recorded as pots in the years from 2013 to 2017 and the level of effort with this gear has remained relatively constant over the same period (Scottish Government, 2018c). This correlates with the most valuable species as crab is targeted utilising this gear type. Otter trawls[34] and dredges are also utilised but to a much lesser extent and hand lines and hand fishing make a contribution to the under 10 m vessel types. However, it is considered the use of mobile gear at Billia Croo is negligible. Other gear types are utilised in ICES rectangle 46E6, however they are recorded as disclosive this indicates a very low level of effort for these gear types. Figure 12-4 indicates that effort and value for creels in the Billia Croo area varies from the inshore area to the area further offshore. A high value area exists to the south of the test site area, the value for the remaining area is moderately high. The number of vessels utilising creels in the inshore area of the test site is 10 – 15, further offshore this varies from 5 - 10 to 3 – 10 in the furthest offshore area of the test site area.

[34] A single boat bottom otter trawl is a cone-shaped net consisting of a body, normally made from two, four and sometimes more panels, closed by one or two codends and with lateral wings extending forward from the opening. A bottom trawl is kept open horizontally by two otter boards.

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Most of brown crab in Scotland is landed from June to December and velvet crabs between July and November. Because of the limited size of vessels in the area, weather conditions are a significant factor in determining levels of activity in the winter months. In addition to full time vessels, there are also several part time vessels that will set a small number of creels in inshore areas during the summer months.

Of potential importance to all fishing vessels is the increased transit time to other fishing areas which will occur as a result of the extension to the test site area to the north. Increased transit time may result in an increase in fuel use and time lost fishing for commercial operators. The NRA (Marine and Risk Consultants Ltd, 2019) contains a review of AIS data which showed two clear routes used by vessels transiting the site; an inshore route and an offshore route. The inshore route is more frequently used particularly by smaller vessels, due to the shorter transit time. Nothing presented within the Project Envelope which accompanies this EA will impact on this inshore route.

Consultation carried out with Orkney Fisheries Association (OFA) identified that when strong westerlies occur this can cause significant wave refraction off the cliffs. In such circumstances, vessels will transit further offshore and typically utilise the offshore route passing to the west of the test site. Analysis of vessel traffic as part of the NRA suggests that passing traffic leave less than 500 m spacing from the cardinal buoys marking the boundary of the site. With the proposed extension in place vessels would have to divert further offshore to clear the new test site boundary. The additional distance is considered minimal and would not require fishing vessels to change course significantly to what is already required to clear the test site. Table 12-4 details the transit distances using various routes on a journey from Stromness harbour to a site 5 nm north of the test site. The increase in distance between the current offshore route and the modifed route to take account of the extension, is considered minimal at 0.21 nm

Table 12-5 Transit times from Stromness to five nm north of Billia Croo (Marine and Risk Consultants, 2019)

Transit route	Distance in nm
Inshore route to the east of the test site	9.7
Current offshore route to the west and north of the test site	11.2
Modified offshore route (to account for the proposed extension area) to the west and north of the test site	11.41

A significant lull in vessel density is already encountered immediately north of the test site (Figure 12-3) indicating that vessels are already diverting around the area which would form the extension area (Marine and Risk Consultants Ltd, 2019). In addition, the proximity analysis carried out as part of the NRA reports that there is negligible difference in the volume of transits in the existing site in comparison with the extension, supporting the fact that vessels already transit clear of the footprint of the proposed extension (Marine and Risk Consultants Ltd, 2019).

Another impact which has been identified as potentially important to vessels is exclusion from areas of fishing. The test site is not recorded as an exclusion zone, however consultation undertaken with OFA as part of the NRA (Marine and Risk Consultants Ltd, 2019) highlighted that due to the presence of cables, devices, mooring systems and hazards because of decommissioned infrastructure, fishermen tend to avoid the site to avoid damage to vessels and gear. The test site including the proposed extension occupies an area of sea of approximately 11 km^2, some of this area overlaps with areas considered to be valuable for static gear. As discussed, the site does not represent an exclusion zone for fishing activity, but it is recognised that many fishing operators choose to avoid the site. The site is considered to represent a relatively small area of suitable creeling areas in the wider environment and therefore if fishermen choose to avoid the site it is not considered to represent a significant impact.

Snagging of gear on either operational infrastructure or post decommissioning relics has also been raised as a concern during consultation undertaken with OFA as part of the NRA process (Marine and Risk Consultants Ltd, 2019). The Billia Croo test site is well established and local fishermen are aware of the site and have a good understanding of the types and locations of devices installed. Additionally, all deployments are communicated through Notice to Mariners, and are well marked and charted. Fishing operators are therefore aware of the risks which may be posed by deployments at the site. During consultation with OFA, it was

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discussed that to date no contacts between vessels and devices or snagging incidences have been reported, neither had issues of poorly visible devices (Marine and Risk Consultants Ltd, 2019).

Appraisal conclusion for mobile and static gear operators: No potentially important impacts on commercial fisheries are predicted as a result of the Billia Croo Project Envelope.

All developers at EMEC have an obligation to return the site to the condition it was received from EMEC, this also forms part of Marine Licence conditions. Developers submit video footage showing the seabed prior to installation and post decommissioning to EMEC and Marine Scotland (previously UK Government Dept BEIS) along with a report, this ensures the seabed is left in a satisfactory condition post decommissioning. Additionally, developers have a Decommissioning Programme in place prior to installation which has been approved by the regulator. With these conditions in place, if developers decommission in line with their Decommissioning Programme, snagging on post decommissioning relics can be considered very unlikely.

There is also a responsibility on fisheries operators to review up to date navigation charts which clearly mark the Billia Croo test site and associated assets.

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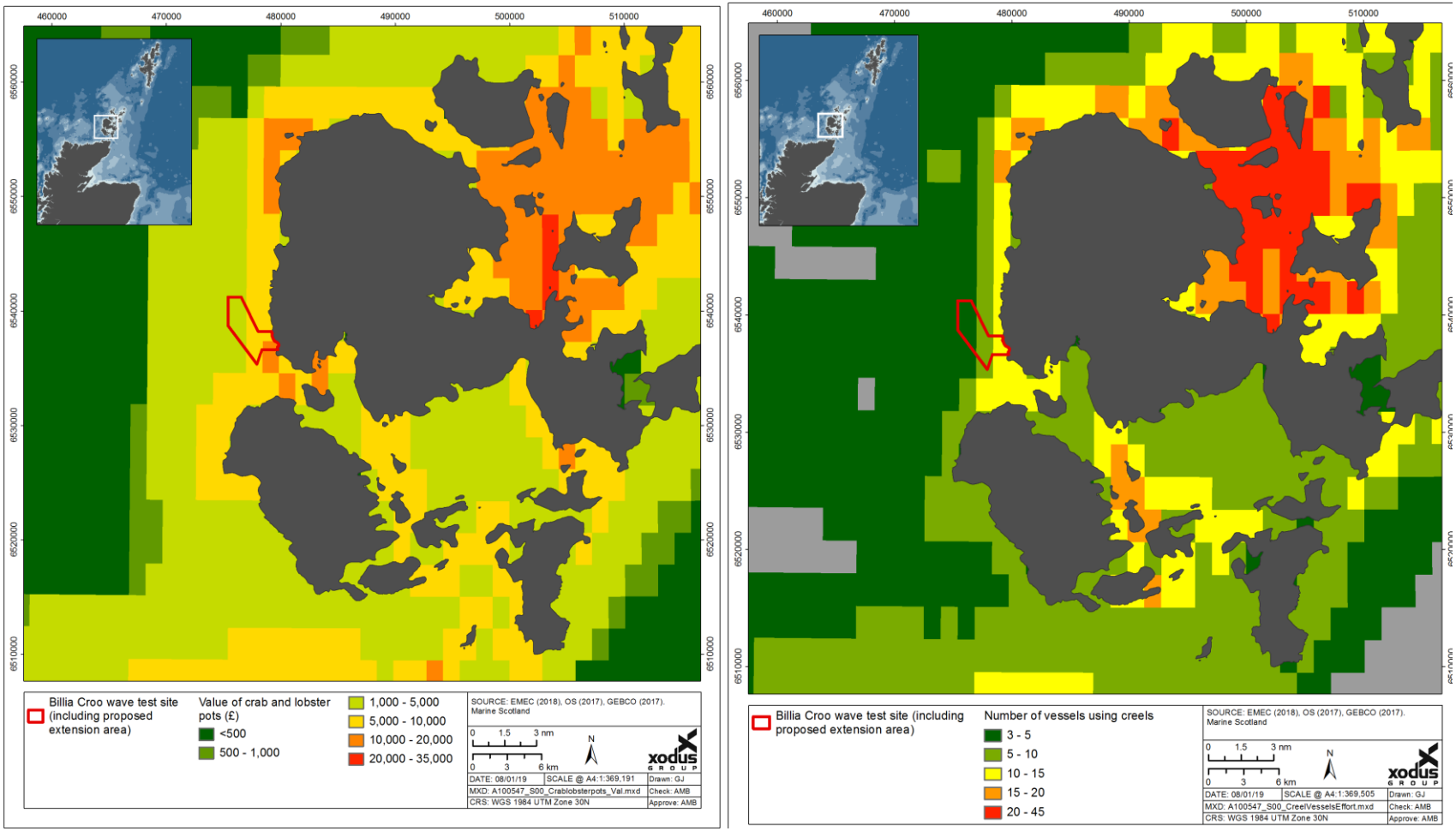
Figure 12-4 Value and effort of creeling vessels in the Billia Croo area (ScotMap, 2014)



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12.4 Appraisal of cumulative impacts

In terms of cumulative impacts to commercial fisheries, the key consideration would be projects with the potential to exclude fisheries operators from the same area as the Billia Croo test site especially where this may occur simultaneously. The SSE proposed cable between Orkney and mainland Scotland is located approximately 1 km from the test site at the closest point (Section 3.7). During cable installation it is anticipated there will be an exclusion zone for both fishing and vessel transit around the area of cable lay. If this occurs simultaneously with an installation at Billia Croo this may lead to two areas of exclusion for fishing vessels in close proximity to each other. Any exclusion however will be temporary in nature and fishing operators will be made aware of planned operations well in advance through Notice to Mariners. This will not be an important cumulative impact. All other projects presented in Figure 3-2 are considered to be too far away to act cumulatively in a way that would exclude fisheries operators. As concluded in Section 6 no impacts are predicted to fish and shellfish species including cumulatively with other projects as a result of activities presented in the Project Envelope, it is therefore considered no cumulative impacts to commercial species will occur.

Appraisal conclusion for cumulative impacts to commercial fisheries: Although it is possible that installation works at Billia Croo and other projects may occur in a similar area simultaneously this will be for a short duration and not considered to be important at an industry level. No other cumulative impacts are predicted.

