THE CROWN ESTATE

Pentland Firth and Orkney Waters Enabling Actions Report

Identification of cumulative and in combination effects associated with wave and tidal developments in the Pentland Firth and Orkney waters

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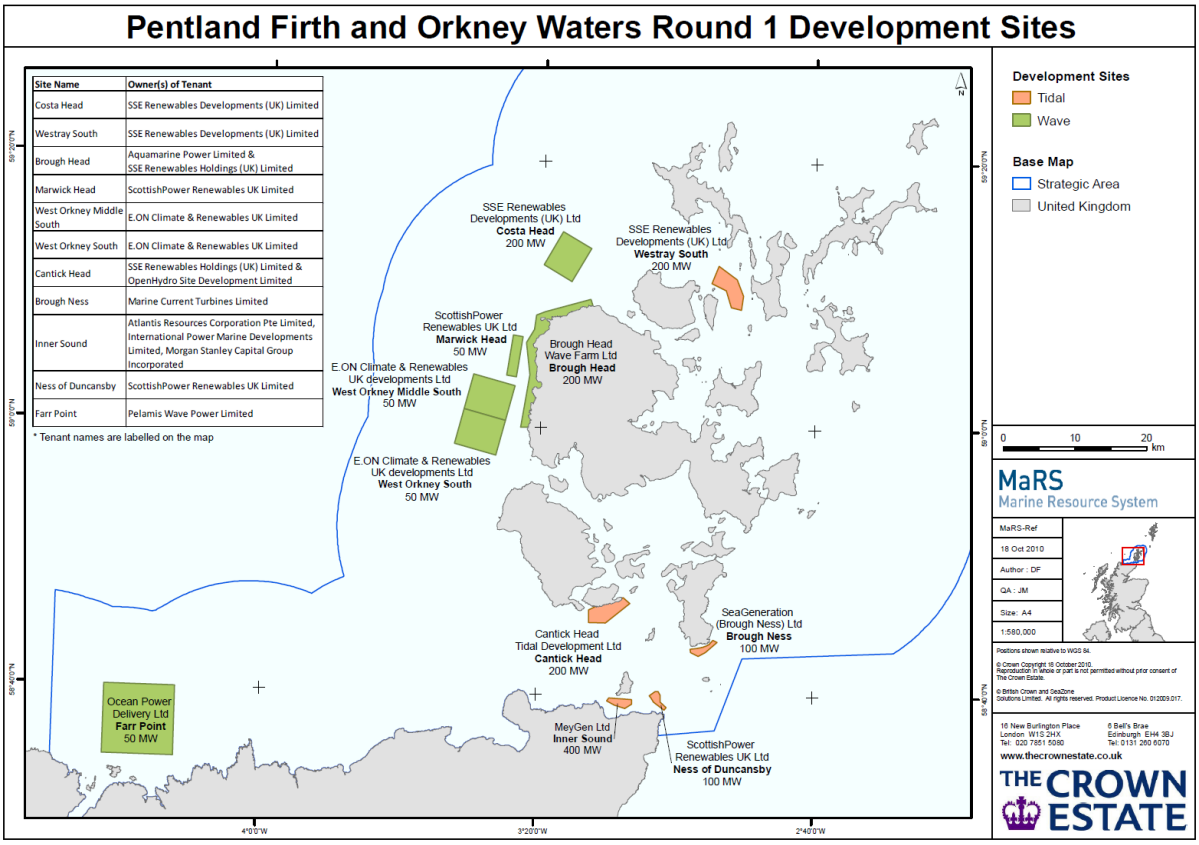

Identification of cumulative and in combination effects associated with wave and tidal development in the Pentland Firth and Orkney Waters

Discussion Document

The Crown Estate

April 2011
Final Report
9W2739

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1 INTRODUCTION

1.1 Rationale

The Crown Estate (TCE) announced the successful bidders for its commercial wave and tidal leasing round in Scotland's Pentland Firth and Orkney Waters in March 2010. The Pentland Firth and Orkney Waters is the first area to be made available for commercial scale development of wave and tidal energy in Scotland and indeed the whole of the UK.

The first round of leases will provide approximately 1.6 GW of installed capacity by 2020. The successful bidders have now signed agreements for lease with TCE, which secures their access to the seabed and allows them to commence the statutory consenting process for their projects. Lease details and locations are shown in **Table 1-1** and **Figure 1** respectively.

Table 1-1 Pentland Firth and Orkney Waters Leases

Developer (Technology)	Site	Capacity
Wave		
SSE Renewables Developments Ltd	Costa Head	200 MW
Aquamarine Power Ltd & SSE Renewables Developments Ltd (Oyster)	Brough Head	200 MW
Scottish Power Renewables UK Ltd	Marwick Head	50 MW
E.ON Climate and Renewables UK Developments Ltd	West Orkney South	50 MW
E.ON Climate and Renewables UK Developments Ltd	West Orkney Middle South	50 MW
Pelamis Wave Power Ltd (Pelamis)	Farr Point	50 MW
Tidal		
SSE Renewables Developments Ltd	Westray South	200 MW
SSE Renewables Holdings (UK) Ltd & OpenHydro Site Development Ltd (OpenHydro)	Cantick Head	200 MW
SeaGeneration (Brough Ness) Ltd SeaGen	Brough Ness	100 MW
MeyGen Ltd	Inner Sound	400MW
Scottish Power Renewables UK Ltd	Ness of Duncansby	100 MW

The development of multiple projects in relatively close spatial proximity to one another and within a similar development time frame means that there is potential for them to interact with one another as well as with other existing and planned projects and activities, potentially resulting in significant environmental effects.

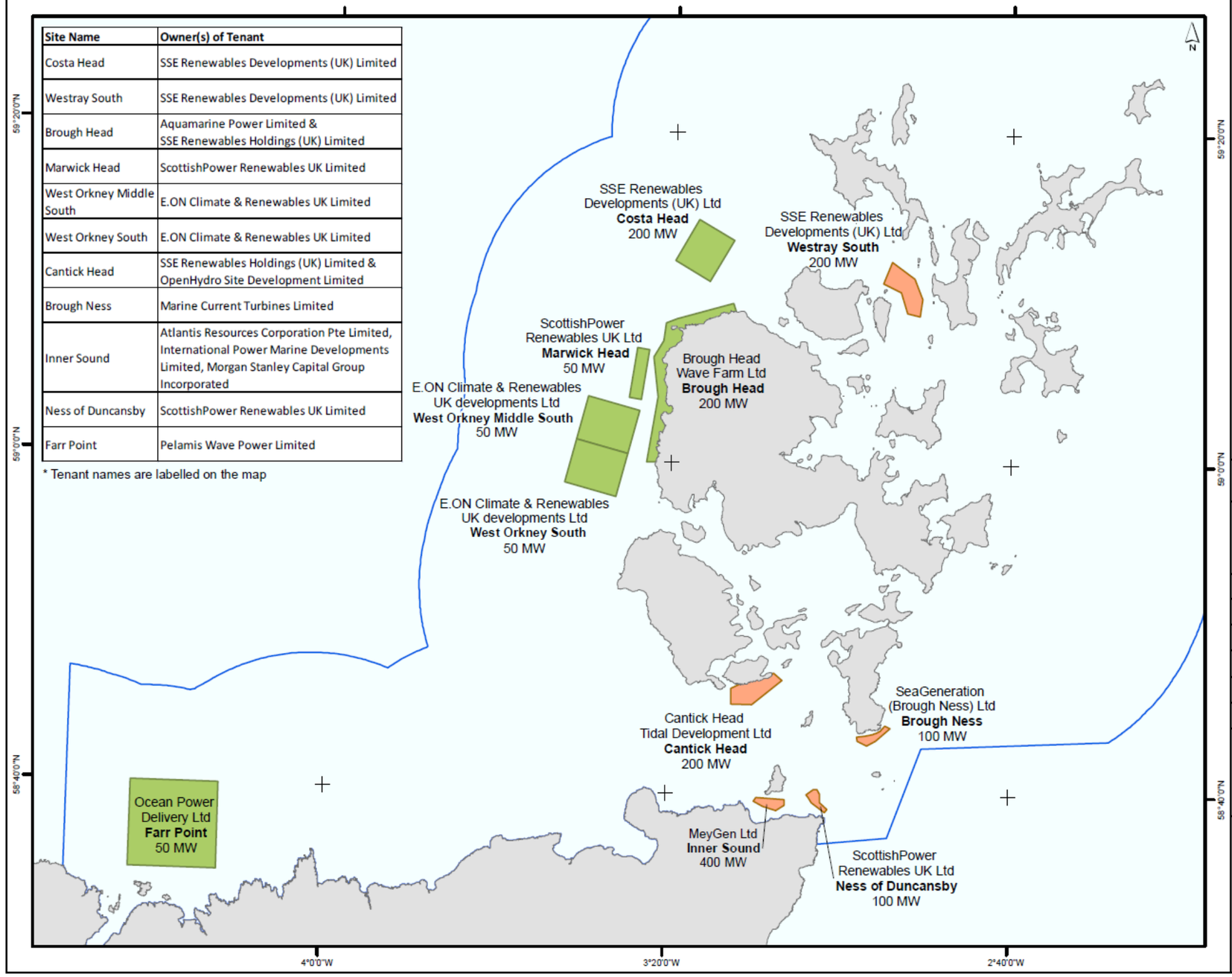
As part of the project consenting process, developers are required to consider potential 'cumulative' and 'in-combination' effects arising from project installation, operation and decommissioning, and to assess those effects as appropriate.

To support developers in this process TCE commissioned Royal Haskoning to commence the Cumulative Effects Assessment (CEA) process by identifying those potentially significant cumulative and in-combination effects resulting from wave and tidal development in the Pentland Firth Strategic Area (PFOWSA).

Pentland Firth and Orkney Waters Round 1 Development Sites

Site Name	Owner(s) of Tenant
Costa Head	SSE Renewables Developments (UK) Limited
Westray South	SSE Renewables Developments (UK) Limited
Brough Head	Aquamarine Power Limited & SSE Renewables Holdings (UK) Limited
Marwick Head	ScottishPower Renewables UK Limited
West Orkney Middle South	E.ON Climate & Renewables UK Limited
West Orkney South	E.ON Climate & Renewables UK Limited
Cantick Head	SSE Renewables Holdings (UK) Limited & OpenHydro Site Development Limited
Brough Ness	Marine Current Turbines Limited
Inner Sound	Atlantis Resources Corporation Pte Limited, International Power Marine Developments Limited, Morgan Stanley Capital Group Incorporated
Ness of Duncansby	ScottishPower Renewables UK Limited
Farr Point	Pelamis Wave Power Limited

* Tenant names are labelled on the map



Development Sites
- Tidal
- Wave

Base Map
- Strategic Area
- United Kingdom

0 10 20 km

MaRS
Marine Resource System

MaRS-Ref	
18 Oct 2010	
Author : DF	
QA : JM	
Size: A4	
1:580,000	

16 New Burlington Place
London W1S 2HX
Tel: 020 7851 5080

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Figure 1 Lease Sites

1.2 Rationale and Aims of this Study

Royal Haskoning recently worked with TCE and the developers comprising the Forth and Tay Offshore Wind Developers Group (FTOWDG) to identify potential cumulative and in-combination effects resulting from development of multiple wind farm sites off the east coast of Scotland. Potential effects were identified and appropriate assessment methods devised; and then presented in a series of Discussion Documents issued for comment to statutory bodies and key stakeholders.

The approach taken by FTOWDG to CEA has been well received by statutory bodies and key stakeholders, and the intention is to adopt a similar approach in relation to wave and tidal development in the PFOWSA, with some adaption of the CEA process to take account of differences between offshore wind and wet renewable developments.

The aims of this Discussion Document are:

- To identify potential cumulative and in-combination effects arising from development within the PFOWSA;
- To identify those potential environmental effects which are likely to need assessment cumulatively and those which are unlikely to give rise to cumulative effects and could therefore be 'scoped out' of any future assessment;
- To agree which of these potential effects should be dealt with in a strategic manner and which are more appropriately addressed by developers individually within their Environmental Impact Assessments (EIAs); and
- To record findings in a document, as the basis for further discussion with consultees.

2 CUMULATIVE EFFECTS ASSESSMENT

This document is based on the following assumptions:

- Cumulative effects can result from an accumulation of effects from numerous and various types of activities.
- Cumulative effects can also result from a combination of effects from one single type of activity.
- In either of the above cases, cumulative effects can be different in nature (e.g. synergistic), larger in magnitude, greater in significance, more long-lasting, and/or greater in spatial extent than is the case with individual effects.

2.1 Requirement for CEA

2.1.1 Environmental Impact Assessment

The PFOWSA wave and tidal projects will require a number of consents prior to development. The lead consent will be that granted under Section 36 of the Electricity Act 1989 (to construct and operate an electricity generating scheme). Environmental Impact Assessment in support of this consent application is required under the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000.

Where EIA is required, environmental information must be provided by the developer in the form of an Environmental Statement (ES). The Regulations prohibit the planning authority from granting consent for EIA development without taking into account an ES, together with any associated environmental information. Schedule 4 specifies the information that must or may be provided in such an ES (depending on the nature of the anticipated significant effects), which includes:

> *"A description of the likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary, **cumulative**, short, medium and long term, permanent and temporary, positive and negative effects of the development, resulting from (various issues)…"*

Schedule 4 clearly indicates that the potential for **cumulative effects** should be considered and, where appropriate, assessed.

2.1.2 Nature Conservation and Appropriate Assessment

Where any plan or project, which is not directly connected with the management of a designated site for conservation purposes, and which is likely to have a significant effect on a European site (i.e. Special Area of Conservation or Special Protection Area) either alone or **in combination** with other plans or projects, it will be subject to the Habitats Regulations Appraisal (HRA) process. Where there is potential for a significant effect on a designated site and its interest features, an Appropriate Assessment (part of the HRA process) is required under the European Habitats Directive and the Conservation (Natural Habitats, & c.) Regulations 1994 (as amended in Scotland).

2.2 Definitions

There are a number of existing definitions of cumulative and in-combination effects. Examples are provided below.

1. *"accumulation of human induced changes in valued environmental components … additive or interactive"* (EC, 1993).

2. Cumulative effects, or impacts, are described as *"changes to the environment that are caused by an action in combination with other past, present and future human actions"* (CEAA, 1999). They can be positive or negative, as well as either direct (e.g. loss of habitat to development) or indirect (e.g. diffuse pollution). They can occur both spatially across geographic areas, and temporally over time, and can result from effects arising from a single development as well as effects arising from multiple developments.

3. *"… result from the incremental impact of the action when added to other past, present and reasonably foreseeable actions regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions …"* (US Council on Environmental Quality, 2005).

4. *"… effects that result from incremental changes caused together with other past, present or reasonably foreseeable actions"* (EC, 1999).

5. Neither the Habitats Directive nor the Conservation Regulations provide a definition of 'in-combination', although the Regulations do limit the scope of any in-combination test to 'other plans and projects', which include the following (English Nature, 2001):
    - *"Approved but as yet uncompleted plans or projects;*
    - *Permitted ongoing activities such as discharge consents or abstraction licences; and*
    - *Plans and projects for which an application has been made and which are currently under consideration but not yet approved by competent authorities."*

2.2.1 Recommended Definitions

To aid assessment it is important to apply pragmatic and clear definitions of cumulative and in-combination effects. The following definitions are proposed, supported by guidance issued by the EC (European Communities, 2005). These definitions are already familiar to statutory bodies and a number of key stakeholders whom have been involved in discussions with the FTOWDG.

Cumulative – the effects of a proposal for one type of development with other developments* of the same type (i.e. wet renewables and other wet renewables) [*including existing, approved and proposed schemes]. It may be appropriate to treat effects of wave developments on tidal developments (and vice versa) as ' in combination' rather than cumulative, acknowledge the different potential effects of different wet renewable devices.

In-combination – the effects of the above in combination with other, different projects and activities (e.g. wet renewables in combination with dredging or wind farms in combination with shipping).

Question to Reader:

Q1. Do you agree with our definition of cumulative and in-combination effects? If not, what would you propose (please provide reasoning / a reference)?

2.3 Development of CEA Methodology

There exists no standard approach to CEA, and so over the past two years the FTOWDG has worked to identify a process and refine it to ensure suitability to offshore renewable development in Scottish waters.

Based upon the work of the FTOWDG to date and the guidance listed in **Box 1** below, a proposed CEA process is mapped out in **Table 2-1**. This document represents the outputs of the 'Preliminary Review' stage, with elements of 'Scoping' also completed..

Box 1: CEA Guidance

European Commission (1999). Guidelines for the assessment of indirect and cumulative impacts as well as impact interactions. EC DG Environment, Nuclear Safety & Civil Protection. Report produced by Hyder Consultants.

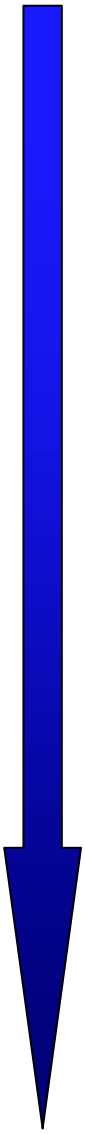
English Nature (2001). Alone or in combination. Habitats regulations guidance note Natura 2000. HRGN 4.

Land Use Consultants (2006). A practical toolkit for assessing the cumulative effects of spatial plans and development projects on biodiversity in England. English Nature Research Report No. 673.

Canadian Environmental Assessment Agency (CEAA) (1999). Cumulative Effects Assessment Practitioners Guide. Prepared by: The Cumulative Effects Assessment Working Group (Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling and D. Stalker) and AXYS Environmental Consulting Ltd.

Government of Alberta, Canada (2006). Cumulative Effects Assessment in Environmental Impact Assessment Reports Required under the Alberta Environmental Protection and Enhancement Act. http://www.gov.ab.ca

Table 2-1 Proposed Cumulative Effects Assessment process.

Process	Task	Aim/Objective	Work / Output (Examples)
CEA 	Preliminary Review	• Describe the proposed development project(s) • Identify distance from other projects; • Identify if cumulative effects may arise, and if so types of effects. • Determine whether CEA is required	• Consultation with the developer • Consultation with statutory bodies • Local knowledge and information
	Scoping	• Identify environmental receptors likely to be affected by cumulative effects • Identify relevant projects and plans for inclusion in CEA • Identify spatial and temporal boundaries for the CEA • Describe the current state of the environment and any key environmental issues • Describe the nature of the cumulative effects that are likely to occur • Develop CEA methodology • Identify stakeholders and consultees	Scoping report including: • Background data comprising existing literature and specialist studies • Issues 'scoped out' (i.e. not requiring further assessment • Identification of areas requiring further investigation in the CEA • Description of appropriate methodology to be employed in the CEA • Consultation strategy
	Assessing Cumulative Effects	• Describe in detail the environmental baseline of the study area • Predict likely cumulative effects of the project(s) and alternatives • Assess cumulative effects arising from the project(s) and alternatives • Avoid, reduce or mitigate significant adverse cumulative effects and maximise beneficial cumulative effects • Develop proposals for monitoring of cumulative effects	• Specialist reports (marine mammal desk study) • Quantification of significant cumulative effects • Spatial and temporal analysis of cumulative effects • Solutions to adverse effects • Feedback into the design process, as applicable • Appropriate Assessment (if relevant)
	CEA	• Produce CEA report in accordance with available guidance	• CEA report / relevant coverage in EIA report

2.4 Identifying Projects, Activities and Receptors

The starting point in the identification of potential cumulative and in-combination effects is an understanding of the following:

- Existing and proposed projects and activities which may interact to result in cumulative and in-combination effects; and
- Those environmental receptors (physical, biological and human) which may be impacted by cumulative and in-combination effects, and their current status.

This Discussion Document takes account of existing and proposed[1] projects as well as activities and receptors under the headings listed in **Table 2-2**.

Table 2-2 Receptors, Projects and Activities considered within CEA

Receptors	Projects & Activities
Physical Environment	• Wave and Tidal Projects
• Geology and Coastal Processes	• Offshore and Onshore Wind Farms
Biological Environment	• Shipping and Navigation
• Marine Mammals	• Traffic and Transport
• Fish and Shellfish Resources	• Commercial fisheries
• Ornithology	• Military Activities
• Designated Sites	• Cables and Pipelines
• Benthic Ecology	• Oil and Gas Infrastructure
Human Environment	• Marine Aggregate Extraction
• Shipping and Navigation	• Waterfront and Coastal Development
• Commercial Fisheries	• Airspace and radar
• Tourism and Recreation	• Shipping and Navigation
• Archaeology and Cultural Heritage	Dredging and Sea Disposal
• Seascape and Landscape	
• Socio-Economics	
• Other Users	

Question to Reader:

Q2. Are there other receptors, activities or issues relevant to cumulative or in-combination effects that should be included in this document?

2.4.1 Technology Characterisation

Wave and tidal energy technologies are highly diverse in terms of their physical form and the way they interact with, and extract energy from, the environment. In addition, the potential effects associated with such novel technology are not well understood.

[1] In terms of proposed activities and projects, only those that are 'reasonably forseeable' are included within the scope of this study. 'Reasonably forseeable' relates to those activities and projects for which sufficient information is available on which to base any assessment of effects.

To support the identification of potential cumulative and in-combination effects, Royal Haskoning has completed a wet renewables technology characterisation exercise (Appendix A). The varied technical nature of each of the independent wave and tidal technologies involved in the Pentland Firth increases the difficulty of any cumulative assessment. It was therefore decided during the technology characterisation to 'group' types of wave and tidal development and therefore enabling a generic understanding of potential environmental effects.

The characterisation identified the following generic types of device:

Tidal devices:

- Horizontal axis turbine
- Vertical axis turbine
- Reciprocating hydrofoil

Wave devices:

- Point absorber
- Attenuator
- Offshore overtopping device
- Onshore overtopping device
- Offshore oscillating water column
- Onshore oscillating water column
- Oscillating wave surge converter
- Submerged pressure differential

This approach overlaps with the generic types of wave and tidal device identified by Scottish Natural Heritage and Marine Scotland for consideration by consultants during the current development of environmental monitoring methods for such devices. The generic simplified device types identified are as follows:

Wave devices:
a) A floating attenuator or point absorber (e.g. Pelamis or OPT); and
b) A seabed mounted oscillating waver surge convertor (e.g. Aquamarine).

Tidal device:
c) A horizontal axis turbine with exposed blades (e.g. MCT, Hammerfest Strom Ltd, Atlantis Resources Corporation Ltd); and
d) Open Centre tidal device (e.g. Open Hydro)

To simplify the CEA it is proposed that the CEA process focuses on the potential effects associated with these four types of devices.

Question to Reader:

Q3. Do you agree with the classification of devices? If not, what alternative would you propose?

2.5 CEA Boundaries

Boundaries have been set to help rationalise the assessment task.

2.5.1 Spatial Boundaries

The spatial boundaries of the assessment are not limited to the lease site boundaries. Boundaries are rather set on the basis of the extent of potential effects upon sensitive receptors. Receptors include marine mammal, bird and fish species, which can be highly mobile and wide ranging. **Figure 2** below highlights the proposed spatial boundary; it includes the PFOWSA and surrounding environment up to 35 km, in alignment with the approach taken to support Habitats Regulation Assessment of the PFOWSA (ABPmer, 2010). It is important to note that this boundary has been applied to this exercise only, and the scale and scope of subsequent studies will be determined by the characteristics, ecology etc, of receptors under consideration.

2.5.2 Temporal Boundaries

Temporal boundaries are largely defined by project development timelines; assessment will need to take account of potential effects over the whole life of projects thorough to decommissioning.

It is intended that all projects will be installed by 2020, however individual project installation details are not available to Royal Haskoning at the present time. It is acknowledged that TCE has a milestone programme in place for the development of the round but agreement between developers is required prior to publication.

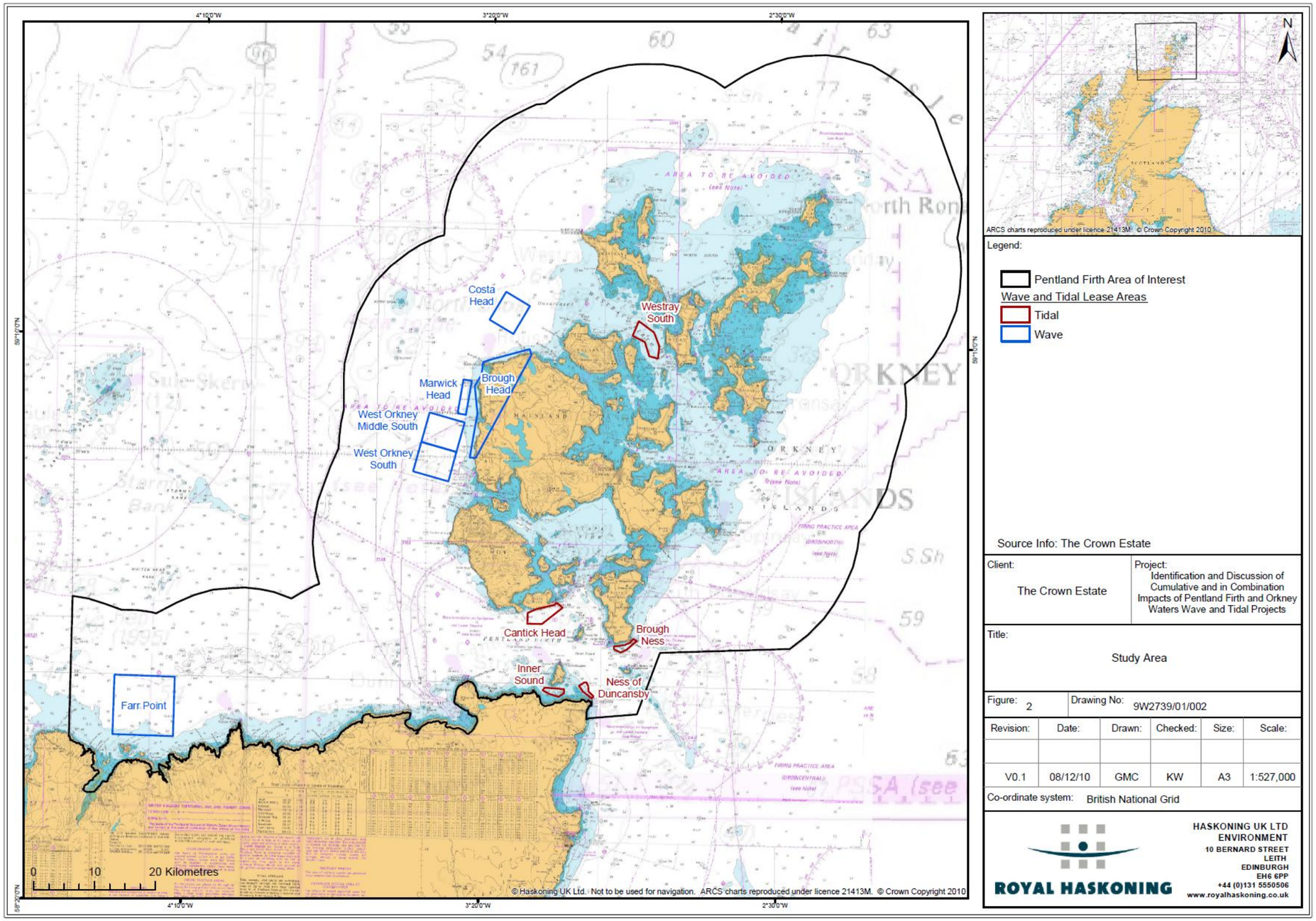


Figure 2-1 Study Area

3 IDENTIFICATION AND SCOPING OF EFFECTS

In the following sections of this document, potentially significant cumulative and in-combination effects are identified.

Effects are considered on a receptor-by-receptor basis and broken down under the headings listed in Section 2.4 above.

Under each receptor heading, the known baseline conditions of that receptor are briefly described based on publicly available information, which has been collated in a desk-based review.

'Key Issues' are then identified; these essentially represent potentially significant cumulative and in-combination effects. Effects are identified on the basis of expert opinion and a desk-based review of relevant literature/data, including but not limited to the following sources:

- Scottish Government-led projects (ongoing) investigating the effects of marine renewable energy development on the environment, including the work of the Marine Energy Spatial Planning Group (MESPG);
- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al.*, 2010)
- Screening and Scoping Review for the Pentland Firth Strategic Area (PFOWSA) Leasing Round Habitats Regulations Assessment. Report to The Crown Estate by (ABPmer, 2010).
- Report to Inform Appropriate Assessment for the Pentland Firth Strategic Area (PFOWSA) Leasing Round. Report for The Crown Estate by ABPmer 2010.
- The Marine Renewables Strategic Environmental Assessment (2007), which includes consideration of potential cumulative effects
- Scottish Natural Heritage's review of marine renewable energy developments and their natural heritage impacts (2003);
- Environmental Statements and technical reports associated with existing marine renewables projects; and
- Any other data provided by the European Marine Energy Centre or specific developers.

The significance of an effect is determined on the basis of the likely magnitude of the effect and the considered importance of the receptor following the principles set out in **Table 3-1**.

Table 3-1 Example of an impact prediction matrix (taken from Scottish Government EIA Guidance)

Effect Magnitude	Receptor Importance			
	Lesser	Local	Regional	National/international
High	Minor	Moderate	Major	Major
Medium	Negligible	Minor	Moderate	Major
Low	Negligible	Negligible	Minor	Moderate

Those effects with a rating of 'minor' to 'major' should be further considered within a more detailed CEA.

Finally, following the identification of key issues, data gaps are identified (which if filled would better inform CEA), and high-level recommendations are made in terms of how key issues may be assessed in detailed CEA (e.g. within regional collaborative studies, or within individual projects EIAs via the application of standardised impact assessment methods).

3.1 Assumptions

The findings of this study are necessarily based upon a number of assumptions.

Firstly, given the limited information currently available in terms of project definition (device numbers, footprints, installation methods, noise outputs, etc), potential effects are considered on the basis of a 'realistic worst case' scenario (following Rochdale Envelope principles), considering the maximum potential footprint of the wave and tidal projects and their associated impacts. Understanding of what constitutes the 'realistic worst case' is based upon the findings of the technology review (see Section 2.4.1) and discussions with TCE and developers.