12.5 Receptor conclusion

A summary of the appraisal for each of the receptors is provided in Table 12-6 below. Note that, even where no important impacts on the development site are identified, in some cases there may still be a recommendation for mitigation or monitoring. Under these circumstances, mitigation is regarded as good-practice, while monitoring may serve to improve generic understanding of the relationships between stressors and receptors. Where mitigation or monitoring is considered to be a likely licence or condition of consent this is highlighted in Table 4-8.

Table 12-6 Summary of commercial fisheries appraisal conclusion

Feature type	Appraisal conclusion	Mitigation/Monitoring recommended?
Static and mobile gear vessels	The potential impacts considered the most important for commercial fishery interests in the Billia Croo test site area were exclusion, snagging risk and increased transit time	Yes see Table 12-7
	No important cumulative impacts are anticipated	Yes see Table 12-7

In relation to the impacts described in Table 12-6 mitigation and monitoring is identified to keep the potential impacts to a minimum.

Site-wide monitoring and research ideas may be more effectively pursued at a strategic level (by EMEC/Crown Estate Scotland/Marine Scotland/SNH/developer consortium), but developer input or ideas are welcomed.

To conclude, the Billia Croo test site is not considered to be an important fishing area for static or mobile gears. The inshore area is known to be utilised for storage of static gear and the test site is also on a transit route for static and mobile gear vessels transiting to fishing areas further north. The potential impacts which were considered of importance were exclusion from fishing grounds, snagging of gear and increased transit times as a result of the extension area. Appraisal of these impacts concluded that none would result in an important impact to commercial fisheries interests in the area.

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Table 12-7 Suggested mitigation and monitoring

Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licensing requirement / Likely condition of consent	Explanation
Damage to vessels and fishing gear	Static and mobile fishing gears	Snagging/interaction with WECs and other infrastructure	All devices/assets should be clearly marked and charted Notice to Mariners will be issued to inform fishing operators of deployments at Billia Croo All developers deploying at EMEC will submit pre-installation and post decommissioning seabed footage All developers will develop a Decommissioning Programme which will be approved by the regulator	Yes	Through clearly marking the devices and infrastructure and through Notice to Mariners, all fishing operators should be well aware of activities within the Billia Croo test site and be able to plan accordingly Seabed footage will provide developers with a baseline for their project and will be used to inform the decommissioning process to ensure the seabed is returned to its condition prior to the commencing A Decommissioning Programme will set out the process of Decommissioning proposed for a project ensuring the seabed is left in a favourable condition as agreed with the regulator
Exclusion from fishing areas	Static and mobile fishing gears	Exclusion from areas of fishing during installation and decommissioning activities and from the test site throughout operation	All devices/assets should be clearly marked and charted	Yes	Through clearly marking the devices and infrastructure and through Notice to Mariners, all fishing operators should be well aware of activities within the

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Impact	Receptors	Impact pathway	Mitigation/Monitoring	Licensing requirement / Likely condition of consent	Explanation
Increased transit time	Static and mobile fishing gears	Because of the extended lease area, there will be a slight increase in transit time for vessels fishing to the north of the site	Notice to Mariners will be issued to inform fishing operators of deployments at Billia Croo All devices/assets should be clearly marked and charted Notice to Mariners will be issued to inform fishing operators of deployments at Billia Croo		Billia Croo test site and be able to plan accordingly Through clearly marking the devices and infrastructure and through Notice to Mariners, all fishing operators should be well aware of activities within the Billia Croo test site and be able to plan accordingly

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13 ARCHAEOLOGY

Stage 1 of this appraisal has used the definitions and categories presented in Table 3-1. The appraisal now picks up at Stage 2 of the methodology where effect pathways and importance are identified as described in Section 3.

13.1 Potential effects

For marine archaeological receptors, the defined potential effect categories are applied to activities/effect pathways relevant to activities as described in the Project Envelope and following standard marine historic environment guidance (Firth, 2013). First, potential effects are considered in broad principles. Deployment, installation and decommissioning effects (Table 13.1) are addressed separately from those during the operational and maintenance phases (Table 13.2).

Note that details specific to Billia Croo, both environmental and relating to project-specifications, are not considered until the detailed appraisal later in this section.

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Table 13-1 Potential effects on marine archaeological receptors during deployment, installation and decommissioning of infrastructure

Marine Historic Environment – Potential generic effects from device deployment, installation and decommissioning
Summary of activity categories – see Project Envelope for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Use of vessels during deployment, installation and decommissioning (e.g. jack-up barge; multi cat; workboat; DP vessel; dive-support vessel; crane-barge; tug; specialist cable-laying vessel) > Deployment and use of equipment to monitor devices or other parameters during installation (e.g. ROV, cameras or acoustic devices) > Removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) from the seabed

Activity / potential effect pathway	Archaeological feature	Potential importance and reasoning
Loss of or damage to marine historic environment assets	Known assets	**Potentially important** – any of the device designs and other infrastructure that impact on the seabed have the potential to result in the damage/loss of archaeological features lying on the seabed if such assets are shown to be present. Similar effects may be expected from vessel anchoring systems that impact the seabed, or the removal of devices and other infrastructure in ways that disturb the seabed during decommissioning activities. Effects are considered to be permanent.
	Unknown assets	**Potentially important** – any of the device designs and other infrastructure that impact on the seabed have the potential to result in the damage/loss of unknown archaeological features, which may lie undiscovered on or below the surface of the seabed, if any are present. Similar effects may be expected from vessel anchoring systems that impact the seabed, or the removal of devices and other infrastructure in ways that disturb the seabed during decommissioning activities. Effects are considered to be permanent.
	Submerged prehistoric landscapes	**Potentially important** – any of the device designs and other infrastructure that impact on the seabed have the potential to result in the damage/loss of submerged prehistoric landscape deposits or features, if any are present. Similar effects may be expected from vessel anchoring systems that impact the seabed, or the removal of devices and other infrastructure in ways that disturb the seabed during decommissioning activities. Effects are considered to be permanent.

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Table 13.13-2 Potential effects on marine archaeological receptors during operations and maintenance of infrastructure

Marine Historic Environment – Potential generic effects from operation and maintenance
Summary of activity categories – see Project Envelope description for detail > Installation and removal of device(s), and other infrastructure (e.g. foundations; mooring systems; cabling; buoys) on the seabed, in the water column or above the surface, which may involve lifting/cutting of infrastructure, drilling, or grappling operations > Physical presence of device(s), foundations, moorings, buoys and other infrastructure on the seabed, in the water column or above the surface > Operation of device(s)/power generation > Repeat removal and redeployment of equipment for maintenance (e.g. device removed from water or floating structure removed from berth; replacement of mooring system) > Other maintenance activities (e.g. biofouling removal; ROV/diver inspection or repairs) > Use of vessels (e.g. DP vessel; jack-up barge; multi cat; workboat; dive-support vessel; crane-barge; tug) > Use of equipment to monitor devices in situ or other environmental parameters (e.g. ROV, cameras or acoustic devices)

Activity / potential effect pathway	Archaeological feature	Potential importance and reasoning
Loss of or damage to marine historic environment assets	Known assets	**Potentially important** – any of the device designs and other infrastructure on the seabed or in the water column above that result in localised scouring have the potential to result in the damage/loss of archaeological features lying on the seabed if such assets are shown to be present. Maintenance vessel anchoring systems that impact the seabed, or the repeated removal and replacement of devices and other infrastructure in ways that disturb the seabed also have the potential to result in the damage/loss of any archaeological features lying on the seabed. Effects are considered to be permanent.
	Unknown assets	**Potentially important** – any of the device designs and other infrastructure on the seabed or in the water column above that result in localised scouring have the potential to result in the damage/loss of unknown archaeological features, which may lie undiscovered on or below the surface of the seabed, if any are present. Maintenance vessel anchoring systems that impact the seabed, or the repeated removal and replacement of devices and other infrastructure in ways that disturb the seabed also have the potential to result in the damage/loss of any such features. Effects are considered to be permanent.
	Submerged prehistoric landscapes	**Potentially important** – any of the device designs and other infrastructure on the seabed or in the water column above that result in localised scouring have the potential to result in the damage/loss of submerged prehistoric landscape deposits or features, if any are present. Maintenance vessel anchoring systems that impact the seabed, or the repeated removal and replacement of devices and other infrastructure in ways that disturb the seabed also have the potential to result in the damage/loss of any such features. Effects are considered to be permanent.

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13.2 Archaeological context

13.2.1 Submerged landscapes and prehistoric sites

Submerged landscapes are where human beings and early hominids previously lived or hunted on terrain which was at that time dry land, or where they exploited fish and shellfish on the coast which is now submerged

The survival of submerged landscapes and in particular submerged peat deposits and woodland remains that contain organic microfossils (e.g. pollen, diatoms, foraminifera) and macrofossils (e.g. seeds, wood, buds, insects) are important resources in reconstructing former landscapes, the activities of past human communities and sea level change, shown most recently in Orkney Waters and the Pentland Firth by the ongoing research by the Rising Tide Project and Dr Scott Timpany (Bates *et al*., 2013; Timpany *et al*., 2017).

Recent research and modelling indicates that the relative sea level was perhaps 20 m lower 10,000 years ago, before rising comparatively quickly up to 7,000 years ago, slowing after that until by roughly 5,000 years ago the coastlines of Orkney are, with some later localised transgressions and variation, roughly as we see them now (Bates *et al.* 2013; Dawson & Wickham-Jones, 2007; Wickham-Jones & Bates, 2016). Relative sea level has continued to rise since prehistory.

Inferences can be made on the potential for the survival of prehistoric deposits in the area of Billia Croo from coring, bathymetric, side scan sonar (SSS) and sub-bottom profile (SBP) data obtained by various surveys in and close to the test site and observations made during numerous diving operations at various devices and in the general area by SULA Diving.

Bathymetric data shows a relict submerged cliff edge shoreline with a steep drop from -10 m bottoming at -40-50 m that could relate to the coastline of Orkney as it stood some 10,000 years ago at the end of the last Ice Age (Dawson & Wickham-Jones 2007).

SSS surveys combined with data from SBP surveys and other studies indicate that there is a transition from exposed bedrock (inshore) to mobile sandy sediments around the 25-20 m contour (Sharman *et al*. 2010). Surficial deposits in the area of the EMEC test site are predominantly mobile or featureless sand interspersed with intermittent glacial erratics and patches of coarser sediment interpreted as glacial till deposits since they tend to correlate with areas of deeper sediment deposition and a change in seabed topography (Pollard *et al*. 2012; Christie *et al*. 2014a; 2014b). Where present, deposits appear to be 1-10 m thick, overlying bedrock (Christie *et al*. 2014a).

In summary, in the offshore lease area, the extension area, and the route to shore at Billia Croo (inshore lease area), the potential for the survival of prehistoric deposits is negligible-low, especially because most of the site is exposed bedrock, or mobile sediments comprising sandy gravels and gravelly sands.