Potential cumulative effects associated with export cables, landfalls and terrestrial cables through to substation connection are considered within this document. However, it is important to understand that these project components are yet to be defined by all developers, and so potential effects are considered generically.

Question to Reader:

Q4. Are developers content with consideration of cumulative and in combination effects for both on and offshore elements of the assessment up to the substation connection?

4 PHYSICAL ENVIRONMENT

4.1 Geology and Coastal Processes

4.1.1 Baseline Environment

Bathymetry

Within the PFOWSA water depths vary considerably; with inshore waters[2] around Orkney generally less than 25m Chart Datum (CD) and rarely exceeding 40m depth (see **Figure 3**, below). In comparison the offshore waters and the Pentland Firth itself are significantly deeper, with depths between 60m and 100m, reaching over 100m in discrete areas.

Geology

The PFOWSA is underlain by a sedimentary sequence of Devonian age rocks, also referred to as the old red sandstone. The present day coastal geomorphology is related to variations in the hardness and composition of this sandstone bedrock which in many places has resulted in the creation of dramatic vertical cliffs. The PFOWSA contains a number of nationally important examples of glacial and pre-glacial deposits and raised beaches. A number of these are designated as geological SSSIs and Geological Conservation Review Sites (GCR), with those GCR forming part of a number of Sites of Special Scientific Interest (SSSI) detailed later in section 5 and shown in Figure 4.

Coastal processes

Coastal processes within the PSFA vary from the south to the north. Much of Orkney is rocky and subject to harsh wave conditions, and this is particularly the case to the south. Consequently most beaches experience long term coastal and cliff erosion with an overall transfer of sediment from east to west, although site specific circumstances may vary from this. The central parts of the PFOWSA and certain parts of mainland Scotland are subject to much lower levels of wave action and generally experience very little sediment transfer. In the northern third of the PFOWSA the convoluted nature of the coastline limits the potential for beach to beach transfers, although there is evidence of some sediment movements resulting from wave action on more exposed part of the coast in this area (Marine Scotland *et. al,* 2010).

Hydrodynamics

Tidal

Due to its location, lying close to the boundary between North Atlantic and North Sea, tidal systems with the PFOWSA are very complex. The incoming North Atlantic tidal wave reaches Orkney several hours before the North Sea tidal wave, causing a net flow of water from west to east on the flood tide, particularly through the Pentland Firth (Dacre *et al*., 2001). The flows are strongly modified by local conditions of water depth and topography. Tidal races and eddies are typical throughout the area. These have the

[2] For the purposes of this narrative inshore is defined as generally the areas between the islandsbetween the islands or within 2km of more exposed open, outer coasts of the archipelago.

effect that frequently the flood and ebb tides do not directionally oppose one another, a potentially important consideration in the siting of tidal power devices (Marine Scotland *et al.* 2010).

Wave
Low pressure systems moving from west to east across the North Atlantic largely dictate the wave climate in the PFOWSA with the highest and most frequent waves approaching from westerly directions. Generally the east side of Orkney experiences a less severe wave climate than the west due to sheltering from the dominant westerly wind by the rest of the Orkney isles (Marine Scotland *et.al.* 2010a).

4.1.2 Key Issues

Based on available literature, the following are perceived to be the main potential effects on the physical environment and coastal processes as a result of the development on wave and tidal farms within the marine environment (CEFAS, 2004):

- Alteration of local hydrodynamic conditions (i.e. waves and tidal flows);
- Changes to the sedimentary environment (e.g. suspended sediment concentrations, sediment transport pathways, patterns and rates, and sediment deposition);
- Alteration of sedimentary seabed structures (e.g. sandbanks and other large scale bed forms);
- Indirect effects of the above changes on other environmental receptors (e.g. benthos, fisheries, water quality).

Potential impacts on coastal processes are expected to be site-specific and localised. The PFOWSA sites lie in areas where seabed sediments are generally fairly coarse or there is exposed bedrock with high wave energy or fast flowing tidal movement. While localised scour around turbine structures and cables may occur, it is unlikely that there will be any interaction between sites (ABPmer 2003, 2008; CEFAS, 2005).

4.1.3 Data Sources

- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al*., 2010)
- Regional Locational Guidance for Marine Energy (Marine Scotland *et al.*,2010b)

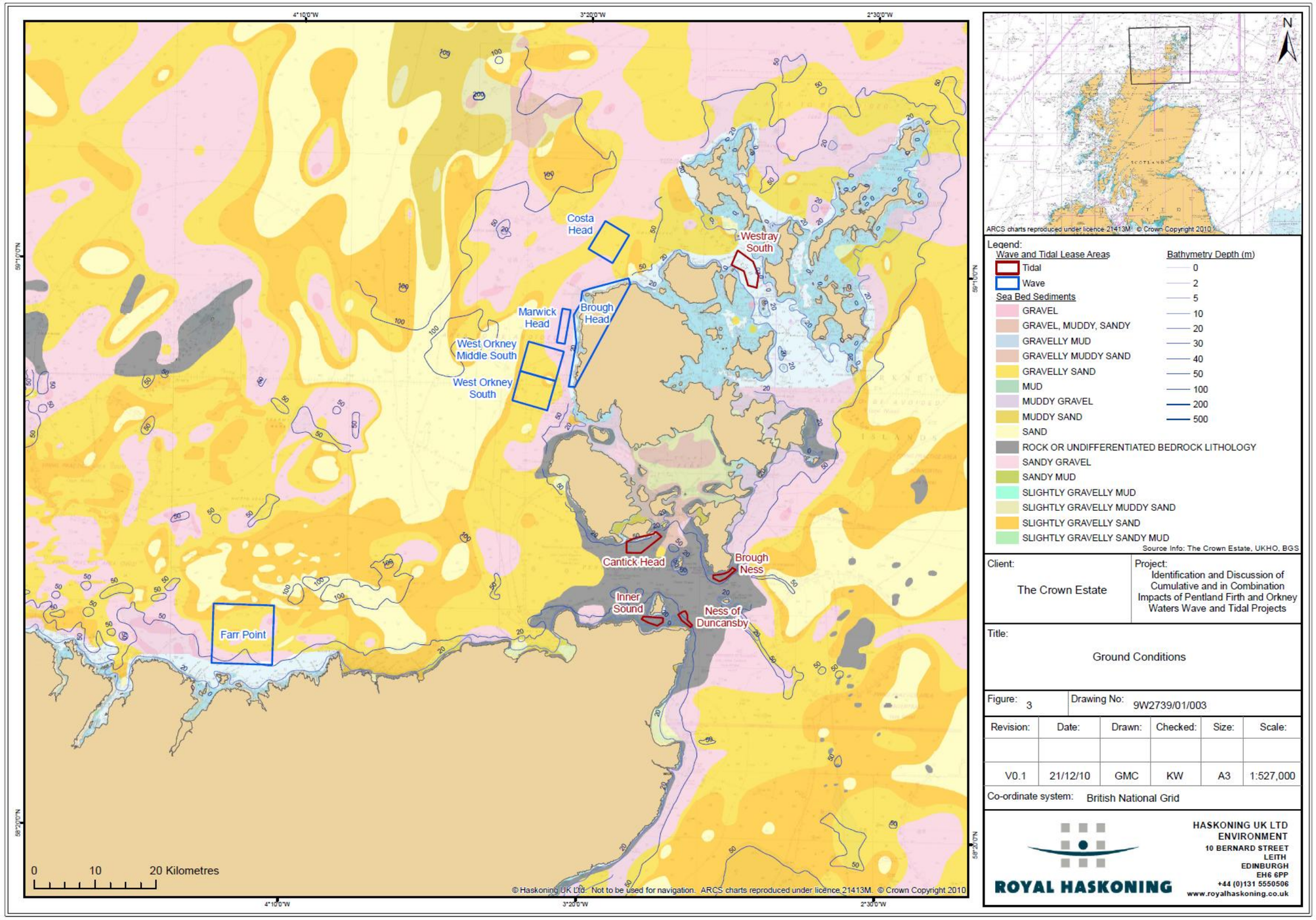
4.1.4 Data Gaps

For a number of the proposed lease sites the technology is still undefined. The types of device and the installation methodology required are still to be established and this information will be required to assess impacts on physical environment and coastal processes. The number and type of devices as well as the routes of subsea cables that will connect the proposed offshore wave and tidal farms to the onshore grid, and inter-array subsea cables, are also not yet known for all sites.

4.1.5 Recommendations for CEA

Effects are expected to be site-specific and therefore it is anticipated that the key issued identified can be addressed within project EIAs.

However, given logistical benefits, it maybe beneficial for some developers to undertake collaborative oceanographic studies, with the resulting data used to inform individual EIAs.



Client: The Crown Estate	Project: Identification and Discussion of Cumulative and in Combination Impacts of Pentland Firth and Orkney Waters Wave and Tidal Projects

Title: Ground Conditions

Figure: 3 | Drawing No: 9W2739/01/003

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
V0.1	21/12/10	GMC	KW	A3	1:527,000

Co-ordinate system: British National Grid

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5 BIOLOGICAL ENVIRONMENT

5.1 Designated Sites

5.1.1 Baseline Environment

Large stretches of the coastline within the PFOWSA have been designated as a result of the presence of habitats and/or species of nature conservation importance. Figure 4 shows the location and extent of sites of European, national and local importance. Many of the awarded lease sites fall within one or more environmental designations (Figure 4).

The European designations include: Special Areas of Conservation (SACs) which are designated under the EC Habitats Directive (92/42/EEC); Specially Protected Areas (SPAs) which are designated under the European Birds Directive (79/409/EEC). Many SPAs are also Ramsar sites, designated under the Ramsar Convention. Table 5.1 below lists the European designations and Ramsar sites which fall within the PFOWSA.

To supplement the existing network of SACs, new potential SACs are being identified in UK offshore waters for Annex I habitats (reefs, sandbanks, submarine structures made by leaking gases). Several potential offshore SACs have already been identified, none of which fall within or near to the study area (JNCC website (a)). However, it is expected that several more offshore sites, where Annex I habitat is present, will also become potential SACs in the near future.

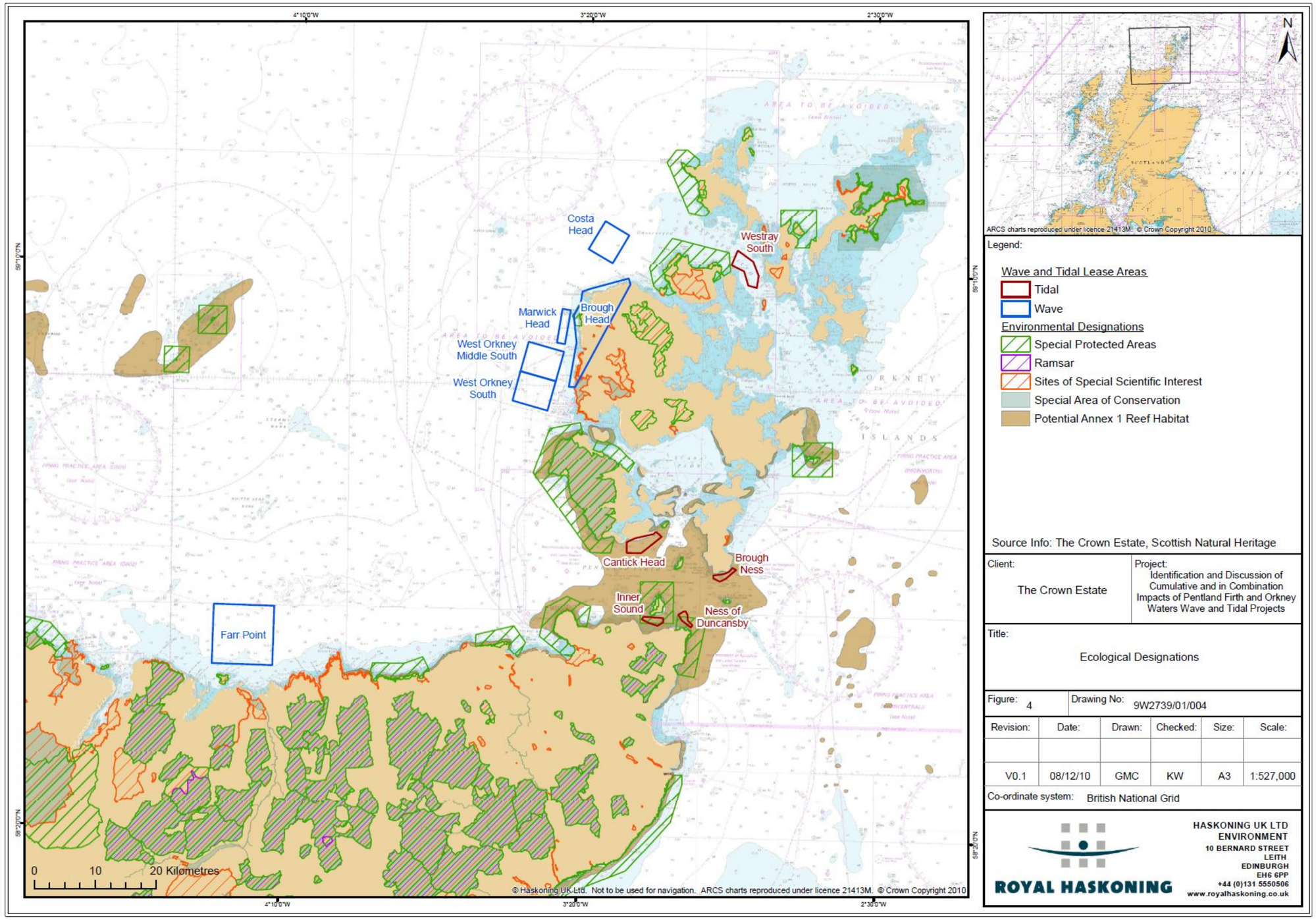
Table 5.1: Designated sites

Site	Designation	Conservation interest
Aukskerry	SPA	**Qualifying species:** Breeding populations of Arctic tern and storm petrel (*Hydrobates pelagicus*).
Calf of Eday	SPA	**Qualifying species:** Breeding populations of cormorant (*Phalacrocorax carbo*), fulmar great black-backed gull, guillemot, and kittiwake. **Qualifying aggregation:** Seabird assemblage, breeding.
Copinsay	SPA	**Qualifying species:** Breeding populations of fulmar, great black-backed gull, guillemot, and kittiwake. **Qualifying aggregation:** Seabird assemblage, breeding.
East Sanday Coast	SPA	**Qualifying species:** non breeding populations **of** bar-tailed godwit (*Limosa lapponica*) and purple sandpiper (*Calidris maritima)*.
East Sanday Coast	Ramsar	**Qualifying species:** non-breeding populations of purple sandpiper (*Calidris maritima*) and Turnstone (*Arenaria interpres*).
Faray and Holm of Faray	SAC	**Qualifying species:** Grey seal (*Halichoerus grypus*).
Hoy	SPA	**Qualifying species:** Breeding colonies of Arctic skua (*Stercorarius parasiticus*), fulmar, great black-backed gull (*Larus marinus*), great skua (*Stercorarius skua*) guillemot, kittiwake, peregrine, puffin and red-throated diver (*Gavia stellata*). **Qualifying aggregation:** Seabird assemblage, breeding.
Hoy	SAC	**Qualifying Habitats:** Acid peat-stained lakes and ponds, Alpine and subalpine heaths, Base-rich fens, Blanket bog

Site	Designation	Conservation interest
		Dry heaths, Hard-water springs depositing lime, Plants in crevices on base-rich rocks, Vegetated sea cliffs and Wet heathland with cross-leaved heath.
Invernaver	SAC	**Qualifying Habitats:** Alpine and subalpine calcareous grasslands, Alpine and subalpine heaths, Base-rich fens, Coastal dune heathland, Dune grassland, Dunes with creeping willow, Dunes with juniper thickets and Shifting dunes with marram.
Loch Sterness	SAC	**Qualifying Habitat:** Lagoons.
Marwick head	SPA	**Qualifying species:** Breeding populations of guillemot and Kittiwake. **Qualifying aggregation:** Seabird assemblage, breeding.
North Caithness cliffs	SPA	**Qualifying species:** Breeding colonies of fulmar (*Fulmarus glacialis*), guillemot (*Uria aalge*), kittiwake (*Rissa tridactyla*), peregrine (*Falco peregrinus*), puffin (*Fratercula arctica*) and razorbill (*Alca torda*). **Qualifying aggregations:** Seabird assemblage, breeding.
North Sutherland Coastal Islands	SPA	**Qualifying species:** non-breeding populations of Greenland barnacle goose (*Branta leucopsis*).
Papa Westray	SPA	**Qualifying species:** Arctic skua and Arctic tern.
Pentland Firth Islands	SPA	**Qualifying species:** breeding colonies of Arctic tern (*Sterna paradisaea*).
Rousay	SPA	**Qualifying species:** Breeding populations of Arctic skua, Arctic tern, fulmar, guillemot and kittiwake. **Qualifying aggregation:** Seabird assemblage, breeding.
Sanday	SAC	**Qualifying species:** Common seal (*Phoca vitulina*). **Qualifying Habitat:** Intertidal mudflats and sandflats, Reefs and Subtidal sandbanks.
Strathy Point	SAC	**Qualifying Habitat:** Vegetated sea cliffs
Stromness Heaths and Coast	SAC	**Qualifying Habitats:** Base-rich fens, Dry heaths and Vegetated sea cliffs.
Switha	SPA	**Qualifying species:** non-breeding population of Greenland barnacle goose.
Loch of Isbister	SAC	**Qualifying Habitats:** Naturally nutrient-rich lakes or lochs which are often dominated by pondweed. Very wet mires often identified by an unstable 'quaking' surface **Qualifying species:** Otter (*Lutra lutra*)
Orkney mainland moors	SPA	**Qualifying species: breeding populations of** Hen harrier (*Circus cyaneus*), Red-throated diver, short-eared owl (*Asio flammeus*), and non breeding populations of Hen harrier ,
West Westray	SPA	**Qualifying species:** Breeding populations of Arctic skua Arctic tern, fulmar, guillemot kittiwake and razorbill. **Qualifying aggregations:** Seabird assemblage, breeding.
Loch of Stenness	SAC	**Qualifying Habitats:** Lagoons

In addition to SAC and SPA designations, a number of maritime and coastal habitats are also protected under national legislation through the designation of Sites of Special

Scientific Interest (SSSI) and National Nature Reserves (NNR). In total there are 22 SSSIs on Orkney and along the North Caithness coast designated for maritime and coastal habitats (Marine Scotland, 2010 a).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Wave and Tidal Lease Areas
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Special Protected Areas
Ramsar
Sites of Special Scientific Interest
Special Area of Conservation
Potential Annex 1 Reef Habitat
Source Info: The Crown Estate, Scottish Natural Heritage
Client: The Crown Estate
Project: Identification and Discussion of Cumulative and in Combination Impacts of Pentland Firth and Orkney Waters Wave and Tidal Projects
Title: Ecological Designations
Figure: 4
Drawing No: 9W2739/01/004
Revision: | Date: | Drawn: | Checked: | Size: | Scale:
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5.1.2 Key Issues

Offshore wave and tidal farm development (both individual sites and sites acting cumulatively) within the study area could present significant issues for some bird species upon which coastal SPA designations are based, and thus have resulting significant effects on the conservation objectives and conservation status of the associated SPA. Whilst attempts will be made to avoid coastal designated sites, cable routing and onshore substation development may affect designated site features.

Conservation objectives for designated sites generally seek to maintain the population, distribution and extent of designated features, and the structure and function of the site. Under the Conservation (Natural Habitats, & c.) Regulations 1994 (regulations amended in Scotland) the competent authority (in this case Marine Scotland) must consider the effect of a development on European sites when considering whether to grant a license of consent and an Appropriate Assessment as outlined in Section 2.1, may be appropriate. The competent authority must consider whether projects are likely to have a significant effect on a European site alone, or in combination with other plans or projects.

5.1.3 Data Sources

- Report to inform Appropriate Assessment of the Pentland Firth Strategic Area leasing round (ABPmer, 2010);
- JNCC website;
- SNH site link;
- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al.*, 2010a);
- APEM aerial digital survey of PFOWSA for ornithology and marine mammals (2010 to 2011), The Crown Estate Enabling Action;
- Marine Energy Spatial Planning Group (MESPG) working groups.

5.1.4 Data Gaps

- The likelihood of new designations (e.g. pSAC, pSPA) being applied to sites is unknown and consultation with SNH will be required as part of the EIA process.
- Data collection TCE enabling actions (APEM aerial digital surveys).

5.1.5 Recommendations for CEA

Developers may be required to consider the connectivity between their development sites and European designated site features, including bird, marine mammal and fish species. On the basis of this the requirement for site-specific Appropriate Assessment will be confirmed.

5.2 Marine Benthic Ecology

5.2.1 Baseline Environment

Within the PFOWSA much of the seabed is composed of bedrock, with some associated gravels and sands (Marine Scotland *et al.*, 2010a). However, the Pentland Firth itself (between the Orkney Islands and mainland Scotland is composed mainly of solid rock.

5.2.2 Key Issues

There are no conservations sites within the PFOWSA that have been designated for benthic species or habitats (Table 5.2). Cumulative impacts are not thought likely based on publically available results from other developments, in particular the SeaGen Project, Northern Ireland.

5.2.3 Data Sources

- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al.,* 2010a);
- Marine Scotland interactive database(MSI);
- Preliminary assessment of the conservation importance of species and habitats of the Pentland Firth and Orkney Islands in relation to the development of renewable energy schemes. Report to Scottish Natural Heritage. Moore, C.G. 2008.

5.2.4 Data Gaps

The benthic data available for the Pentland Firth is limited to where Marine Scotland has undertaken drop video analysis and alongside previous local data collection for specific developments. Additional data focuses on specific coastal sites or areas where there have been wrecks or key issues of interest.

5.2.5 Recommendations for CEA

On the basis of anticipated impacts being site specific and in the absence of known protected species or habitats within lease areas, it is anticipated that any potential effects, such as habitat loss within device footprints, would be addressed within project specific EIAs.

5.3 Marine Mammals

5.3.1 Baseline environment

The waters within the PFOWSA support a wide range of marine mammals including: harbour porpoise *Phocoena phocoena*, killer whale *Orcinus orca*, Minke whale *Balaenoptera acutorostrata*, pilot whale *Globicephala* spp., white beaked dolphin *Lagenorhynchus albirostris*, harbour (or common) seal *Phoca vitulina* and grey seal *Halichoerus grypus*.

The PFOWSA sits entirely within Scottish waters which are regarded as very important for seals, containing approximately 43% of Europe's harbour seal population and 85% of Europe's grey seal population

There are a number of seal breeding and haul out sites in the PFOWSA; some of which have been designated as SACs for breeding colonies (**Table 5.1**). Although there are no

specific SACs designated for seals along the North Caithness coast, there is a large grey seal colony located at Dunscanby Head.

Whales, dolphins and porpoises are also frequently sited in the PFOWSA. These are all identified as species of European Community interest and are afforded protection under Annex IV of the Habitats Directive. They are also all protected under the Wildlife and Countryside Act (1981).

There have also been sightings of leatherback and other turtles in the area. Most of these were recorded to the north of Orkney during late summer and early autumn. (Marine Scotland 2010)

Key Issues

Based on available literature, the following are perceived to be the main potential effects on marine mammals as a result of development within the marine environment:

- Disturbance as a result of elevated construction and operational sound;
- Potential longer term avoidance or changed behaviour within the development area by marine mammals;
- Increased collision risk due to construction and maintenance traffic;
- Potential collision with devices during operation;
- Potential reduction of the feeding resource due to effects on prey of noise and vibration, and habitat disturbance; and
- Conflict with commercial fisheries as a result of increased effort within reduced fishing areas.

Marine mammals' extensive use of sound for communication, prey capture, predator avoidance and probably navigation, and the possession of large gas-filled organs makes them vulnerable to both disturbance and physiological damage from underwater noise of sufficient magnitude. Identifying these effects, and the levels of sound which may induce them, has been the subject of considerable research; extensive reviews are provided by Richardson *et al*. (1995), Nowacek *et al.* (2007), Southall *et al.* (2007) and Weilgart (2007). UK Strategic Environment Assessments have also considered the issue of noise (e.g. Hammond *et al.* 2006, 2008) and concluded that the most significant potential disturbance of marine mammals from offshore construction arises from underwater noise associated with the installation of driven piled foundations.

Underwater noise can have a severe effect on marine mammals in the immediate vicinity of high level sources (Nedwell *et al*., 2003). As the distance from the source increases, noise will attenuate and the potential effects will diminish.

The effects of noise on marine mammals can be classed into three groups:

- Primary effects – such as immediate or delayed fatal injury of marine mammals near powerful sources e.g. explosive blasts underwater;
- Secondary effects – such as injury (including permanent or temporary hearing threshold shift), or deafness, which may have long term implications for survival; and
- Tertiary (behavioural) effects – such as avoidance of the area or masking of sounds that may have significant effects where the manmade source is in the vicinity of breeding grounds, migratory routes or feeding areas.

There have been a number of recent studies completed in relation to offshore wind which have investigated noise impacts on marine mammals. Recent studies funded by COWRIE (Nedwell *et al*, 2007; Thomsen *et al*, 2006; Nedwell *et al,* 2003) suggest that the noise generated during pile driving operations during offshore construction may result in the injury of marine species at distances of the order of 100m from the piling activity.

Calculations suggest that a strong avoidance reaction (above 90dBht) from a range of species will be expected within several kilometres. Noise may still be at a level that elicits a behavioural effect (above 70dBht) at ranges of the order of 10km or more.

The analysis of estimated spatial effects ranges in marine mammals in relation to pile driving activities, within the recent Offshore Energy SEA (DECC, 2009), concluded that pile driving sources are generally unlikely to have a significant effect on marine mammal populations. This is due to the fact that the spatial scales over which either observable or biologically meaningful effects are likely to result do not generally support significant groups of animals. The only exception is where populations of small odontocetes occur at locally high population densities.

Once installation is complete, the effective noise that may be propagated from an array of operational wave devices or tidal turbines has not been characterised to date, though evidence from wind farm turbines suggests that operational noise levels are unlikely to result in detrimental effects on marine mammal populations (DECC, 2009). However, the nature of noise generated by tidal turbines is likely to differ considerably from that produced by wind turbines.

One of the most relevant pieces of legislation in terms of assessing and mitigating for the effects of noise on marine mammals is The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended in Scotland), which form the legal basis for the implementation of the EU Habitats and Birds Directives in Scottish territorial waters. Under Regulation 39 it is an offence "deliberately to disturb" any European Protected Species, which includes all species of dolphin, porpoise and whale, and several species of marine turtle. The Regulations were amended in 2007 (referred to as The Conservation (Natural Habitats &c.) Amendments (Scotland) Regulations 2007) to provide further interpretation of the term "disturbance", which prior to the amendment had been a cause of considerable contention in terms of what actually constitutes disturbance and whether disturbance is permissible as part of a consented development. Amended Regulation 39 (under The Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2007) now states that it is an offence:

> *"(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; or*
> *(vi) to 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;"*

At present, there is limited guidance from Scottish Natural Heritage or the Scottish Government on how to tackle this issue of deliberate disturbance, however in 2008 the JNCC produced draft guidance for consultation which provides an interpretation of what constitutes a 'significant' group and explains the 'disturbance offence' in greater detail. Following amendments to the regulations in 2009 the guidance was amended and is expected to be published 2010/2011. The guidance refers to the Habitats Directive Article 12 Guidance (European Commission, 2007) stating that in their view significant disturbance must have some ecological impact.

The Harbour seal (*Phoca vitulina*) populations within the Pentland Firth and Orkney waters are in decline and monitoring of this species will form an essential part of monitoring for cumulative impacts of wave and tidal development within the PFOWSA.

5.3.2 Data Sources

- SMRU;
- MESPG;
- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al.*, 2010a).

5.3.3 Data Gaps

Specific species behaviour and movement is unclear for each site and baseline cumulative effects around the Pentland Firth are currently unknown. There is therefore a requirement to understand current marine mammal behaviour within the Pentland prior to cumulative assessment being undertaken.

5.3.4 Recommendations for CEA

Given the mobile and wide ranging nature of marine mammals, and their conservation importance, it would be beneficial to address key issues at a more strategic, regional level, as well as within individual project EIAs.

In order to understand the potential effects of development on marine mammal individuals and populations and undertake a meaningful assessment, it may be useful to pool and undertake joint analysis sightings/distribution data (e.g. TCE aerial survey data, site specific boat and shore-based survey data). Such a regional approach is currently being progressed by offshore wind farm developers in the Moray Firth and off the east coast of Scotland on the basis of advice from statutory bodies.

5.4 Fish and Shellfish

5.4.1 Baseline environment

The PFOWSA supports a diverse range of fish and shell fish species. Landings data provided by the Scottish government (National Statistics, 2010) show that main species landed into the district of Orkney are shell fish (Table 5.2) including edible crabs scallops and lobsters. A greater range of species are landed into the district of Scrabster which contains part of the PFOWSA (Table 5.2).

Table 5.2: Live weight of species landed into ports within the district of landings district of Orkney and Scrabster (only main species included). Data Source: The Scottish government 2010.

Scrabster				Orkney
Species	**live weight (tonnes)**	**Species**	**live weight (tonnes)**	**live weight (tones)**
Blue ling	89	Megrims	622	
Bream - rays	220	Monks	1,753	

Scrabster				Orkney
Cod	754	Plaice	53	
Dogfish spur	73	Pollack	22	
Forkbeard	20	Redfish	52	
Greenland - halibut	180	Saithe	1,854	
Gurnards - red	77	Skates & rays	78	
Haddock	2,413	Tusk	37	
Hake	1,630	Whiting	535	
Lemon sole	21	Witches	39	
Ling	581			
Total demersal	11,204			1
Total pelagic	7			3
Edible crabs	2,829			1,830
Green crabs				136
Lobsters	112			146
Mussels	341			
Nephrops	153			
Periwinkles				70
Scallops	538			150
Squid	113			
Velvet crabs	121			909
Whelks	99			101
Other shellfish	25			8
Total shellfish	4,330			3,350
Total landings	**15,541**			**3,355**

Many of the species present within the PFOWSA are listed on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species, including the native oyster, cod and haddock. Common skate, basking shark and native oyster are also listed as UKBAP species (Marine Scotland *et al*., 2010a).