13.2.2 Shipwrecks, aircraft and obstructions

Shipwreck inventories and documentary sources are usually biased towards the 18th century and later when more systematic reporting began (Pollard *et al*., 2014, 44). Therefore, there are few known historical records of medieval and earlier wrecks. The coastal archaeological evidence suggests exploitation of the marine environment within the area for fishing and transport purposes from prehistoric times.

As a maritime nation with a reliance on marine based trade and exchange, there have been countless shipwrecks around UK waters from all periods, many of which remain unreported. Especially with the strong seas in the area, there is a high probability for unknown, unrecorded vessels to have sunk here over the centuries. If these have not been destroyed by the marine environment, the remains of such vessels and their associated artefacts may not always be visible in geophysical data due to being constructed from materials that do not provide strong geophysical or magnetic returns or buried beneath the surface of the seabed. However, based on results from the surveys conducted, the nature of the

seabed as shown by the surveys the risk of impacting unknown remains is likely to be low, although the potential risk rises slightly in areas of less mobile sand where preservation by burial is more likely.

The modern period of World War 1 (WW1) and World War 2 (WW2) has the greatest potential for the preservation of wrecks and aircraft sites. This is partly due to their size, relative age and their metal construction. It is also because the area around northern Scotland, Orkney and Shetland was an active battlefield where the blockade of Germany during WW1 and WW2 was maintained and prosecuted by major elements of the Royal Navy using the base at Scapa, Orkney and squadrons based in Shetland. This blockade in turn was contested by Germany using surface raiders, U-Boats and mines.

No marine cultural heritage statutory designations have been identified in the Project Envelope area. There are no UK Hydrographic Office (UKHO) reports showing the existence of any wrecks within the area and none shown on the relevant UKHO charts. The UKHO has four wreck cards for the area (see Table 13.3). UKHO 1116 relates to an object struck by a fishing vessel, but the object was most likely floating debris, and nothing has been located in the area by subsequent surveys. UKHO 88867, 88868 and 88869 were located during a survey conducted in 2018 (Figure 13-1). This is the area previously used for testing a seabed mounted wave energy devices and assets remain in this location.

A total of fifteen shipwrecks were identified for this area, all of which foundered on the shore or Braga Skerry (see Table 13.3). No exact wreck positions are known, but the records must be taken as indicative of the potential for wrecks (and artefacts) having been present in the area at some point in time. Although fifteen wrecks may seem a relatively high number for such a small area, Billia Croo is a main landmark for navigation from the Atlantic through Hoy Sound to Stromness and the sheltered waters of the Bay of Ireland and Cairston. Due to the weather and tidal conditions encountered in the area the number of ships lost over the centuries is likely to be considerably be higher.

All the shipwrecks were recorded (the earliest on record is the *Margery*, lost in 1777) as lost somewhere between Braga Skerry, Breck Ness and Black Craig (Figure 13-1). Considering the nature of the shoreline, the weather and sea conditions experienced along this coast, it is unlikely that the vessels remain intact and in the reported area of foundering, or that any remains survive. The majority of vessels lost in the area were wooden sailing ships stranded in the shallows and many are listed as being broken up and salvaged at the time. Those that came ashore in heavy weather were inevitably broken up by the sea on the rock-strewn coastline. Similarly, later vessels of iron construction were the result of strandings and, given the exposed rocky nature of the coastline and environmental conditions in the area, are not likely to remain intact unless buried in sediment.

Consequently, the only evidence of shipwrecks would be ballast and metal fittings from the wooden wrecks (including anchors) and scattered debris from the metal wrecks. In areas where there is sediment any material will become buried, while on rocky substrates material tends to be dispersed over large areas, falling into gullies and forming concretions. Under these circumstances, multi-beam bathymetry and side scan sonar tend not to be able to distinguish between the wreck and the geology of the seabed. Magnetometry is the only method of determining if a wreck may be present. Given that the area is mostly exposed bedrock and any sediment being shallow and mobile, it is unlikely that much, if anything, survives and nothing has been observed during SULA Diving investigations in the area.

If they survived in good condition, most of these wrecks would be considered to be of high or medium importance, because of their date, being involved in international or regional trade, or as evidence of new and changing technologies (Wessex 2006, 2011a, b and c). However, they are likely to have completely broken up. None of the surveys noted in section 13.2.1 has identified likely wreckage from these vessels, indicating that the likelihood of these wrecks or wreckage from them being located within the test site is negligible-low.

There are two known aircraft losses that could be in the area (see Table 13.3). Any aircraft found is automatically protected under the Protection of Military Remains Act 1986 if lost on active service. Therefore, these would be considered of very high importance if found, although this risk is negligible-low and therefore not important.

Table 13.3 List of possible wreck sites within or close to the Billia Croo test site

Name	UKHO wreck number	Canmore (Historic Environment Scotland, 2019)	Description	Circumstance of loss	Date lost	Proximity to Project Envelope	Source	Importance
Margery	-	327410	Wooden Sloop. Cargo of Easdale slates	'Lost' between Breckness and Black Craig, Outertown, Stromness	15/01/1777	Unknown	1, 6	Medium
Mellona	-	287335	Wooden Brig	Wrecked near Breckness	26/10/1806	Unknown	1, 6	Medium
British Queen	-	224111	Timber laden for N Shields Master Jeffreys, from Pictou	Ashore at Breckness. Cargo and materials saved. Possibly salvaged	30/11/1811	Unknown	1,2,6	Medium
William	-	259701	Vessel, Sligo to London	Wrecked a few miles north of Stromness in violent gale. Part of stern and small articles washed ashore	15/12/1832	Unknown	1, 6	Uncertain
George	-	270207	Wooden Smack of Aberdeen. Cargo of butter. Captain Simpson	Wrecked to the North of Breckness	15/12/1832	Unknown	1, 6	Medium
Duke of Sussex	-	225587	Wooden rigged ship, from Sunderland to Cape of Good Hope. Cargo of coal and glass	Wrecked in gale at Breck Ness. The master, his wife, 1st and 2nd Mate plus five crew drowned. Their grave is in Stromness Kirk Yard	25/01/1840	Unknown	1, 6	High
Bromby	-	270251	Wooden Schooner. Liverpool to Aberdeen. General cargo	Wrecked in Hoy Sound, off Breckness. Some of cargo recovered to Stromness	09/11/1842	Unknown	1, 6, 9	Medium
Star of Dundee	-	225584	Wooden Schooner. 78 tons. Capt. Lawson. Wick to Bristol. Cargo of herring	Driven ashore at Black Craig. Sole survivor supposed to have sheltered in cave and climbed cliff following day	05/03/1843	Unknown	1, 2, 6	Medium

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Name	UKHO wreck number	Canmore (Historic Environment Scotland, 2019)	Description	Circumstance of loss	Date lost	Proximity to Project Envelope	Source	Importance
Isabella	-	-	Vessel of Kirkwall. Liverpool to Stettin	Ashore Black Craig. Possibly salvaged	21?/03/1843	Unknown	10	Uncertain
Betsy	-	277247	Sloop of Wick. From Wick to Liverpool. Cargo of herring	Onshore at Breckness. Crew and part of cargo saved	00/11/1847	Unknown	1, 6	Medium
Robert & Alice	-	226763	Wooden Sloop of Inverness. Lossiemouth. Capt. Gillanders. Cargo of herring	Lost on Braga Skerry. Ship and crew lost	07/10/1854	Unknown	1, 2, 6	Medium
Lord Mulgrave	-	226771	Wooden Barque. 417 tons, built Whitby. Capt Atkinson. From Shields to New York/Quebec. Cargo including coal	Driven ashore, in gale SW/11, at Point of Tanga, Black Crag, Outertown, Stromness. 5 crew lost	09/03/1859	Unknown	1, 2, 6	High
Clifton Hall	-	226836	Wooden Barque of Sunderland. 354 tons. Liverpool to Shields. Cargo of salt	Abandoned in sinking condition off Hoy, gale WNW/9, crew landed in Walls, Longhope. Drifted ashore near Black Craig	27/02/1869	Unknown	1, 2, 6	High
Arcturus	-	256174	Wooden Barque of Rugenwalde, Germany. 530 tons. Capt Brandhoff. From Onega, Russia to Liverpool. Cargo of deals and boards	Stranded on Braga Skerry, Breckness in gale NW9 while running for shelter. Crew reached shore in small boat, which capsized in surf	13/10/1881	Unknown	1, 6	High
Shakespeare	-	229392	Steel Steam Trawler of Hull. 182 tons. Capt Patch	Lost on Point of Spaal near Braga Skerry, to N of Breck Ness with loss of 4 men. Survivors taken off by L/B and LSA	12/11/1907	Unknown	6	Low
Unknown (Dead)	1116	102302	Object reported. Not found in subsequent survey in 2009	MFV ILENE damaged when struck submerged object. Object not sighted	19/04/1982	Unknown	4, 6, 9	Negligible

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Name	UKHO wreck number	Canmore (Historic Environment Scotland, 2019)	Description	Circumstance of loss	Date lost	Proximity to Project Envelope	Source	Importance
Unknown	88867	-	Unknown contact reported from survey	In area of disused Oyster renewable energy device	20/03/2018	Within	4, 9	Negligible
Unknown	88868	-	Unknown contact reported from survey	In area of disused Oyster renewable energy device	20/03/2018	Within	4, 9	Negligible
Unknown	88869	-	Unknown contact reported from survey	In area of disused Oyster renewable energy device	20/03/2018	Within	4, 9	Negligible
A/C Skua L2951	-	287560	Blackburn Skua Type II. L2951 771 Sqn	Crash landed in the sea 6 miles west of Stromness killing both the crew	26/04/1944	Unknown	1, 6, 8, 9	Very High
A/C Sea Otter JM761	-	287564	Vickers Supermarine Sea Otter. JM761 771 Sqn. Flying from Abbotsinch (Glasgow) to the airfield at Twatt, Orkney (HMS Tern) with two crew and a gunnery officer as passenger	Engine failure near Hoy, so the pilot made a successful forced landing in Hoy Sound. However, the hull must have been damaged and the Sea Otter began to sink. Rescued by Navy launch	25/04/1944	Unknown	1,8.9	Very High

Sources: 1 = Whittaker (1998); 2 = Larn & Larn (1998); 3 = Ferguson (1987); 4 = UKHO; 5 = Ferguson (1988); 6 = Canmore; 7 = Wrecksite.eu; 8 = A.R.G.O.S; 9 = Lamb (2007); 10 = John o'Groat Journal.