The PFOWSA waters contain important spawning grounds for herring and important nursery for species such as sandeel and *Nephrops.* Sandeels are an important food source for both commercial fish species such as cod, haddock and whiting and are also an essential food source for seabirds and mammals. Figures 5a to 5d show key fish spawning and nursery areas within the PFOWSA.

Orkney also supports a number of diadramous (migratory between fresh and salt waters) species, specifically sea trout, Atlantic salmon and eels.

Atlantic salmon is an Annex II species under the European Habitats Directive and passes through the estuaries on migration to and from offshore feeding grounds. Little is

known about salmon's migration or behaviour once the open sea is reached, however evidence (Hawkins *et al*, undated) suggests that fish movements are likely to occur nearer to the coast, supported in the recent Marine Scotland migratory fish study (Malcolm *et al* 2010).

5.4.2 Key Issues

The issues listed below are considered to be relevant to the assessment of potential cumulative effects on the natural fishery resource within the study area. They are essentially the same as those that would be considered during a site-specific assessment, but the effects need to be considered on a broader scale.

It should be noted that in addition to the potential impacts set out below, benefits/enhancement to the natural fishery resource could arise due to the development of tidal and wave farms. Such benefits could be associated with the new habitat conditions created and the restriction of fishing access.

The following paragraphs summarise potential effects resulting from wave and tidal development:

- Degradation of water quality locally due to elevated suspended sediment concentrations, affecting epi-benthos, larvae and fish present within the water column;
- Elevated noise during construction (and at other project stages) may act as a barrier to some fin fish species (it is likely that hearing specialists, including sprat and herring, would be able to detect the noise of a pile driving operation at a level that would induce behavioural changes, such as disturbance, at a distance of up to 30km [Shepherd *et al.*, 2006]).
- EMF from export cables influencing migratory movements;
- Physical presence;
- Increased trawling effort within areas which previously may have seen limited effort (due to displacement);
- Increased fishing effort targeting epifaunal species;
- Disruption of spawning and nursery areas as a result of the instalment of turbines, cables and scour protection; and
- Possible enhancement of fishery.

Electromagnetic field (EMF) effects from underwater cables on elasmobranchs (and other electrosensitive species) have been the subject of research (e.g. Gill *et al*., 2009). Studies indicate that elasmobranch species can respond to EMF associated with subsea cables, but that responses (e.g. change in swimming direction, change in migratory route) are not predictable and do not always occur. Effects appear to be species dependent and individual specific, with individuals moving either more or less within the zone of EMF. Further monitoring at offshore renewable sites is recommended.

Evidence gathered to date suggests that effects of EMF are negligible (e.g. Faber Maunsell & Metoc, 2007). At this stage it is not considered that EMF effects will be extensive or act on a cumulative basis, and can be addressed on a site-specific basis.

In order to collate comprehensive natural resource data within the study area, a multi-strand approach would typically be adopted. This would require:

- Analysis of combined epifaunal and fish surveys using appropriate gears to acquire fish and epifaunal data simultaneously;
- Analysis of all available fisheries data (e.g. sandeel monitoring data);
- Scottish Fisheries Protection Agency / Marine Fisheries Agency data (landings, overflight data, patrol vessel sightings, effort statistics, etc); and
- Consultation with relevant Fishermens' associations and individual fishermen.

It is important to characterise fish communities in relation to specific sites. Information collected can be used to characterise species diversity in relation to habitat type, sediment characteristics, depth and faunal community. Given the requirement for site-specific data, it is likely that individual developers will initiate characterisation of their respective sites. This information can then be fed into a generic document describing the natural resource across the wider area. This would provide both site-specific data and a broad scale assessment of the natural resources present and the generic document could be used by developers to pull the relevant information on cumulative effects (associated with their site) into their EIA.

5.4.3 Data Sources

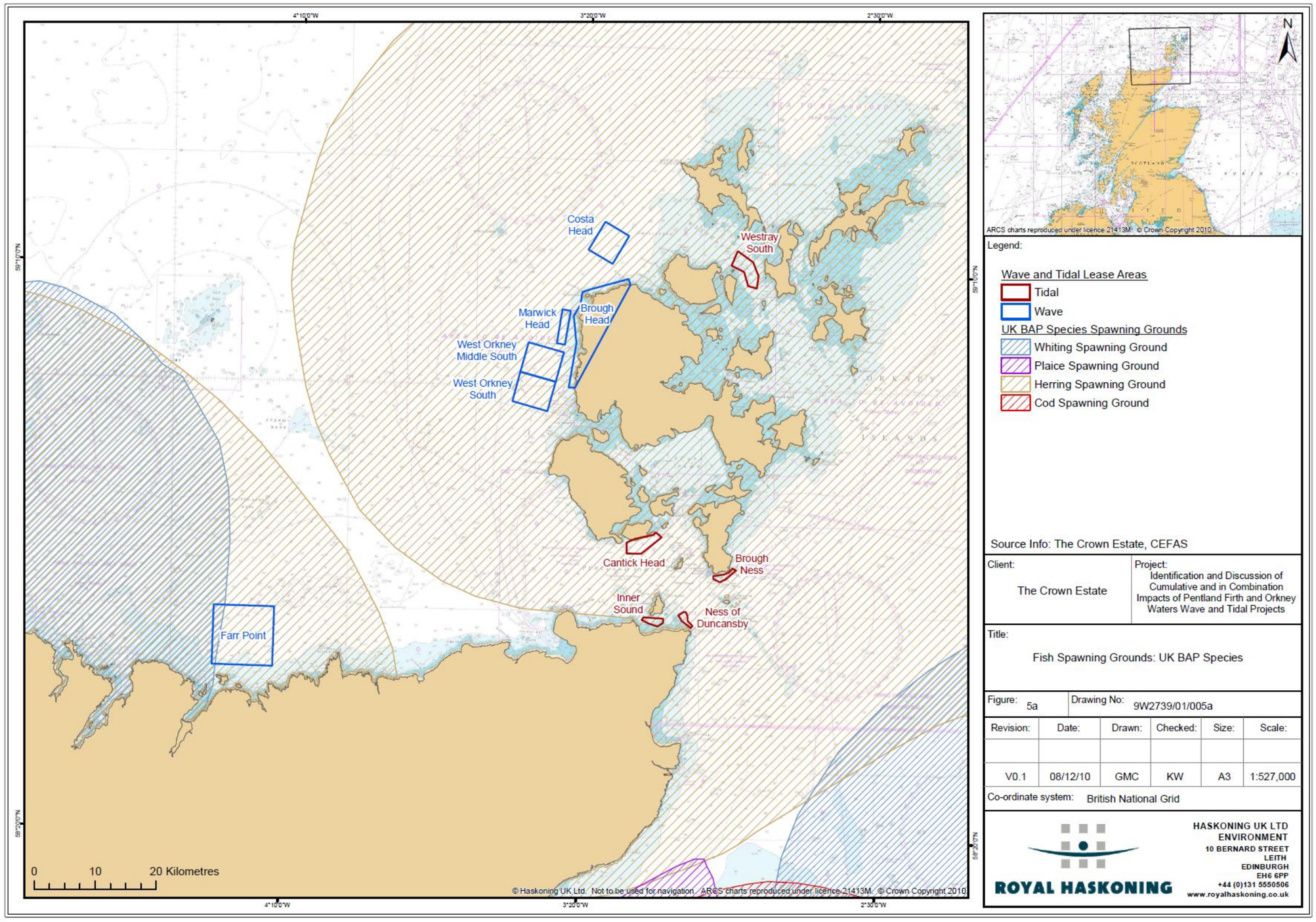
- Detailed landings data which can be obtained from the Marine Analytical Unit, Marine Scotland – Science;
- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al.*, 2010a).

5.4.4 Data Gaps

It is important to characterise fish communities in relation to specific sites. Information collected can be used to characterise species diversity in relation to habitat type, sediment characteristics, depth and faunal community. Given the requirement for site-specific data, it is likely that individual developers will initiate characterisation of their respective sites.

5.4.5 Recommendations for CEA

As for other mobile species, a meaningful assessment of potential effects is likely to require consideration of effects beyond individual site boundaries. It may be useful for developers to pool any data gathered to inform their EIAs and undertake collaborative analysis in relation to particular species/issues (e.g. potential barrier effects in relation to migratory fish).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Legend:
Wave and Tidal Lease Areas
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Wave
UK BAP Species Spawning Grounds
Whiting Spawning Ground
Plaice Spawning Ground
Herring Spawning Ground
Cod Spawning Ground
Source Info: The Crown Estate, CEFAS
Client: The Crown Estate
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Title: Fish Spawning Grounds: UK BAP Species
Figure: 5a
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Revision: V0.1
Date: 08/12/10
Drawn: GMC
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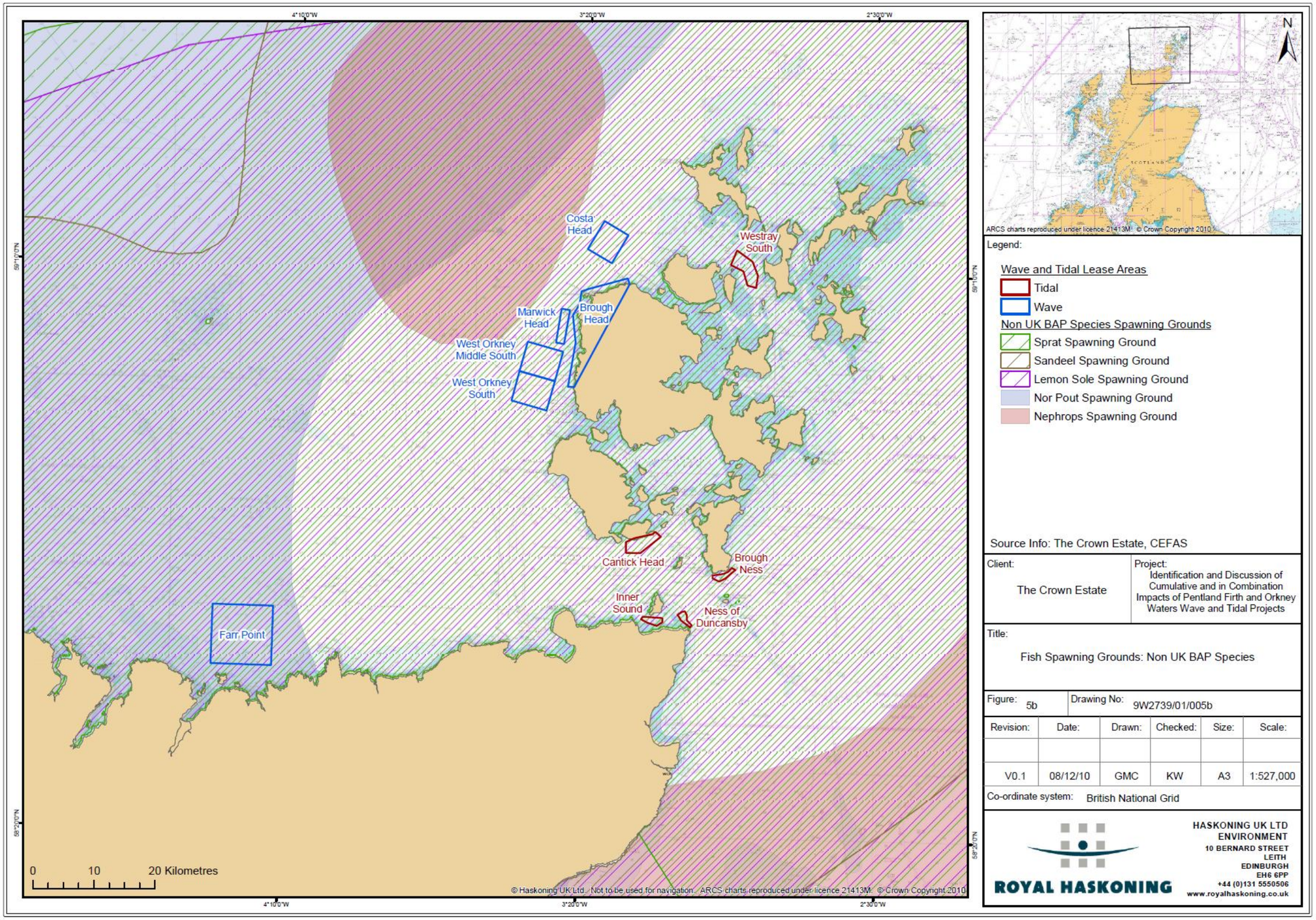
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Legend:
Wave and Tidal Lease Areas
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Non UK BAP Species Spawning Grounds
Sprat Spawning Ground
Sandeel Spawning Ground
Lemon Sole Spawning Ground
Nor Pout Spawning Ground
Nephrops Spawning Ground
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Title: Fish Spawning Grounds: Non UK BAP Species
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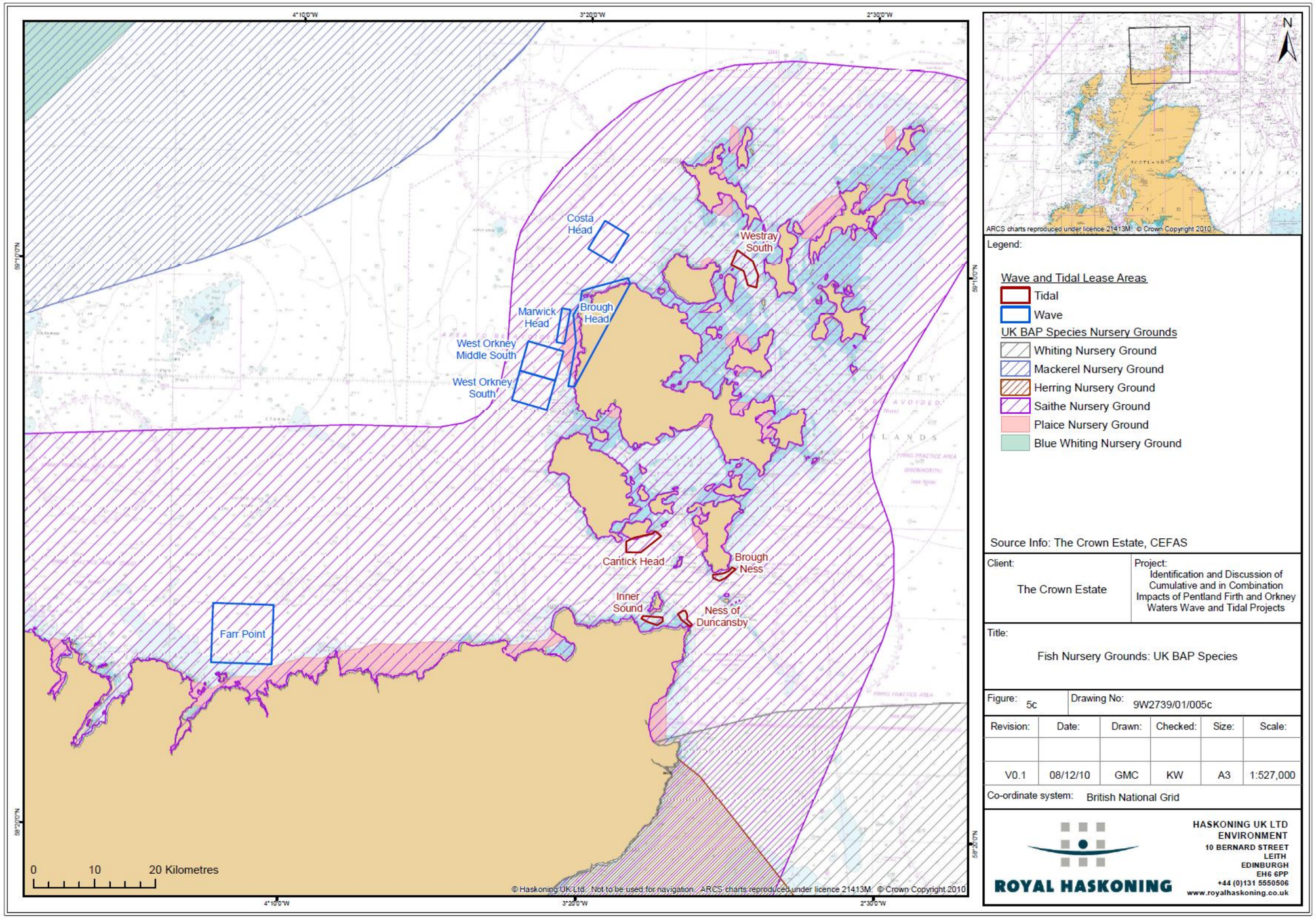
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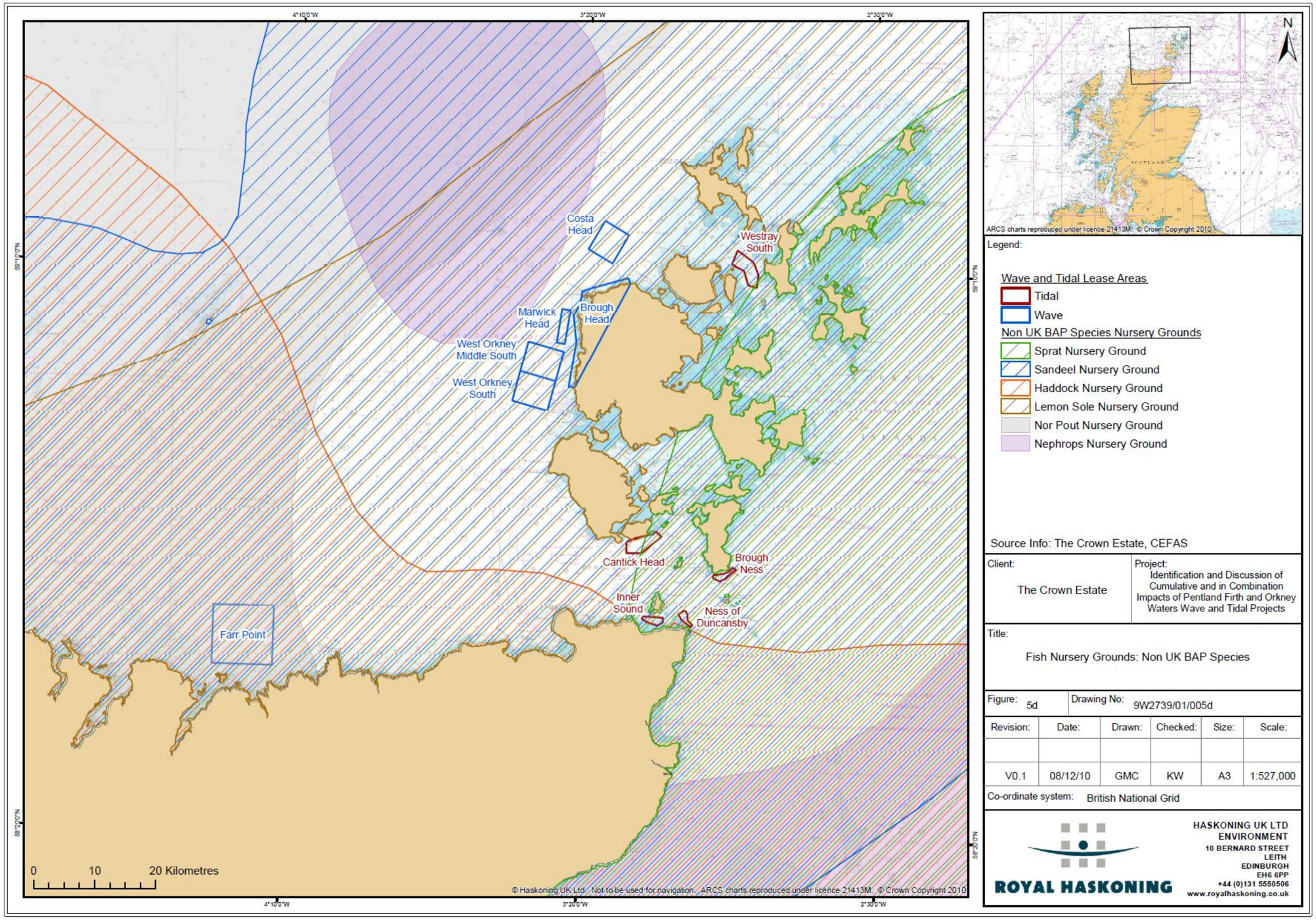
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Legend:
Wave and Tidal Lease Areas
Tidal
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Non UK BAP Species Nursery Grounds
Sprat Nursery Ground
Sandeel Nursery Ground
Haddock Nursery Ground
Lemon Sole Nursery Ground
Nor Pout Nursery Ground
Nephrops Nursery Ground
Source Info: The Crown Estate, CEFAS
Client: The Crown Estate
Project: Identification and Discussion of Cumulative and in Combination Impacts of Pentland Firth and Orkney Waters Wave and Tidal Projects
Title: Fish Nursery Grounds: Non UK BAP Species
Figure: 5d
Drawing No: 9W2739/01/005d
Revision: V0.1
Date: 08/12/10
Drawn: GMC
Checked: KW
Size: A3
Scale: 1:527,000
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5.5 Ornithology

5.5.1 Baseline Environment

The coastlines of the PFOWSA support extensive colonies of migratory and breeding seabirds including Atlantic puffins, black-legged kittiwakes, Arctic skuas and Arctic terns, razorbills, northern fulmars, common guillemots, storm petrels and greater black-backed gulls. Smaller colonies of European shag are also considered important to the area. The coastal areas, in particular saltmarsh and wetland areas support wading birds, both overwintering and breeding.

Rare and vulnerable birds are afforded protection through the designation of SPAs (see Section 5.1).

5.5.2 Key Issues

There are a number of potential issues relating to offshore wet renewables that could theoretically have a cumulative effect on bird populations, especially where there are surface piercing devices being installed. These largely centre around the following, and arise both on a site-specific basis and at a more strategic level:

- Habitat loss during construction – direct disturbance from construction work and ancillary activity;
- Habitat loss during operation – direct disturbance from the operation of the turbines as well as maintenance activity;
- Modification to migratory routes – involving increased energy consumption and, if development forms a physical barrier, possible removal of nearby feeding and roosting sites for some species;
- Collision risk to birds – for some diving species.; and
- Disruption to habitat function – displacement of feeding areas with increased predation or reduction in prey availability, disruption of movements to, from and within breeding-roosting foraging sites.

Excepting collision risk issues, some of the main potential impacts from single or multiple developments will centre on displacement. In some instances, particularly for mobile rafting flocks, this may not have any significant implications, but for species potentially dependent on a defined site for foraging, impacts could be more important.

5.5.3 Data Sources

- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al.*, 2010a);
- JNCC;
- RSPB.

5.5.4 Data Gaps

There is limited knowledge about annual variability in both bird numbers and species, which will need to be established prior to completing a cumulative assessment. Further site specific data is required and assessment will require construction methodology timing and duration, in order to work out seasonal impacts. The Crown Estate are currently undertaking strategic bird surveys for the PFOWSA and these will be used to

outline areas of strategic interest alongside providing an overview to inform individual project EIA.

5.5.5 Recommendations for CEA

Recommendations here are aligned with those outlined for Marine Mammals (Section 5.3). Potential effects on birds will not be restricted to individual project boundaries and thus developers may benefit from the sharing of data and its analysis. Again, useful lessons may be learned from the ongoing work of the FTOWDG, where EIA data collection methods have been aligned in order to enable the pooling and joint analysis of data.

Guidance on cumulative effects assessment in relation of offshore wind has been published by COWRIE (King *et al*, 2009), and the FTOWDG has usefully implemented this approach whereby key sensitive species which will be subject to further CEA are identified. Such as approach could be adapted and applied to wave and tidal development in the PFOWSA.

6 HUMAN ENVIRONMENT

6.1 Commercial Fisheries

6.1.1 Baseline Environment

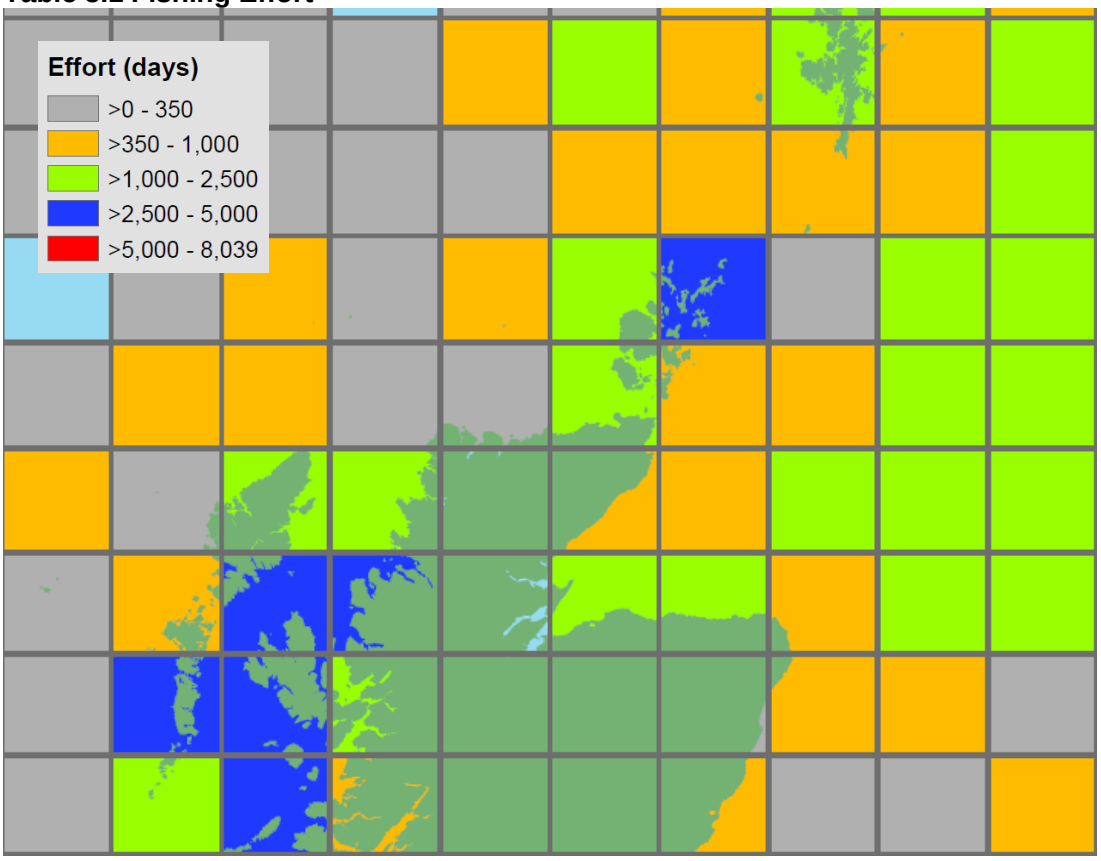
The fishing industry is a very important source of income to the local economy within the PSFA. Orkney is also regularly used by fishing fleets that are either passing through the area to access key commercial fishing grounds or land at local harbours e.g. Scrabster, Stromness or Kirkwall.

The PFOWSA falls within ICES rectangles 46E5, 46E6 46E7, 47E6 and 47E8 Table 5.1 VMS3 data indicates that within the PFOWSA landings are highest from the north east the PFOWSA and are lowest in the South west (Figure 6)

The inshore areas within the PFOWSA are mostly used for targeting common whelk, crab and lobster and the offshore areas are used for pelagic and demersal fishing.

[3] Vessel monitoring systems data is transmitted by fishing vessels when fishing and includes as a minimum the position, time at a position, and speed of fishing vessels.

Table 5.1 Fishing Effort



Whilst offshore waters to the north and east of the PFOWSA are important for pelagic species the main commercial fishing within the study area targets shell fish. The inshore waters of the PFOWSA support important fisheries for edible crab, lobster, velvet crab, whelk and scallops. This is reflected in the 2009 landings data for the district of Orkney.

6.1.2 Key Issues

The potential effects on commercial fisheries resulting from wave and tidal farm construction and operation are as follows:

- Loss of access to fishing grounds during construction;
- Displacement to less profitable grounds;
- Concentration of fishing effort on remaining available grounds;
- As a result of the concentration of effort, the possibility of conflict between operators of different types of gear;
- Increased steaming times to fishing grounds;
- Potential reduced Catch Per Unit Effort as a result of displacement to less profitable grounds;
- Elevated running costs;
- Displacement of or reduction in, fish and shellfish resources due to the effects of wave and tidal farm installation and operation; and
- Positive effects, such as increases in biodiversity and biomass leading to increased catches.

In order to collate and interpret comprehensive fisheries data for the study area, and to allow an assessment of the potential for cumulative effects to arise, a multi-strand approach could be adopted. This may require:

- Analysis of Scottish Fisheries Protection Agency / Marine Fisheries Agency data (landings, overflight data, patrol vessel sightings, effort statistics, etc);
- Consultation with relevant Fishermens' Associations and individual fishermen;
- Port visits and assessment of catch / landings;
- Identification of vessels utilising potential development sites; and
- Possible dedicated quantification by observers of catch aboard vessels which are deploying gear types within specific development sites.

Once this data collection exercise has been undertaken as part of individual EIAs, the data can be shared in order to make an effective judgement on cumulative effects. Data sharing will be ongoing, with data being accumulated as the individual projects undertake their EIAs.

6.1.3 Data Source

- Detailed landings data which can be obtained from the Marine Analytical Unit Marine Scotland – Science;
- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al.*, 2010a).

6.1.4 Data Gaps

Vessels under 15m length are not captured by the data shown in Figure 6 but fishing activity within the 12nm limit is almost exclusively confined to <10m vessels. As such, the data may not accurately reflect patterns of inshore fisheries activity. It is thought that the majority of fishing effort is undertaken by UK registered, and mainly Scottish vessels. International fishing interests are thought to be minimal across all PFOWSA sites. However, the exact composition of the local fishing fleet cannot be determined without further data analysis and consultation with local fishermen. Finer scale spatial and temporal patterns of fishing activity may be better understood following consultation with the industry.