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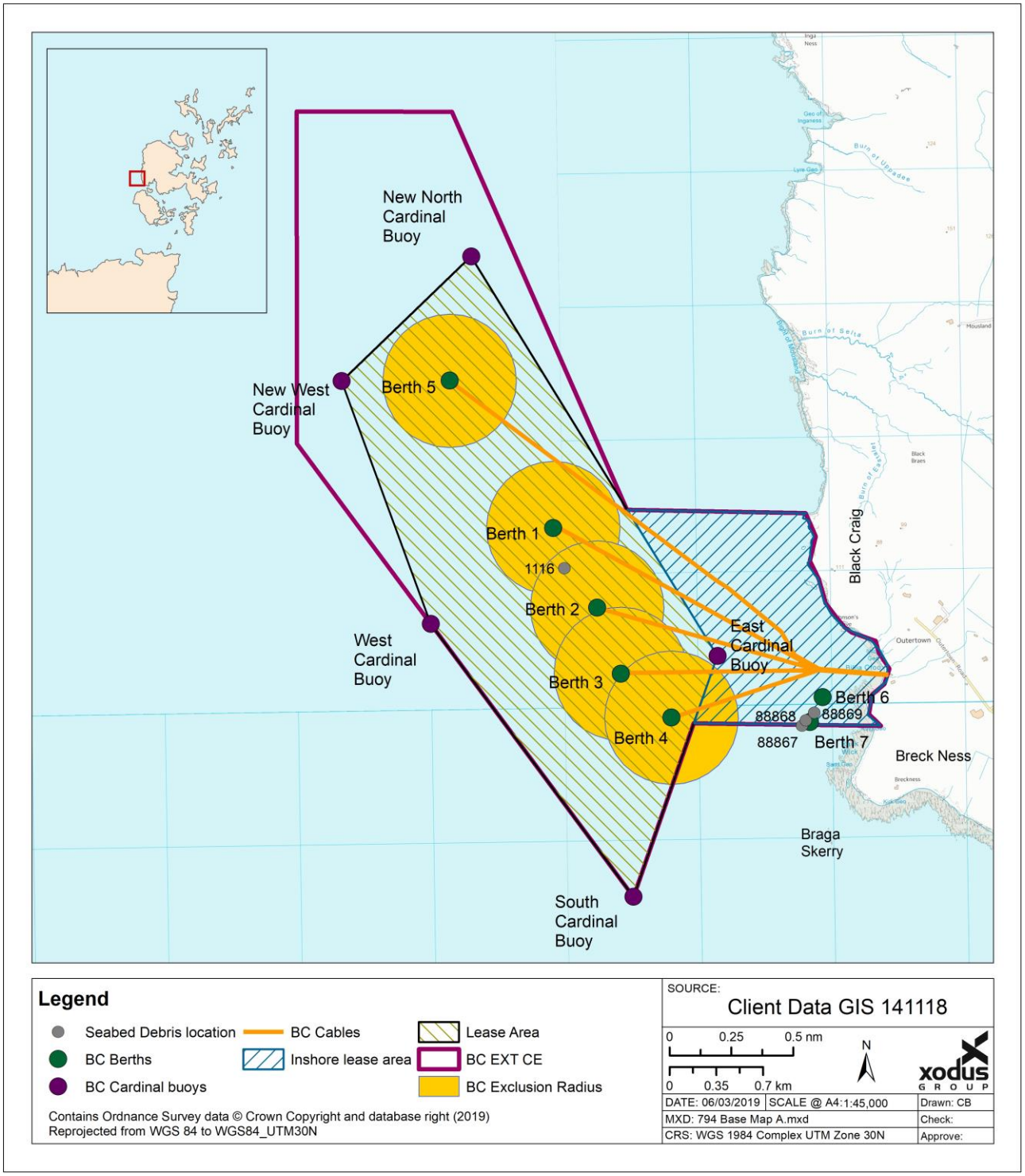
Figure 13-1 Location of known seabed debris sites within or close to the Project Envelope



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13.2.3 Historic minefields and unexploded ordinance (UXO)

During both World Wars a large amount of ordnance, both offensive and defensive, was used in the seas around the Orkney Islands and the Pentland Firth. Some of these munitions still exist and are regularly found by divers or fishermen. These finds are taken very seriously by the MoD who immediately deploy a bomb disposal team to assess and deal with the items located. They are usually detonated where they are found as it is considered too dangerous to move them.

One of the largest German minefields was laid to the north of mainland Scotland by surface raider SMS Möwe in January 1916. This was known to the British as the Whitten Head Field and had over 250 mines. By the end of April 1916, the Royal Navy had accounted for 70 of these mines and considered the field cleared. However, there is the possibility that live mines from the Whitten Head minefield could have drifted into the area either as a result of minesweeping operations or mines having broken free of their moorings. Mines associated with the Whitten Head Field have been found ashore on Orkney and in the Pentland Firth.

However, there are no reports of mines being laid in the Billia Croo area or of bombs being dropped, there are no reports for finds in this area in the Bi - Monthly Minesweeping Reports, and no reports from U Boats operating in the area in both World Wars. Therefore, the indications are that there is negligible-low potential for unexploded historic ordnance in the Billia Croo test site.

13.3 Summary of impact appraisal for Billia Croo

This impact appraisal takes account of a maximum-case scenario based on the Project Envelope where all available berths within the test site are developed and operating at capacity. It addresses the differing consenting and licensing regimes. This appraisal will inform the consenting process for both Marine Licence and S36 applications. However, it should be noted that, if there are key deviations in the device design or in any activity (deployment, installation, decommissioning, operations and maintenance), further appraisal work may be required. Any additional appraisal work required will be undertaken by the individual developer (further advice should be sought from EMEC in the first instance).

Table 13-4 presents the relevant legislation and the reasons for undertaking an appraisal for several features in the test site area.

Table 13.4 Appraisal mechanism for archaeological features

Feature type	Appraisal mechanism/relevant legislation	Applicable	Reasoning
Scheduled Ancient Monuments	The Ancient Monuments and Archaeological Areas Act 1979	No	None present.
Ships and aircraft lost on military service	The Protection of Military Remains Act 1986	Yes	Potential for two unlocated military aircraft to be in the Project Envelope area.
Protected features of Historic MPAs	Marine (Scotland) Act 2010	No	No Historic MPAs in the Project Envelope area.
Other sensitive archaeological / cultural heritage features	Appraisal of other features under: > The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (relevant to projects located 0-12 nm from shore) > The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 > Marine (Scotland) Act 2010	Yes	Captures assessment of all other potentially sensitive historic environment features that may be present in the Project Envelope area.

13.4 Military remains

There are two aircraft that were lost on military service during World War II somewhere west of Stromness. While records from the time indicate that it is unlikely the aircraft are located within the Project Envelope area,

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the locations of these wrecks have never been found. The likelihood of survival in this highly dynamic environment means that there is not considered an important risk of impacting remains from these aircrafts. However, it should be noted that any aircraft remains found are automatically protected under the Protection of Military Remains Act 1986, since they were lost on active service, and impact would automatically contravene the Protection of Military Remains Act 1986, even if they were unknown prior to the impact.

Appraisal Conclusion for military remains: While there is negligible-low risk of impacting aircraft remains, good practice mitigation (especially due to the automatic nature of their legal protection) should be applied to eliminate the risk. This would comprise ROV or diver inspection of where the seabed is to be disturbed prior to installation. Therefore, no important impacts are concluded for military remains.

13.5 Appraisal of other (non-designated) archaeological features

There are no known historic environment assets in the Project Envelope area. However, there is potential for wreckage to survive in gullies and be buried in any less mobile sediments from wrecks that would be considered important if they survived (see Table 13.3). However, the likelihood of survival is considered negligible-low due to the highly dynamic environment and salvage activities conducted at the time a vessel was lost.

Appraisal Conclusion for (non-designated) archaeological and cultural heritage features: While there is negligible-low risk of impacting historic environment assets, good practice mitigation should be applied due to the potentially important nature of any remains. This would comprise instigation of The Crown Estate's *Protocol for Archaeological Discoveries: Offshore Renewables Projects* (2014). EMEC operates an Archaeological Discoveries SOP (SOP128) to guide EMEC personnel, clients and marine contractors on the method of preserving and recording discoveries. Therefore, no important impacts are concluded for non-designated archaeological and cultural heritage features.

13.6 Appraisal of cumulative impacts

There are a number of offshore renewables and marine cable projects in the Pentland Firth and Orkney Waters (Table 3-2 and Figure 3-2), which are all designed to avoid significant impacts on the historic environment. The likelihood of impacts on historic environment assets as a result of the proposed activities at Billia Croo described in the Project Envelope are not considered to be important. Therefore, it is not considered that the Billia Croo test site will have any significant cumulative effect on marine historic environment assets.

Appraisal conclusion for cumulative impacts on marine archaeology: No cumulative impacts are predicted to marine archaeological features because of cumulative impacts from the Billia Croo test site.

13.7 Receptor conclusion

A summary of the appraisal for each of the receptors is provided in Table 13-4 below. Note that, even where no important impacts on the development site are identified, in some cases there may still be a recommendation for mitigation or monitoring. Under these circumstances, mitigation is regarded as good-practice, while monitoring may serve to improve generic understanding of the relationships between stressors and receptors. Where mitigation or monitoring is considered to be a likely licence or condition of consent this is highlighted in Table 13-5.

Table 13-4 Summary of historic environment appraisal conclusions

Feature / receptor type	Appraisal conclusion	Mitigation / Monitoring recommended?
Shipwrecks & wreckage	Non-important impacts possible, but likelihood negligible-low	Yes see Table 13-5
Aircraft & wreckage	Important impact possible, but likelihood negligible-low	Yes see Table 13-5
Prehistoric deposits	No impacts predicted	No

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Feature / receptor type	Appraisal conclusion	Mitigation / Monitoring recommended?
All archaeological features	No important cumulative impacts are predicted	Yes see Table 13-5

Given the possibility of potential impacts and the opportunity to learn from test deployments, potential mitigation and monitoring measures are presented in Table 13-5. Site-wide monitoring and research ideas may be more effectively pursued at a strategic level (by EMEC/Crown Estate Scotland/Marine Scotland/SNH/developer consortium), but developer input or ideas are welcomed.

Table 13-5 Suggested mitigation and monitoring

Impact	Receptor	Mitigation/Monitoring	Licensing requirement / Likely condition of consent	Explanation
Loss of or damage to marine historic environment assets	Potential wrecks and wreckage	The Crown Estate's 2014 *Protocol for Archaeological Discoveries: Offshore Renewables Projects* EMEC's Archaeological Discoveries SOP (SOP128)	No	Adherence to the protocol and SOP will ensure the potential for loss or damage to potential wrecks, wreckage and aircraft wreckage is kept to a minimum.
Loss of or damage to marine historic environment assets	Potential aircraft wreckage	The Crown Estate's 2014 *Protocol for Archaeological Discoveries: Offshore Renewables Projects* EMEC's Archaeological Discoveries SOP (SOP128)	No	Adherence to the protocol and SOP will ensure the potential for loss or damage to potential wrecks, wreckage and aircraft wreckage is kept to a minimum.
		Seabed survey / diver inspection or drop-down camera survey prior to installation of devices or infrastructure on the seabed	Possibly	Developers are required to report the condition of the seabed ahead of any installation activity. This would help to identify any potential aircraft wreckage on the seabed.

Important impacts on historic environment assets are not predicted as a result of the proposed activities at Billia Croo described in the Project Envelope. In order to manage the potential for impacts on unknown heritage, a reporting protocol should be instigated for the discovery of previously unknown marine cultural material during development. The Crown Estate's reporting protocol (2014) would be sufficient (https://www.wessexarch.co.uk/our-work/offshore-renewables-protocol-archaeological-discoveries). Should any cultural heritage sites be reported during marine works, it is recommended that they are investigated by a qualified marine archaeologist as their potential for retaining cultural heritage information could be high. A pre-installation seabed survey or diver survey prior to or during work on the seabed could identify if any aircraft wreckage is present, to inform any micro-siting to avoid any potential impact. It should be noted that impact upon planes lost on military service automatically contravenes the Protection of Military Remains Act 1986, even if they were unknown prior to the impact.

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14 MITIGATION, MONITORING AND RESEARCH

14.1 Overview

Sections 4 – 13 provided detailed appraisals of the potentially important impacts to receptors in the vicinity of the Billia Croo test site. These appraisals support a S36 consent side-wide application which incorporates the Billia Croo test and activities as described in the detailed Project Envelope. It is considered that all activities as per the Project Envelope have been pre-appraised, allowing developers to dedicate more effort into the development and delivery of their active and required mitigation, monitoring and research. In each preceding appraisal suggested mitigation, monitoring and research measures have been presented, this section provides a summary of this information.

Each appraisal in Sections 4 – 13 assesses potential impacts based on generic impacts, where impacts are considered potentially important they are then assessed in relation to the site-specific conditions and the Project Envelope for Billia Croo. Where impacts are considered to be important, mitigation has generally been suggested and in some cases, even where impacts are not considered to be important, mitigation has been suggested as good practice. Where mitigation has been suggested, it is expected that implementation of such measures will aid in reducing the severity or remove the respective impact. suggestions for monitoring have been made in relation to a number of potential impacts. Monitoring may serve to check the status of a particular impact with the intention to remove, introduce or inform mitigation. Monitoring also has the potential to increase understanding of potential impacts to developers, regulators and industry.

Any site-wide research at Billia Croo is likely to be applicable at an industry level with less focus on specific devices or device-types. Research will generally be led by EMEC with the potential for developers, regulators and academic institutions to be involved. For each new development to be sited at the test site, the following should be submitted together with the Marine Licence application:

- A Project Environmental Monitoring Programme (PEMP) to be agreed with Marine Scotland – this should incorporate any identified mitigation required through this appraisal as well as any additional mitigation along with any monitoring requirements
- A Construction Method Statement (CMS), and
- A Vessel Management Plan (VMP).

Section 3.3 of this document provides a suggested structure and content for a PEMP, together with the minimum expected contents of a CMS and VMP from an environmental perspective. The primary objectives of this section are:

- To provide a summary of all mitigation and monitoring that has been suggested in the individual appraisals in Sections 4 – 13, this will include measures which form licence conditions and measures which are regarded as good practice. Where proposed developments align with the Project Envelope, this section can be utilised to inform appropriate mitigation and monitoring measures for inclusion in PEMPs.
- To highlight research projects and monitoring which may apply across the Billia Croo test site. Developers should consider all existing and proposed research when drafting a PEMP.

14.2 Summary of suggested mitigation activities

Throughout individual appraisals (Sections 4 - 13) where impacts are determined to be potentially important, mitigation measures are suggested to reduce or remove the impact. Some mitigation measures may be included as licence conditions, especially where they relate to protected sites or species where conforming with relevant legislation is necessary. Suggested mitigation measures described throughout the appraisals, is presented in. This list is not exhaustive, and developers should continuously consider mitigation measures as technology and the industry progresses

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Table 14-1 Potential mitigation measures as suggested by receptor appraisals (Sections 4 - 13)

Impact	Receptors	Mitigation	Licensing requirement / Likely condition of consent	Explanation
Introduction and facilitation of MNNS	Benthic species and habitats; fish and shellfish.	Adoption of good practice: > The use of a vessel anchor and devices anchor/mooring plans will be informed by visual inspection of the seabed to identify and avoid any sensitive habitats/species, which may be carried out as part of maintenance activities; > All devices moorings will be removed during decommissioning; > Marine Biosecurity Planning Guidance (SNH, 2014a); > Marine Biosecurity Planning – Identification of best practice: a review (SNH, 2014b); > Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (IMO, 2011); > Code of practice on non-native species (Scottish Government, 2012); > Good practice for water management (IPIECA, 2010); and > Non-native species secretariat – Check, Clean Dry procedure (GB NNSS, 2019).	No	Although unlikely to form a licence or consent requirement, it is recommended that the suggested guidelines, codes and good practice are followed to limit impacts on the benthic environment because of MNNS. The following wording is generally included in Marine Licences: *The Licensee must ensure that the risk of transmitting MNNS to and from site is kept to a minimum, by ensuring appropriate bio-fouling management practises are implemented during any works*. It is recommended that the suggested guidelines, codes and good practice are followed to limit impacts on the benthic environment as a result of MNNS.

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Impact	Receptors	Mitigation	Licensing requirement / Likely condition of consent	Explanation
Seabed habitat disturbance/loss or changes to seabed habitat	Benthic species and habitats	The use of a vessel anchor and device anchor/mooring plans	No	Device and mooring plans will be informed by visual inspection of the seabed to identify and avoid any sensitive habitats/species, which may be carried out as part of maintenance activities.
	Benthic species and habitats	All infrastructure including moorings will be removed during decommissioning. This will form part of a Decommissioning Plan which is a requirement for all developers.	Yes	Removal of infrastructure and moorings will allow the benthic environment to recover to pre-installation conditions which will be recorded ahead of any installation activities taking place.
Changes to hydrodynamic regime	Benthic habitats and species	Planning of berth locations.	No	Planning placement of berths, to try and avoid cumulative wake effects
Visual and noise disturbance during all stages because of vessel activity, drilling noise and cable laying	Cetaceans; basking sharks; pinnipeds; otters and birds	**All:** Adherence to the principles of the Scottish Marine Wildlife Watching Code (SNH, 2017).	No	Although this will not be prescribed as a licensing requirement or consent condition this should be adhered to as good practice. The code aims to: > Help minimise disturbance to marine wildlife; > Help you to enjoy watching marine wildlife; > Improve your chances of seeing wildlife; > Provide a standard for the wildlife watching industry; and > Help you to stay within the law.

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Impact	Receptors	Mitigation	Licensing requirement / Likely condition of consent	Explanation
		All: Vessel movements and occupancy within the Billia Croo test site will be managed through EMEC's SOPs.	No	SOPs limit the number and size of vessels which can utilise the test site simultaneously.
		All: A VMP which includes a traffic management scheme, will be included as a part of the PEMP.	Yes	> This mitigation measure should reduce the potential impacts of disturbance from vessel presence and activity onsite. > A Vessel Management Plan is required as part of the PEMP.
		Pinnipeds: Vessel activity should avoid seal haul outs as per Marine Scotland Guidance on harassment (Marine Scotland, 2014a). VMPs will also discuss the minimum approach distance to designated seal haul outs.	Yes	By adhering to the harassment guidance and the VMP disturbance to seal using haul outs will be minimised.
		All: Consideration of vessel and construction noise within a Construction Method Statement.	Yes	A CMS will form part of the PEMP.
		Cetaceans, pinnipeds and basking sharks: Application of the EMEC MMO protocol where necessary, with special consideration of basking sharks which may take longer to exit the area.	Yes, but likely only for pin piling	Use of the EMEC MMO protocol will minimise disturbance as a result of underwater noise.
		Otters: requirement for an EPS Licence.	Possible	This will require project specific assessment where beach excavation for cable installation is required. – the requirement for an otter survey, licensing and specific mitigation should be determined through consultation with SNH.

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Impact	Receptors	Mitigation	Licensing requirement / Likely condition of consent	Explanation
	Seabirds: auks sea duck and diver species and European shag	Project vessel activity should avoid areas preferred by these species as far as possible. When not, possible vessels should reduce speeds to <10 knots when diving birds are present.	No	The severity of disturbance response is reduced by vessel speed.
	Cetaceans, basking sharks and pinnipeds	> EPS Licensing; > Basking Shark Licensing; and > Seal Licensing.	Possible	> An EPS Licence for cetaceans is recommended for potential disturbance as a result of installation activities (not including vessel activities) > A Basking Shark Licence is recommended where noisy activities have the potential to disturb basking shark species. > EPS and Basking Shark Licensing provide an opportunity for considering device-specific mitigation measures where considered appropriate. > A Seal Licence is not considered to be a likely requirement. This would only be needed if disturbance was predicted to seals within a designated site.

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Impact	Receptors	Mitigation	Licensing requirement / Likely condition of consent	Explanation
Entanglement in mooring systems	Cetaceans, basking sharks and pinnipeds	If entanglement occurs, procedures for emergency shutdown and liaison with regulators should take place until re-start or mitigation is agreed.	Possible	An emergency shutdown protocol for any entanglement events will help to minimise potential injury to any entangled animals.
		> EPS Licensing; > Basking Shark Licensing; and > Seal Licensing.	Possible	> EPS Licences recommended as a precautionary approach to entanglement. > EPS and Basking Shark Licensing provide an opportunity for considering device-specific mitigation measures where considered appropriate. > A Seal Licence is not considered to be a likely requirement. This would only be needed if disturbance was predicted to seals within a designated site.
Barrier effect as a result of the presence of WECs and other infrastructure presence	Cetaceans, basking sharks and pinnipeds	Mitigation will only be considered if monitoring indicates the impact is unacceptable. Mitigation would depend on the level of the impact and be agreed with the regulator but may consider the layout of WEC's within the test site.	No	Unlikely to form a licence or consent.
Disturbance from navigation safety lighting or vessel work lights	European storm petrel (fledglings) Manx shearwater (fledglings)	Navigation lighting of above surface structures should be designed to provide sufficient light for purpose but, excessive bright lights should be avoided. Flashing or coloured lights may decrease attraction and impact of such lighting.	No	Unlikely to be a requirement as no breeding colonies of sensitive species within 10 km

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Impact	Receptors	Mitigation	Licensing requirement / Likely condition of consent	Explanation
	Atlantic puffin (fledglings) Migrating passerines	Vessel work lights should be designed to provide sufficient light for purpose but, excessive bright lights should be avoided.		
Damage to vessels and fishing gear	Static and mobile fishing gears	All devices should be clearly marked and charted. Notice to Mariners will be issued to inform fishing operators of deployments at Billia Croo. All developers deploying at EMEC will submit pre-installation and post-decommissioning seabed footage. All developers will have an appropriate Decommissioning Programme in place. Regular consultation with local fishing association and societies, to ensure fisheries are aware of upcoming works onsite and the pipeline of developer activities.	Yes	A Decommissioning Programme is required to be submitted and approved by the regulator.
Loss or damage to marine historic environment assets	Potential wrecks and wreckage (archaeological discoveries)	Adoption and adherence to EMEC's Archaeological Discoveries SOP which is in line with The Crown Estate's 2014 *Protocol for Archaeological Discoveries: Offshore Renewables Projects*	No	Adherence to this SOP will ensure that any archaeological discoveries are reported correctly, and any appropriate protective actions are taken.