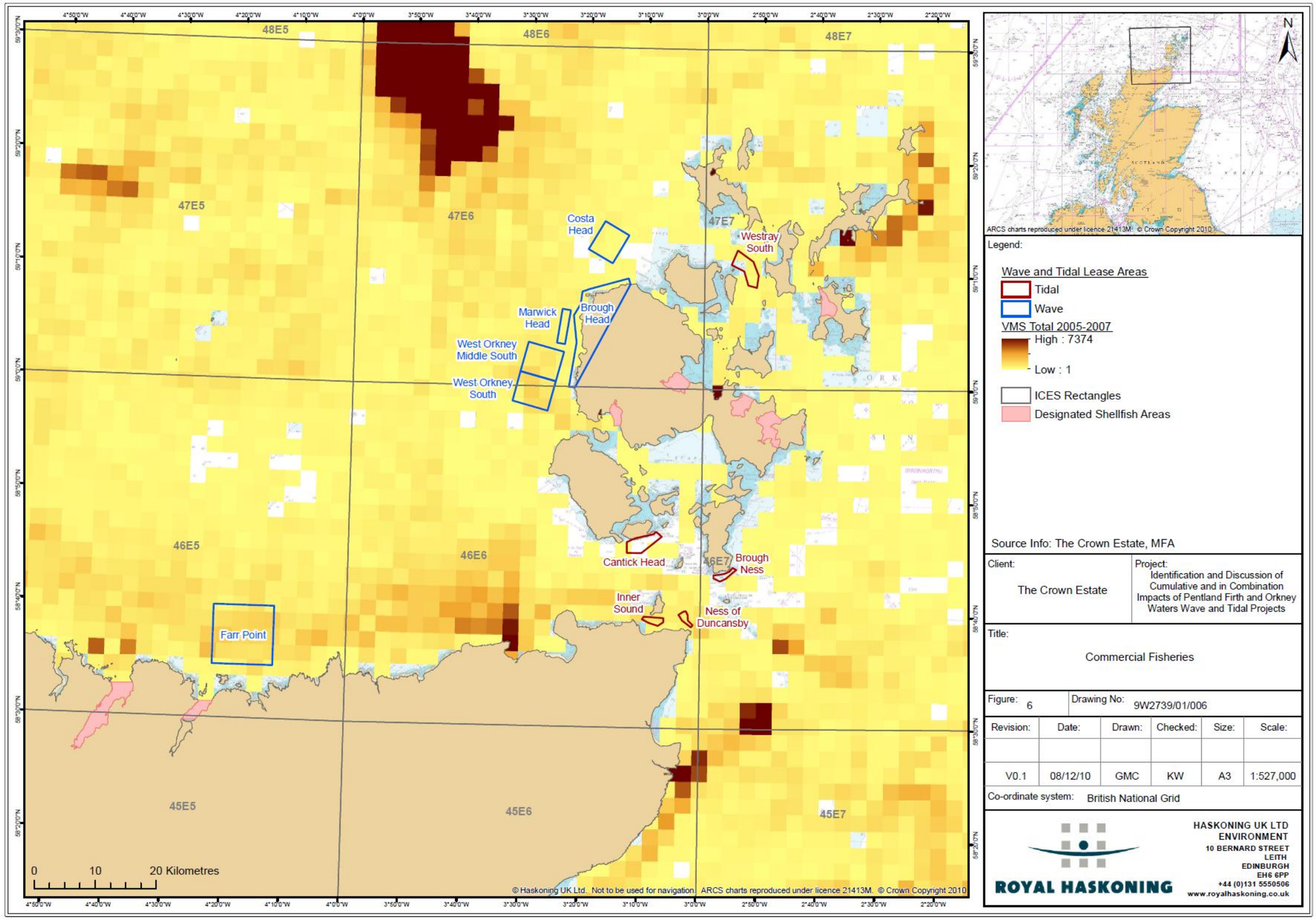
In addition local fishery consultation will be required to ensure smaller vessels are captured, there are likely to be a high number of areas within PFOWSA that employ creeling and single manned vessels.

Marine Scotland are about to commence a fisheries mapping study due to be undertaken in 2010 which will compile baseline for inshore fishery data within the area. Further to this DEFRA are currently completing a project entitled "UK Fishing Industry Mapping Project" which aims to collect fishing vessel movement to identify where fishing occurs on the UK continental shelf.

6.1.5 Recommendations for CEA

The potential cumulative effects on commercial fisheries activities is recognised and in the first instance it is recommended that developers working in close proximity to one another within particular locations consider undertaking consultation with fisheries stakeholder on a joint basis to best understand the concerns of fishermen and how they can be strategically addressed. For example, developers may be able to work together

to time EIA surveys to minimise disruption to the industry, or work collaboratively on the identification of positive mitigation measures.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N
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Wave and Tidal Lease Areas
Tidal
Wave
VMS Total 2005-2007
High : 7374
Low : 1
ICES Rectangles
Designated Shellfish Areas
Source Info: The Crown Estate, MFA
Client: The Crown Estate
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Title: Commercial Fisheries
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Drawing No: 9W2739/01/006
Revision: V0.1
Date: 08/12/10
Drawn: GMC
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6.2 Seascape / Landscape

6.2.1 Baseline Environment

The landscape of the PFOWSA is typically characterised by open rolling lowland hills surrounded by dramatic coastal scenery. Much of the landscape comprises fields of improved pastoral grassland with some areas of arable agriculture. Areas of higher ground are characterised by heather moorland (Marine Scotland *et al* 2010a). The western part of the PFOWSA is characterised by dramatic sea cliffs and associated formations. The lower lying coastal areas contain dune systems and sandy bays. There are also numerous shallow inland and sea lochs and indented bays on the mainland Scotland part of the PFOWSA.

The seascape character of Orkney varies from the wild, rugged and exposed seascape associated with the high cliffs of the west coast to low coastal sands and flats in surrounding coastal areas. Views out to open sea from the west coast tend to be expansive and uninterrupted with a feeling of exposure and wildness which is heightened by the remoteness of some areas. Elsewhere, views out to sea from the lower lying areas vary from open and uninterrupted to intimate and small scale within more sheltered bays or indented inlets. These views and the surrounding seascape create a feeling of tranquillity (Marine Scotland, 2010a).

6.2.2 Key Issues

The sensitivity of the landscape will require assessment and is subject to the final design of the devices chosen for each lease site within the PFOWSA. In many cases device type is not yet clear and could potentially range from being surface piercing to being fully submerged. This issue will require further investigation as projects are taken forward. However, it is important to note that the majority of the lease sites are a number of kilometres offshore and this factor will play an important role in the assessment for each project.

The main landscape designation within Orkney is the National Scenic Area for North Hoy and the West Mainland of Orkney.

6.2.3 Data Sources

- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al*., 2010).

6.2.4 Data Gaps

For a number of the proposed lease sites the technology is still undefined and their potential visual impact unknown. Other unknown elements with potential visual implications include the number and type of devices, as well as the routes of subsea cables that will connect the proposed offshore wave and tidal farms to the onshore grid, and inter-array subsea cables.

6.2.5 Recommendations for CEA

While a number of lease sites are isolated, some are clustered in relatively close proximity (e.g. off west coast of mainland Orkney). Depending upon the nature of the development within these sites, developers may seek to work collaboratively to undertake elements of their Seascape and Landscape Visual Impact Assessments (e.g. sensitive viewpoint selection and landscape/seascape characterisation).

6.3 Shipping and Navigation

6.3.1 Baseline Environment

Shipping and navigation are considered important to the local economy within the PFOWSA. The Pentland Firth itself is recognised as a route of international importance for navigation and is therefore considered to be critical for shipping and navigation (Marine Scotland, 2010). The area is used extensively by commercial cargo vessels as the main route from the North Atlantic to the North Sea. It is also used by oil tankers entering and exiting the main oil terminals at Flotta at the southern end of Scapa Flow. This combination of cargo traffic and oil tankers leads to very high numbers of vessel movements occurring within the main central channel **(Figure 7).** Very high densities of shipping also occur within the Orkney waters, in particular within the Scapa Flow area, the Stronsay Firth and around Kirkwall Harbour.

Due to dangerous currents, high winds and violent seas areas of the inshore water within the PFOWSA have been designated as “Areas to Avoid”. These areas are designated to avoid the risk of pollution and apply to vessels over 5000 gross registered tonnes carrying oil or other hazardous cargos (Scottish Government, 2007). Therefore inshore waters within the PFOWSA are mostly used by smaller vessels including, passenger ferries, cargo, recreation and fishing vessels (Marine Scotland, 2010).

6.3.2 Key Issues

The construction and operation of the PFOWSA projects may impact upon shipping and navigation in a number of ways, including:

- Temporary disturbance to regular shipping traffic due to the movement of installation vessels to and from the site during construction, and due to the location of turbines and subsea cables;
- Constriction of shipping routes due to exclusion of shipping from zones around each turbine / farm;
- Resulting increase in vessel density in unobstructed routes;
- Resulting increase in voyage distance / times;
- Increased navigational risk and collision risk due to the existence of turbines, and associated increased risk of pollution events; and
- Visual obscuring of existing navigational markers.

Cumulative effects are expected to arise given the nature of the Pentland Firth and its current usage and relatively high levels of activity associated with commercial ports in Orkney (particularly Flotta). The main data requirement for assessing navigational issues, including cumulative issues, is for an up-to-date maritime traffic survey of each

of the proposed sites (typically undertaken as part of individual site EIAs). Assessment requirements are specified by the Maritime and Coastguard Agency (MGN 371 – Offshore Renewable Energy Installations – Guidance on UK Navigational Practice, Safety and Emergency Response Issues). A requirement exists for each individual site and its immediate surroundings to be fully surveyed in order to detect marine activity that could be affected. Survey data is typically supplemented by analysis of longer-term statistical data on vessel activity and consultation with local experts and users. In the case of the PFOWSA, a combined traffic survey covering all sites is expected to be more effective and ensure no gaps in spatial data coverage. Additional desk-based analysis of longer term data could be undertaken on a site-by-site basis and subsequently shared by developers as needed. The development of any mitigation measures will need to be coordinated between sites to ensure, for example, that displaced traffic is not simply diverted away from one site but into another.

6.3.3 Data Sources

- The Marine renewable SEA (Scottish government 2007);
- The Pentland firth and Orkney waters Marine Spatial Plan (Marine Scotland, 2010a).

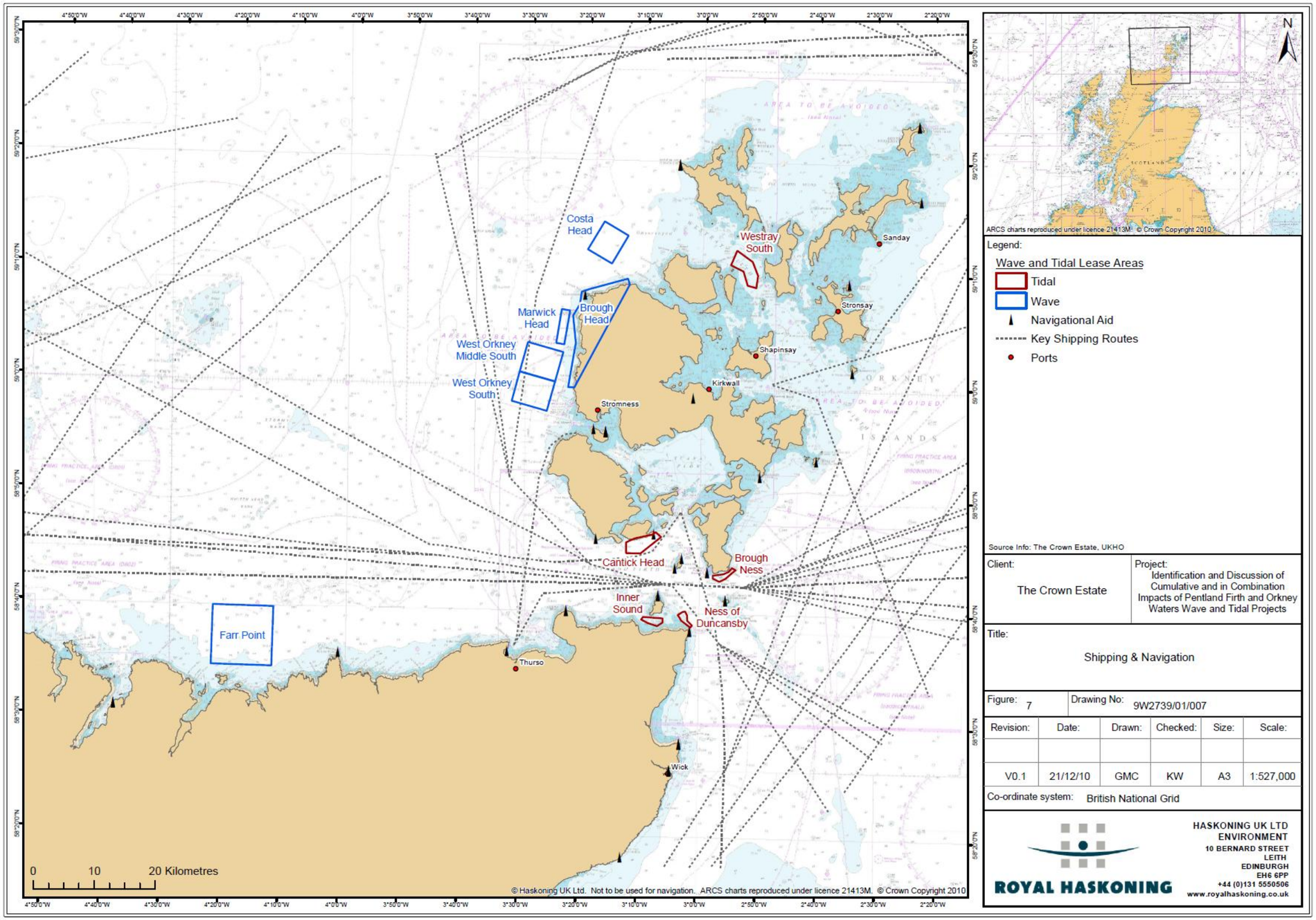
6.3.4 Data Gaps

The data displayed in Figure 7 relates to larger vessels (over 100 tonnes), and will not capture movements of smaller commercial and recreational vessels, such as inshore fisheries vessels. Patterns of smaller vessel movement across or between sites could be confirmed through consultation and survey alongside further data collection from OIC and the local Harbourmaster who will have shipping records for all traffic coming in and out of the area.

Smaller vessel data will also be collated by local consultation with local fishermen and creelers.