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14.3 Potential project specific monitoring activities

Throughout the appraisals presented in Sections 4 – 13, suggested monitoring is presented. Monitoring of a project can serve a number of functions. Monitoring allows action to be taken in the event of an undesirable interaction between a device and receptor, this could be triggering an emergency response as described in Table 14-1 or alerting a developer to the requirement to adopt or adapt mitigation in relation to the interaction. Monitoring of this type may form a licence requirement (e.g. MMO) and is often related to specific species which have supporting protective legislation and where removal of even a small number of individuals may have legal or biological impact.

Another function of monitoring is to increase and improve knowledge of an impact which is particularly relevant where there is a large degree of uncertainty or little information available on the impact. Given Billia Croo's function as a test site, this is particularly relevant where novel technologies are installed often for the first time. Monitoring of WECs and other infrastructure at Billia Croo can provide developers, EMEC and the wider industry with information regarding small scale deployments and an indication of which impacts may be potentially important, particularly as the industry scales up to commercial arrays. Monitoring at this scale can feed into the development of commercial scale deployments by signalling which impacts may be the most significant and therefore require further monitoring or the application of mitigation at commercial scale.

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Table 14-2 Potential monitoring as suggested by receptor appraisals (Sections 4 - 13)

Note: monitoring is delivered via the PEMP, which is itself a condition of the Marine Licence

Impact	Receptors	Monitoring
Various	Birds; seals; cetaceans; basking sharks.	Focal studies on behaviour in the vicinity of devices and marine works. This may be device specific or site wide.
MNNS	Benthic species and habitats, fish and shellfish.	Select devices may be monitored for colonisation. Opportunistic monitoring should be conducted when devices, components or scientific equipment are retrieved. Developers may implement their own MNNS management protocol or biofouling management.
EMF	Diadromous fish, gadoid fish and elasmobranchs.	Measurements of strength of EMF under various energy generation situations.
Habitat creation and FAD effect	Benthic species, fish and shellfish and species of diving birds.	Monitoring on and around select devices and infrastructure will enhance the knowledge base on this subject. This may also form part of the MNNS management protocol. Any use of underwater lighting at night to be gradual and alongside monitoring to determine any fish or bird attraction and collision risk for predators.
Changes to hydrodynamic regime	Benthic species, features of the Stromness Heaths and Coast SSSI.	It is unlikely that any mitigation or monitoring in relation to the hydrodynamic regime will be a licensing or consent requirement. Monitoring is suggested as good practice in order to increase the understanding of potential downstream effects. Measurement of current speeds and wave field in lee of WEC, before and after installation, would quantify downstream impact of WEC on current and wave field.
Changes to seabed morphology as a result of deposition	Benthic habitats and species.	Collecting bathymetry and side scan sonar data in the test site before, after, and e.g. one year after installation would assess the initial shape, volume and then evolution of any spoil or stirred sediment. The release of sediment and small rock fragments will likely be negligible above background levels. Unless there are any species or habitats of importance, there will be no requirement to do so.

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Impact	Receptors	Monitoring
Entanglement	Basking sharks and large whales Large whales	There is still uncertainty about the potential for entanglement and therefore monitoring will serve to gain further information about the likelihood of entanglement at Billia Croo.
Changes to nearby beach morphology	Warebeth Beach	Beach monitoring campaign before and after WEC installation. Some developments which directly impact the beach may wish to undertake a beach monitoring campaign for the duration of the project, but impacts are unlikely here, and the natural site variability will be so high it would be extremely difficult to prove connectivity between the WEC and the beach, through either monitoring or modelling.
Changes to local marine water quality	Breck Ness to Noup Head coastal water body	Boat-based suspended sediment monitoring before, after and e.g. one year after WEC installation could attempt to quantify the impact of the WEC on water quality. The highly dispersive nature of the site and natural background variability mean it would be difficult to record any change above background levels, except during installation itself.
Underwater noise causing disturbance/injury	Birds; seals; cetaceans; basking sharks.	Measurements of source levels from operational wave devices and characterisation of ambient sounds in the marine environment comprising Billia Croo will help determine the likely received levels seals will experience within the test site, and the potential responses they may have to operational devices.
	Cetaceans	Use of C-POD to monitor cetacean activity.
Visual and noise disturbance caused by vessel activity	Diver species; Auk species; Sea duck species; European shag.	Birds' response to vessel activity in the test site and along vessel travel routes should be monitored to determine any behavioural changes and evidence of habituation. Frequency, duration and nature of project vessel activity should be monitored to provide context. Understanding the response of [redacted] to vessel activity in the breeding season is the highest priority.

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Impact	Receptors	Monitoring
Attraction to marine infrastructure, e.g. WECs and navigation buoys.	[redacted] (breeding)	Flight lines [redacted] should be mapped to determine breeding sites, and whether they are within the Hoy SPA. EMEC should support the routine monitoring of numbers and productivity of [redacted] breeding on Hoy.
	Gull and tern species; Black guillemot; European shag.	The use by these species of above surface structures for resting/roosting, and the attraction of foraging to device wakes should be recorded as part of device-specific monitoring.
Displacement from marine infrastructure, e.g. WECs and navigation buoys.	Diver species; Auk species; Sea duck species; European shag.	The spatial pattern of birds uses of the test site relative to berth/device proximity should be monitored to collect behavioural evidence of displacement and evidence of habituation by species with time. Frequency, duration and nature of project vessel activity should be monitored to provide context.
	[redacted] (breeding)	Flight lines of [redacted] should be mapped to determine breeding sites, and whether they are within the Hoy SPA. EMEC should support the routine monitoring of numbers and productivity of [redacted] on Hoy.
Accidental release of contaminants into the marine environment, leading to poisoning, injury or death	All species (Invertebrates, fish, marine mammals, and birds)	Rigorous adherence to the project's embedded mitigation measures. These are aimed at avoiding contamination events occurring and having protocols and equipment ready to deal with any incidents should they occur. Incidents should be reported immediately to the Regulator, as appropriate, and if required, boat-based and beach surveys organised to assess if any wildlife is at risk or has become contaminated.
Disturbance from navigation safety lighting or vessel work lights	European storm petrel (fledglings) Manx shearwater (fledglings) Atlantic puffin (fledglings) Migrating passerines	The status of the small historic Manx shearwater colony at Enegars on Hoy (just 5km from Billia Croo) should be determined and thereafter monitored at least once every four years. Arrangements should be in place with an appropriate wildlife rehabilitation centre to take any disorientated birds that are along the coast in the vicinity of the test site.

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Impact	Receptors	Monitoring
Loss or damage to marine historic environment assets	Potential wreckage	ROV/diver inspection or drop-down camera deployment prior to installation of devices or infrastructure on the seabed

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14.4 Research and site wide monitoring at Billia Croo

14.4.1 Completed and ongoing research

Billia Croo offers a valuable opportunity to advance understanding of wave energy (and other infrastructure) and its potential impacts on the marine environment. Although there is an understanding that research collected at the scale of Billia Croo has an application to commercial scale projects, this is limited by the small scale and temporary nature of deployments at Billia Croo. Nonetheless given the novel nature of the technology, the increase in development demand and the numerous legislative requirements there remains considerable value in research and long-term monitoring into the potential implications of such developments on biological, physical and chemical parameters of the environment as technology evolves from pre-prototype design through to commercial viability.

EMEC is in a unique position having good working links with a range of developers, academic institutions and regulatory bodies. EMEC is currently working with developers and experts to expand the research agenda to cover a range of industry-related environmental and operational issues. EMEC is keen to engage with research and is currently involved in a range of research projects ranging from device-specific, site-wide to international collaborations.

As mentioned EMEC also supports an extensive range of both national and international research projects, a comprehensive list can be found on the research section of the EMEC website (http://www.emec.org.uk/research/).

Research undertaken at Billia Croo may apply to other renewables and indeed marine industries as a whole. Information made available through research should also be used to guide developers in the collective understanding of environmental conditions and impacts and to inform the development of their PEMP.

Table 14-3 summarises research and site-wide monitoring projects that have been delivered or are ongoing by EMEC or partners which is relevant to the Billia Croo test site.

14.4.2 Future research opportunities

A list of future research opportunities is actively maintained by and available from EMEC. Future research may identify previously unconsidered issues as the novel technologies continue to emerge. Likewise, research may be able to support the reduction in emphasis on certain impacts where currently there is a degree of uncertainty.

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Table 14-3 Complete and ongoing research activities at Billia Croo undertaken by EMEC or partners

Research focus	Project details	Status
Wildlife observations	EMEC procured a high magnification camera, which was mounted on the Black Craig observations point with the potential to inform wave energy device operators, as well as the regulatory and other decision makers, about the frequency and nature of any specific interactions between surface-piercing parts of devices and wildlife.	Data has been made available as Microsoft Access databases via Marine Scotland Information website (Marine Scotland, 2016b). The data analysis phase of the project was guided by advice from the Centre for Research into Ecological and Environmental Modelling (CREEM). EMEC produced a Wildlife Observations Project Annual Report as well as a final report (EMEC, 2014). A report detailing the analysis of bird and marine mammal data for Billia Croo was produced by SNH in 2012 (Robbins, 2012). A detailed analysis of the potential for displacement of marine mammal and bird species was completed in 2015 and commissioned by Scottish Government, Marine Scotland and SNH (Long, 2016). The camera is still used for routine operations and bespoke research projects and relevant information is made available to developers.
Acoustic monitoring	The aim of this research was to develop a methodology and procure equipment for characterising the acoustic output of devices. The research was undertaken 2011 – 2012. A site-wide acoustic characterisation of Billia Croo was completed.	A characterisation report was produced following this research (Lepper *et al*., 2012).
Crustacea monitoring project	The project was undertaken between 2011 – 2012 with the aim of monitoring the abundance of lobster at the Billia Croo. Lobsters hatchlings were tagged with microchips to monitor their distribution and movement within the site.	The results were presented in a report to the Scottish Government in 2012 (Lamb, 2012).
Hydrodynamic modelling	DHI were commissioned to construct a numerical model of the Orkney Islands using the flexible version of MIKE 21 Flow Model FM. The model provides detailed information at specified locations regarding water level, currents and waves. The model mesh has a varying spatial resolution, enabling complex tidal channels and local topographic features that may influence the hydrodynamics to be sufficiently modelled.	Ongoing
Wave resource assessment	ICIT were commissioned by EMEC to undertake routine monthly analysis of the MetOcean data	The reports produced are available to developers deploying at the wave site

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Research focus	Project details	Status
	gathered at Billia Croo. This occurred 2006 – 2007. EMEC then conducted their own monthly analysis until 2015. The analysis has since been replaced with berth-specific reports.	and inform them of the site conditions, which will help in device design, assessment and deployment.
Marine safety	This project developed a course which provides the minimum sea safety certification required for people to work offshore in the marine renewables industry, along with demonstration of the safe and efficient deployment and retrieval of a current profiler. This was undertaken 2009 – 2010.	This was joint project between EMEC and the Department of Maritime Studies in Stromness, Orkney. EMEC continues to support the development of training courses for the marine renewable sector.
Various	The FLOWBEC pod was installed at Billia Croo for 4 weeks in 2013. There were two weeks at a highly-tidally influenced area and two weeks at a less-tidally influenced area. EK60, multibeam and fluorometer were all installed.	Complete
Various	EquiMar – the project started in 2008 and developed a suite of protocols for the equitable evaluation of marine energy converters. The project was aimed at improving the environmental and economic impacts.	Complete
Various	ReDAPT: This project involved the deployment of a 1 MW tidal turbine at Fall of Warness. EMECs primary responsibility was the environmental monitoring work package, other monitoring aspects included 3D hydrodynamic modelling and design of a cabled environmental monitoring pod. Some of the outputs from the project have applicable aspects for Billia Croo.	Complete
Birds	Hebridean Marine Energy Futures Project. The aim of this project was to create a wave energy resource model for the Outer Hebrides and also to assess interactions between WECs and their environment. Some of the work packages were undertaken at Billia Croo.	The project occurred from 2011 – 2014. Two reports were published on the data collected at Billia Croo: Investigating the Potential Effects of Wave Renewable Energy Devices on Seabirds (Leesa *et al*., 2014) And Seabirds: Using kernel density estimation to explore habitat use by seabirds at a marine renewable wave energy test facility (Leesa *et al*., 2016).

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15 DEVELOPMENT OF PEMP

15.1 Purpose

The key purpose of a PEMP is:

- Ensuring that there is compliance with conditions of consent in relation to environmental impacts;
- The PEMP is an integral part of the Marine Licence application process and provides each developer with a structured approach to learning more about the interaction of their device with the environment and, more broadly, accumulating learning for the marine renewable energy sector in general; and
- The series of required actions and standards documented in the PEMP should contribute to good project management and cost reduction.

For all developments that concur within the parameters of the Project Envelope appraisals of potential impacts have been completed in the preceding sections of this document (Sections 4 - 13) and details of suggested mitigation and monitoring in relation to the appraisals has been provided. These sections should be consulted by developers and should help to guide the development of the PEMP. Prior to commencement of works at Billia Croo developers are required to prepare a PEMP, which should be agreed with Marine Scotland and EMEC.

An initial draft of the PEMP should form a fundamental part of a developer's Marine Licence and if required S36 consent applications. Subsequent iterations of the PEMP can then be submitted as further details become available, with final agreement of the content by Marine Scotland prior to the commencement of works. Marine Scotland and SNH strongly recommend that the developer liaises closely with EMEC throughout the whole process, pre- and post- submission of any licence application.

The PEMP should distinguish between mitigation[35] and monitoring[36]. It may be that monitoring is in place with the objective to trigger a certain mitigation measure when an impact threshold is crossed. Where this is the case it should be acknowledged. It should also be recognised that there are likely to be gaps in knowledge and understanding of novel technologies and infrastructure which may result in necessary interim measures or monitoring.

The PEMP provides an opportunity to contribute to industry solutions in terms of developing good practice and in developing new innovative approaches to industry-wide problems. Best-practice and innovation from developers in considering options for mitigation, monitoring and research is welcomed by Marine Scotland. Opportunities for innovation should be wide-ranging, from engineering concepts, to different ways of mitigating, monitoring, recording and analysing interactions between developments and all aspects of the environment. It is considered that through successful delivery of the commitments within the PEMP, developers will contribute to the progression of the sector to commercial scale developments through development of a sound evidence base.

15.2 Sources of information

Individual receptor appraisals are provided in Sections 4 – 13. These contain broad and then detailed receptor-specific appraisals and identification of mitigation and monitoring options. Species licensing requirements and requirements under HRA are also considered.

Section 14 of this document summarises the recommended mitigation and monitoring measures, and licensing requirements, identified across the individual appraisals. Research and site-wide monitoring projects that have been previously undertaken or are ongoing are also summarised. Familiarity with these should be used to guide the content of the PEMP.

Other sources of information of value include:

[35] Mitigation is the action of reducing or removing the severity of a potential impact.
[36] Monitoring is the action of observing the progress or condition of something and may be applied to mitigation.

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- EMEC consenting guidance;
- EMEC Marine Mammal Observer (MMO) protocol;
- Scottish Marine Wildlife Watching Code (SMWWC) and associated guidelines (www.marinecode.org);
- Non-natives good-practice management - guidance specific to the renewables industry has yet to be produced, but guidance for other related industries is useful:
    - Marine Biosecurity Planning Guidance (SNH, 2014a);
    - Marine Biosecurity Planning – Identification of best practice: a review (SNH, 2014b);
    - Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species (IMO, 2011);
    - Code of practice on non-native species (Scottish Government, 2012);
    - Guidance for the prevention and management of invasive species in the oil and gas industry - www.ipieca.org/publication/alien-invasive-species-and-oil-and-gas-industry
- Marine Scotland's marine energy research pages: www.scotland.gov.uk/Topics/marine/marineenergy/Research;
- Scottish Government Guidance on Marine EPS: https://www2.gov.scot/Resource/0044/00446679.pdf;
- Marine Scotland Offshore wind, wave and tidal energy applications: consenting and licensing manual: http://www.scotland.gov.uk/Topics/marine/Licensing/marine/LicensingManual; and
- Research reports and peer-reviewed literature.

15.3 Suggested contents of a PEMP

15.3.1 Project description and PEMP purpose

- It will be stated upfront in the document whether the project fully fits within the Project Envelope. Where the project deviates from the Project Envelope, it should be clearly stated and the differences clearly described as well as additional work which may be necessary as part of the PEMP to account for these differences.
- Summary of the PEMP's remit (from a device and developer perspective).
- Information on the designs, methods, equipment and other details to provide a thorough understanding of the project, including:
    - Project Information Summary;
    - device design and operating characteristics;
    - foundation/infrastructure installation methods;
    - device deployment methods; and
    - maintenance methods, including device removal and redeployment.
- Schedule - Likely timescales and dates for the following phases:
    - foundation and infrastructure installation activities;
    - device deployment(s); and
    - operation and maintenance activities, including device removal and redeployment (including likely frequency of repeat events).

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- Reference to gaps in knowledge and understanding and how this will be addressed. A research plan may be included.
- Timetable for revision and finalising the PEMP, together with a reporting schedule for both mitigation and monitoring results. These documents may develop in an iterative fashion but should be presented in a manner that maintains clarity in the version control and in the conclusions reached at each stage.

15.3.2 Description of receptors and proposed mitigation (by receptor category)

- Description of receptors and the potential residual impacts.
- Description of mitigation and recording procedures proposed.
- Reporting schedule: results and effectiveness of mitigation, recommendations for improvement and future opportunities (including those that may be helpful for a commercial scale).

15.3.3 Monitoring proposed (by receptor category)

- Description of monitoring methods proposed, including recording and analysis procedures.
- Reporting schedule: results and analysis of the monitoring, evaluation of the effectiveness of the monitoring undertaken, recommendations for improvement and future opportunities (including those that may be helpful for a commercial scale)

15.3.4 Commitments

Details of commitments to be undertaken by the developer (to include proposed mitigation, monitoring and research, and how/when these will be implemented).

15.3.5 Appendices

- Summarised Table of Commitments / Commitments Register.
- Recording templates.
- Copy of the relevant Marine Licence (and S36 consent) conditions when available.
- Construction Method Statement (CMS) and Vessel Management Plan (VMP) (as required).

15.4 Integration of the PEMP with the CMS and VMP

A CMS and VMP may be included within the PEMP. This allows these three elements to be developed as a ‘toolbox’ to help developers, contractors, vessel skippers and MMOs to discharge their responsibilities and for Marine Scotland to be assured of the discharge of licence conditions. The CMS and VMP sections of the PEMP should cover:

- Timing and duration of works;
- Detail of methods employed in marine works;
- MMO protocols;
- Personnel responsible for discharge of relevant conditions while at sea; and
- Vessel management protocols and procedures relevant to potential environmental impacts (e.g. Good practice measures to minimise disturbance impacts upon wildlife from vessel movements and activity).

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16 CONCLUSIONS

The EA for Billia Croo assesses the potential impacts on relevant environmental receptors at the EMEC Billia Croo test site (Figure 1-1) during the installation and decommissioning, operation and maintenance phases of device and infrastructure testing. The appraisals undertaken are based on the Project Envelope which incorporates a range of technologies and infrastructure and encompasses an extension to the lease area as well as the existing lease area.

Appropriate consideration has been given to the potential impacts on Natura sites in the form of HRA where appropriate:

- SNH advise that no assessment under HRA is required for Atlantic salmon form the Thurso SAC as there is a current lack of knowledge regarding migration routes for the species which means it is difficult to attribute connectivity to SACs unless a project is within or very close to the SAC (not the case for Billia Croo and the Thurso SAC which is located 41 km away).
- No LSE is considered for protected sites with seals as a protected feature.
- For seabirds LSE was deemed potential for the Hoy SPA and the Scapa Flow. However, the appraisal carried out demonstrates that there would no Adverse Effects on Site Integrity (AESI) of any of these SPAs.

Provided that a project falls within the parameters set out in the Project Envelope, it will be considered as pre-appraised in terms of its environmental impacts and no further environmental appraisal by Marine Scotland will be required by the developer to support their Marine Licence (or S36) application Projects falling out-with the envelope may necessitate additional appraisal and consultation, and further advice should be sought from EMEC in the first instance. This further appraisal will have to be agreed with Marine Scotland and SNH in writing.

The conclusions drawn from each of the appraisals are described below.

16.1 Benthic environment

The appraisal concludes that while the development footprint includes some rocky habitat, with potential Annex I stony/rocky reefs, any potential impacts on the physical integrity of sedimentary substrates and of rock, boulder and cobble substrates are not regarded as important at the scale of the development and in the context of the wider environment.

Any potential impacts on benthic habitats and species are considered as not of importance to the ecological functioning of the area. Good-practice mitigation should be applied to minimise the risk of introducing MNNS. In this regard, monitoring of the colonisation of devices and infrastructure by benthic flora and fauna could also form part of a MNNS management protocol.

16.2 Hydrodynamic and physical processes

Any potential impacts on hydrodynamic and physical processes are not considered to be important at the scale presented in the Project Envelope. However, some device-specific monitoring by developers may have merit in informing impact assessments at potential future commercial sites.

16.3 Fish and shellfish

No consideration under HRA as per advice from SNH regarding the uncertainty of connectivity. Any potential impacts on diadromous species, gadoid species, clupeid species and elasmobranch species are not regarded as important at a Scottish population level. However, some monitoring and research in the context of the test facility could have merit. Potential impacts on any other marine fin-fish are not regarded as important at a population level.

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The proximity to the North-West Orkney NCMPA is noted, as sandeel is a qualifying feature. The Billia Croo area is considered a nursery area for sandeel and is also recorded as overlapping with a spawning area, however the sediment at the Billia Croo site is not considered favourable for sandeel spawning. Any potential impacts on sandeels are not regarded as important at a population level, or of a degree that could have any measurable effect on key predators.

The appraisal also considers any potential impacts on shellfish to be unimportant at a population level and suggests that some monitoring and research in the context of the test facility would have merit, and good practice should be adopted to reduce any risk of introducing MNNS.

16.4 Basking sharks

The appraisal concludes that within the bounds of the Project Envelope, potential disturbance, entanglement and barrier impacts will not have any negative implications for the conservation status of basking sharks. Given the small footprint of the mooring systems and low density of basking sharks in the area, entanglement is not predicated to be an important impact. However as there remains some uncertainty about the potential for an entanglement event given the variety of mooring configurations which could be used at the site. As such, developers are urged to develop emergency shut-down procedures for moored or cabled devices with high risk of entanglement, should an entanglement event occur. In the event of entanglement, Marine Scotland and SNH will be consulted. None of the activities identified for further assessment are anticipated to generate instances of mortality or injury to basking sharks.

It is considered that any potential disturbance impacts would not have negative implications for the conservation status of the species, nevertheless uncertainties relating to basking shark hearing sensitivities place emphasis on the importance of monitoring at the test site.

The appraisal indicates that a licence to disturb basking may ne be required, to address potential disturbance impacts resulting from noise emissions from foundation and mooring installation and vessels. Furthermore, a licence to disturb basking shark will be required to cover the potential for injury or death from entanglement in mooring systems for any system that requires mooring lines and/or cables in the water column.

Regarding barrier effects, the appraisal considers the potential for any effect on basking shark distribution or movement to be negligible and no significant population-level impacts are predicted from project activities.

There is no connectivity and no impact pathway to negatively impact basking shark features of the Sea of Hebrides pMPA.

The use of active acoustic devices and the potential for entrapment in WECs will require project-specific appraisal and appropriate consultation to determine the need for a licence to disturb EPS and any additional mitigation and/or monitoring.

16.5 Cetaceans

Within the bounds of the Project Envelope description, the appraisal concludes that the potential disturbance impacts from installation noise will not be detrimental to the maintenance of populations of any cetacean species or their Favourable Conservation Status across their natural range. However, a licence to disturb EPS may be required to address disturbance impacts from the installation of foundation structures and moorings for devices.

However, an EPS Licence to cover the potential for disturbance from noise emissions from non-percussive installation methods is recommended, as per Section 1. Mitigation measures to monitor the occurrence of cetaceans throughout the test site, particularly during installation activities, will help minimise the potential for disturbance impacts to individual animals.

Any system that utilises mooring lines and/or cables in the water column has the potential to cause injury or death from entanglement in mooring systems. It is considered that the potential impacts from such entanglement risk will not be detrimental to the maintenance of the population of the species concerned at Favourable Conservation Status in their natural range. Nevertheless, review of mitigation measures on a

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project-specific basis is recommended to increase awareness and response time, should an entanglement event occur.

The appraisal considers the potential for barrier effects on cetaceans to be negligible and not to generate any significant population-level or management unit-scale impacts.

There is no connectivity with any SAC sites with cetacean features in the UK. For this reason, there is no LSE to bottlenose dolphin as a qualifying feature of the Moray Firth SAC, nor to harbour porpoise as a qualifying feature of the Inner Hebrides and the Minches SCI or Skerries and Causeway SAC and further assessment under HRA is not required. Whilst there is some potential for connectivity with the Southern Trench, North East Lewis and Sea of Hebrides pMPAs, this is considered very limited in magnitude and activities at Billia Croo are not anticipated to impact upon the conservation objectives of these sites or its cetacean protected features.

The use of active acoustic devices and the potential for entrapment in WECs will require project-specific appraisal and appropriate consultation to determine the need for a licence to disturb EPS and any additional mitigation and/or monitoring.

16.6 Seals

Disturbance impacts to seals may be generated by several noise-emissions sources at Billia Croo, including: vessels; active acoustic monitoring equipment; WECs; and the installation of foundations or moorings at the test site.

The activities within the Project Envelope are not anticipated to generate any mortality or injury to seals. Seal injury events resulting from project activities are limited to injuries from mooring installation noise and entanglement. Given the available information on habitat use by both grey and harbour seals, such events are considered unlikely and impacts to the conservation-status of seal populations or fitness of individuals are anticipated to be negligible.

The appraisal considers the potential for barrier effects on grey and harbour seals to be negligible and not to generate any significant population-level impacts.

The Billia Croo test site is not directly connected with any designated seal haul-outs or SACs; however, there is potential for connectivity with the Sanday SAC or Faray and Holm of Faray SAC. Injury and disturbance impacts are not anticipated to occur on a scale as to adversely impact the seal qualifying features of the Sanday SAC or Faray and Holm of Faray SAC. As such, there will be no LSE on grey seals or harbour seals as a qualifying feature of any SAC and further assessment under HRA is not required.

Assessment under the Marine (Scotland) Act 2010 concluded that it is unlikely that a Seal Licence will be required as this is only needed when disturbance is predicted to seals within a designated site (including seal haul out).

16.7 Otters

The Eurasian otter is an EPS which occurs relatively infrequently at Billia Croo. Potential disturbance impacts from project activities are limited to those from vessel presence. Isbister Loch SAC is located approximately 12 km from Billia Croo, and it is considered that there is no connectivity with this site. The installation or additional cabling will require a project-specific appraisal and appropriate consultation to determine the need for a licence to disturb EPS. Disturbance, injury or death is considered unlikely from vessel usage and therefore a licence to disturb EPS is not considered necessary for offshore activities.

16.8 Seabirds

Although the test site and its immediate vicinity are used by a wide variety of seabirds and other waterbirds, in an Orkney-wide context the site generally has low or very low importance for these species, mainly as a foraging site. Exceptions are European shag, black-legged kittiwake and northern fulmar, all of which are sometimes present in relatively large numbers; the site is therefore considered to have low to moderate

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importance for these species. HRA screening in the appraisal shows that many of the birds using the site are likely to be from SPA breeding populations, in particular Hoy SPA and Marwick Head SPA, for example black-legged kittiwake, guillemot, great skua and [redacted]

The appraisal identifies the potential for disturbance from project vessels and displacement from fixed marine infrastructure (e.g. WEC devices) as the most important potential impacts on birds, though for most species any affects would be highly localised. Accidental release of contaminants (in particular oil pollution) and disturbance by lighting are also identified as potential issues for birds but project mitigation measures mean that neither of these are likely to materially impact on bird receptors. Surface-piercing infrastructure (e.g. WEC devices) and their wakes are likely to attract some bird species (e.g. gulls, terns, black guillemot and European shag) through providing perches for roosting and enhanced feeding opportunities; such attraction could lead to localised and small beneficial affects to these species. Particular attention is drawn to the potential for the project vessel activity to cause disturbance to breeding [redacted] foraging in the test site and its immediate vicinity. There is some uncertainty concerning this species' response to vessel activity during the breeding season and whether the breeding sites of individuals using the test site are within Hoy SPA; monitoring to address these knowledge gaps is suggested.

16.9 Commercial fisheries

The commercial fisheries appraisal concludes that the potentially important impacts on commercial fisheries because of activities in the Project Envelope were exclusion from fishing grounds, risk of snagging and increased transit time as a result of the proposed extension area. It was concluded that none of these impacts would have an important impact on any fishing industries operating near the Billia Croo test site.

16.10 Archaeology

The likelihood of important impacts on historic environment assets are predicted to be negligible-low because of the proposed activities at Billia Croo described in the Project Envelope. To manage the potential for impacting unknown heritage, EMEC has an Archaeological Discoveries SOP which is aligned with the Crown Estates Protocol for Archaeological Discoveries: Offshore Renewables Projects. Should any cultural heritage sites be identified during marine works, it is recommended that they are investigated by a qualified marine archaeologist as their potential for retaining cultural heritage information could be high.

A pre-installation seabed survey or diver survey prior to or during work on the seabed could identify if any aircraft wreckage is present, to inform any micro-siting to avoid any potential impact. It should be noted that impact upon planes lost on military service automatically contravenes the Protection of Military Remains Act 1986, even if they were unknown prior to the impact.

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APPENDIX 1: EPS LICENSING TESTS

Three tests must be satisfied before the licensing authority can issue a licence under Regulation 44(2) of the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) to permit otherwise prohibited acts; and an application for an EPS licence to disturb may be rejected unless these tests are satisfied:

Test 1: The licence application must demonstrably relate to one of the purposes specified in Regulation 44(2) (as amended). For development proposals, the relevant purpose is likely to be Regulation 44(2)(e) for which Marine Scotland is currently the licensing authority. This regulation states that licences may be granted by Marine Scotland only for the purpose of "preserving public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment."

Climate change is widely recognised as one of the great environmental challenges facing the world today. Scottish, UK and European targets for reducing carbon dioxide include those set through the UK Climate Change Act (2008), the Climate Change (Scotland) Act (2009), the Energy Act (2013), the Renewables Obligation (Scotland) Order 2002, National Planning Policy Framework (revised 2018), and Scottish Planning Policy, among others. To meet this target, technologies such as marine energy are likely to play a major role. The proposed device and other infrastructure testing will provide an essential stepping stone on the path to commercial viability of the offshore renewables sector, with potential to provide economic benefits as well as the delivery of energy targets in response to climate change. Further considerations in relation to Test 1 may be given by MS-LOT in instances they deem appropriate.

Test 2: No satisfactory alternative.

Regulation 44(3) states that a licence may not be granted unless the licensing authority is satisfied that "there is no satisfactory alternative."

EMEC has been established as a test site for offshore renewables technologies, with support from government. The purpose of the testing facility is to assist and hasten the development of these renewable energy industries, against a background commitment to achieve significant reduction in reliance on carbon dioxide producing alternatives. Any alternative location would be unlikely to be satisfactory in terms of economic, political or environmental expediency. Further considerations in relation to Test 2 may be given by Marine Scotland.

Test 3: Regulation 44(3)(b) states that a licence cannot be issued unless the licensing authority is satisfied that the action proposed "will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status in their natural range".

Favourable conservation status is in Article 1(i) of the EC Habitats Directive; conservation status is regarded as favourable when:

- *Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats;*
- *The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; and*
- *There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.*

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