6.3.5 Recommendations for CEA

Risks to shipping and navigation have been highlighted by consultees as a potential significant issue within the PFOWSA and it is considered that there will be a requirement to complete a meta-scale strategic study of how shipping operations will be impacted should a number of sites go ahead with development. This will be in addition to individual Navigational Risk Assessment (NRA) for EIA which are based on VMS and AIS data, as well as local consultation. This approach is currently being employed by the FTOWDG and has been welcomed by stakeholders off the east coast of Scotland.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Legend:
Wave and Tidal Lease Areas
Tidal
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Navigational Aid
Key Shipping Routes
Ports
Source Info: The Crown Estate, UKHO
Client: The Crown Estate
Project: Identification and Discussion of Cumulative and in Combination Impacts of Pentland Firth and Orkney Waters Wave and Tidal Projects
Title: Shipping & Navigation
Figure: 7
Drawing No: 9W2739/01/007
Revision: V0.1
Date: 21/12/10
Drawn: GMC
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Size: A3
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6.4 Archaeology and Cultural Heritage

6.4.1 Baseline Environment

The PFOWSA contains a rich archeological heritage. In Orkney there are more than 300 Scheduled Monuments (**Figure 8**) and a large number of other important archaeological and historical features and sites. One of the most important areas is the Heart of Neolithic Orkney World Heritage Site designated by UNESCO in 1999. This includes the large chambered tomb of Maes Howe, Skara Brae, the ceremonial stone circles of the Stones of Stenness and the Ring of Brodgar and a number of unexcavated sites that depict life on the island 5000 years ago. There are also numerous brochs, standing stones, chambered cairns and tumuli outside the World Heritage Site, a large number of which are found on the west coast and are at increasing threat from coastal erosion (Marine Scotland 2010).

There is also a wealth of archaeological remains in the south of the PFOWSA along the North coast of mainland Scotland, including prehistoric coastal remains of brochs, standing stones, stone rows, tumuli and chambered cairns. There are over 1200 sites of historic importance in Caithness and Sutherland including 564 Scheduled Monuments, 649 Listed Buildings and 6 Gardens and Designated Landscapes (Marine Scotland 2010).

There are a large number of wreck sites in the waters of the PFOWSA. The wreck of HMS Hampshire lies off Marwick Head, to the west of Orkney Mainland, while the remains of the ships such as the Royal Oak and scuttled German Fleet are important, but lie in Scapa Flow, outside the PFOWSA development areas.

It is also estimated that there are many more undiscovered archaeological sites and features in PFOWSA. This rich archaeological and heritage potential is being further investigated as part of the River of Stone Project (Caithness) and the Strathnaver Province Archaeological Project (Marine Scotland, 2010).

6.4.2 Key Issues

It is anticipated that any effects on the archaeological resource within the PFOWSA will be specific to the proposed development areas and that they will be identified and addressed within individual project EIAs.

6.4.3 Data Sources

- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al.*, 2010);
- Historic Scotland.

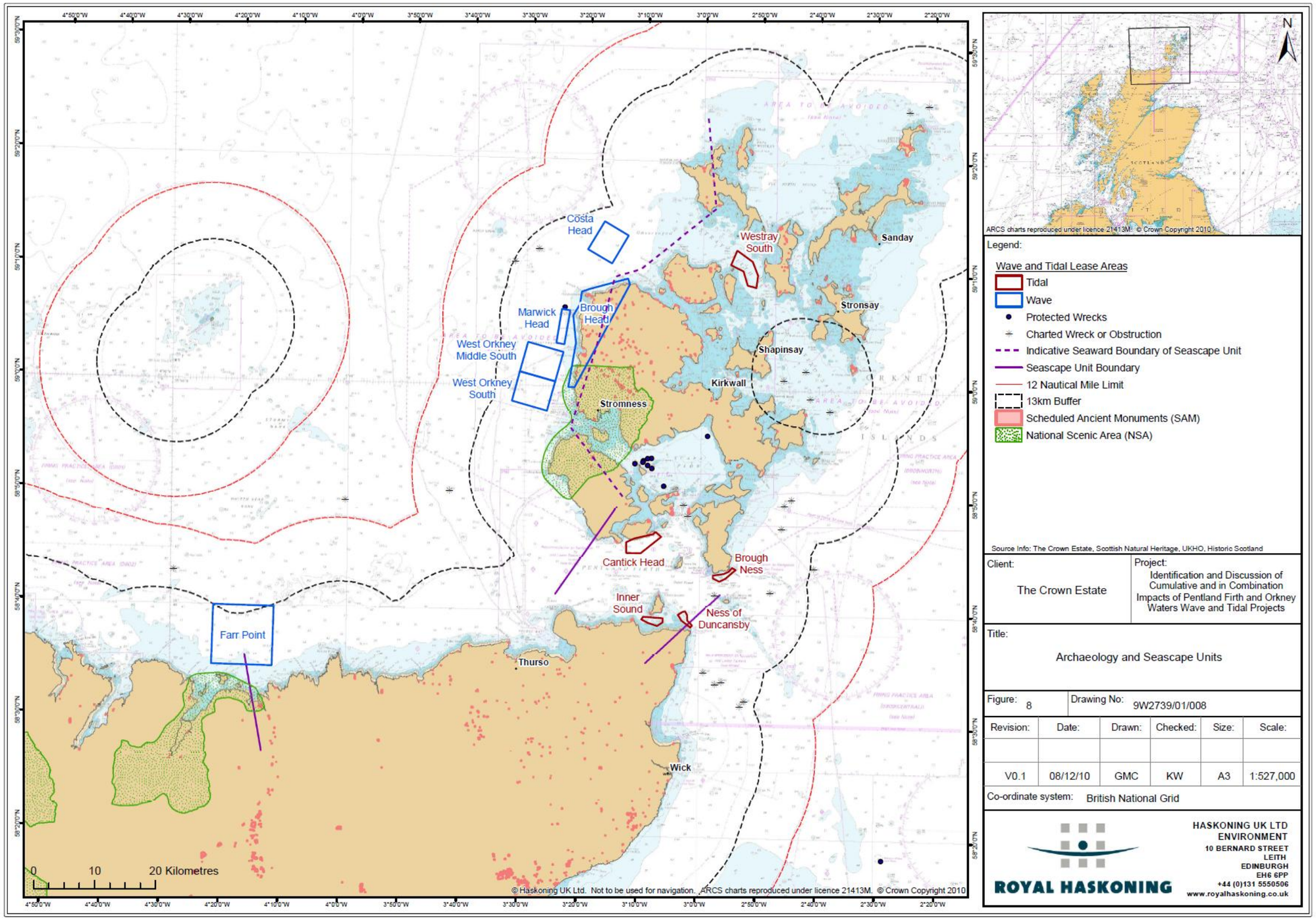
6.4.4 Data Gaps

There is the potential for unknown archaeological sites and features to be encountered within development areas. These will be identified during site characterisation surveys

carried out by individual developers. Device and cable placement would seek to avoid any identified features of interest.

6.4.5 Recommendations for CEA

At the stage, given the lack of data for the development areas, it is proposed that potential effects on the marine and coastal archaeological resource are assessment and managed on an individual project basis. This approach may need to be revisited should site investigations reveal significant archaeological resource across several development areas.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Legend:
Wave and Tidal Lease Areas
Tidal
Wave
Protected Wrecks
Charted Wreck or Obstruction
Indicative Seaward Boundary of Seascape Unit
Seascape Unit Boundary
12 Nautical Mile Limit
13km Buffer
Scheduled Ancient Monuments (SAM)
National Scenic Area (NSA)
Source Info: The Crown Estate, Scottish Natural Heritage, UKHO, Historic Scotland
Client: The Crown Estate
Project: Identification and Discussion of Cumulative and in Combination Impacts of Pentland Firth and Orkney Waters Wave and Tidal Projects
Title: Archaeology and Seascape Units
Figure: 8
Drawing No: 9W2739/01/008
Revision: V0.1
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6.5 Socio-Economics

6.5.1 Baseline Environment

The economy within the PFOWSA has historically been dominated by agriculture, fisheries and forestry. More recently there has been a growth in the importance of tourism, craft production, oil transportation through the Flotta oil terminal, and renewable energy development. Public services also play a significant role, employing around a third of the Orkney Islands' workforce.

Over the past decade the area has experienced population decline, with decline occurring at a greater rate than the Scottish mainland average.

6.5.2 Key Issues

While wave and tidal development has the potential to adversely affect some forms of existing commercial activity, such as fishing, it conversely may be expected to attract investment and create significant local employment opportunities.

6.5.3 Data Sources

- Orkney Islands Council website.

6.5.4 Data Gaps

Understanding of the likely socioeconomic benefits of wet renewables developments for local communities is currently limited. The PFOW Developers Forum has agreed to undertake an assessment of the potential socio-economic impacts, which will also include the development of a methodology (that can then also be used for site-specific studies) and a collation of baseline information. The proposal for the study has identified at least twelve interactions with other marine users / interests. One of these twelve, the social impacts, has a number of subsets which include employment, infrastructure (transport, schools. health services), housing, landscape / seascape and impacts on way of life. The study will include an assessment of the nature of the potential interactions (positive/negative; temporary/permanent; reversible/irreversible).

6.5.5 Recommendations for CEA

The potential for the proposed developments to have cumulative effects on socioeconomics will be subject to further consideration by developers, either on a site by site basis or collaboratively. In order to facilitate this discussion, The Crown Estate is currently finalising a report "Wave and tidal energy in the Pentland Firth and Orkney waters: How the projects could be built; A report commissioned by The Crown Estate and prepared by BVG Associates" that aims to set out basic points around the prospective supply chain for developments of this nature.

6.6 Tourism and Recreation

6.6.1 Baseline Environment

Tourism is a major employer in the PFOWSA and makes a significant contribution to the local economy. Orkney has seen a growth in tourist visitor numbers of 18% since 2005 to nearly 142,000 people per annum and an increase in spend, in real terms, of 13% to almost £32 million (Orkney Islands Council website). The quality of the landscapes, sea and skyscapes, the unique built and natural heritage, its people and communities and the sense of remoteness of the islands are key attractions.

Marine and coastal activities include sailing and boating, scuba diving, sea angling, walking, canoeing, surfing, bird watching and visiting coastal attractions such as castles and archaeological features.

Within the study area there are a number of marinas, RYA sailing clubs, and recreational cruising routs and sailing routes (see Figure Appendix D21). In the waters around the Orkney Islands, the routes are considered predominantly as 'light' use, with heavy cruising routes around the periphery of the island group.

Beaches are also a draw for tourists, and within the study area there are two bathing water beaches and one rural award winning beaches.

Diving is also popular with tourists, who are attracted by the wildlife and physical characteristics of the area, as well as a number of wrecks.

6.6.2 Key Issues

Potential disturbance and displacement of recreational activity, particularly during construction, will be a site-specific issue and it will be considered within EIA on an individual project basis.

As the PFOWSA becomes a focus for world-leading wave and tidal technology, there is the potential for developments to act as visitor attractions; the economic benefits associated with this will be considered within 'socio-economics' studies (see Section 6.5).

6.6.3 Data Sources

- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al.*, 2010);
- Orkney Tourism Strategy and Action Plan.

6.6.4 Data Gaps

No significant data gaps.

6.6.5 Recommendations for CEA

Potential effects on tourism and recreation activity will be considered within individual project EIAs.

6.7 Other Users (Sea and Airspace)

6.7.1 Baseline Environment

Two Military Practice and Exercise (PEXA) areas overlap with the PFOWSA one in the southern part of the PFOWSA and on the western boundary.

Numerous cables and pipelines have been installed within the PFOWSA (Figure 9).

There are no aggregate extraction activities within the PFOWSA.

There are six designated areas for sand and gravel disposal within the PFOWSA and two fish waste disposal sites. The sand and gravel disposal sites are located in: Thurso Bay (two), south of Stroma, south west of Mainland, south of Shapinsay, and north east of Stronsay. The fish waste disposal areas are both located between the islands of mainland and Hoy.

6.7.2 Key Issues

The potential for conflicts of interest with other users and for restrictions to access to particular sea areas will be addressed on a site-specific basis by individual developers as part of the project consenting process.

6.7.3 Data Sources

- Pentland Firth and Orkney Waters Marine Spatial Plan Framework (Marine Scotland *et al.*, 2010);
- PEXA Charts.

6.7.4 Data Gaps

No significant data gaps.

6.7.5 Recommendations for CEA

Potential effects of development on other users will be identified and assessed within individual project EIAs. No further detailed CEA studies are required.

7 METHODOLOGY

Following on from outline identification of potential issues a methodology to form the basis of cumulative assessment for the lease sites within PFOWSA is proposed. This identifies the effects that may act cumulatively or in combination with the PFOWSA developments to cause significant impacts and have been 'scoped in' using a matrix. This will consider cumulative and in combination effects of the projects both during construction and operation of the devices. It is proposed that this provides an appropriate "worst case scenario"(Rochdale approach) and can therefore be used to consider both temporal and spatial effects within the one high level matrix.

The potential effect of each proposed development on potential environmental receptors has been broadly assessed as beneficial or adverse (**Table 7-1**), and a colour-coded scale clearly identifies the number of projects which combine to create a particular cumulative effect. At this stage, due to limited design details for projects, no assessment has been made as to the magnitude of impacts on the receptors.

Table 7-1 A key to the scoping of cumulative effects. The greater the number of projects contributing to a cumulative effect, the darker the shading.

Increasing number of projects contributing to environmental effects			
Beneficial	**1-3 Projects**	**4-6 Projects**	**7-10 Projects**
Adverse	**1-3 Projects**	**4-6 Projects**	**7-10 Projects**

NOTE: This colour-coded system is also used in the matrix below.

The populated matrix provides the following information:

- Those environmental receptors and issues that are likely to be affected by the cumulative and in combination effects of the PFOWSA projects;
- The nature (adverse or beneficial) of the cumulative effect;
- The types of impact that are likely to be of most concern (i.e. physical, chemical or biological);

This matrix enables a basic identification of those environmental impacts which require further assessment in the project EIAs. It is proposed that this can then also be used to enable discussion for issues to be assessed on a regional basis. The matrix may be further developed as required to quantify impacts by applying a weighting or ranking to them. The initial matrix (**Matrix 1)** proposed for this discussion document is shown below.

Receptor	Type and magnitude of cumulative effect									Scoped in to CEA
	Physical Environment		Biological and Chemical Environment			Human Environment				
	Physical Loss	Physical Alteration	Chemical Alteration	Biological Loss	Biological Alteration	Change in employment structure	Change in Regional Income	Change in regional population	Regional Infrastructure	
Designated Sites	a,b,c,d	a,b,c,d	a,b,c,d		a,b,c,d					y
Geology and Coastal Processes	b,c,d	b,c,d	a,b,c,d							y
Marine Mammals	a,b,c,d	a,b,c,d		a,b,c,d	a,b,c,d					y
Marine Benthic Ecology	a,b,c,d	a,b,c,d	a,b,c,d	a,b,c,d	a,b,c,d					N
Fish and Shellfish	a,b,c,d	a,b,c,d		a,b,c,d	a,b,c,d	a,b,c,d	a,b,c,d	a,b,c,d		y
Ornithology	a,b,c,d	a,b,c,d		a,b,c,d	a,b,c,d					y
Commercial Fisheries	a,b,c,d	a,b,c,d		a,b,c,d	a,b,c,d	a,b,c,d	a,b,c,d	a,b,c,d		y
Shipping and Navigation	a,b,c,d	a,b,c,d				a,b,c,d	a,b,c,d	a,b,c,d		y
Other Users	a,b,c,d	a,b,c,d								N
Seascape / Landscape	a,b	a,b		a,b,c,d	a,b,c,d					y
Recreation and Tourism	a,b	a,b								N
Archaeology and Cultural Heritage	a,b,c,d	a,b,c,d								y
Socioeconomics						a,b,c,d	a,b,c,d	a,b,c,d	a,b,c,d	
Traffic and Transport									a,b,c,d	UNKNOWN

Impact	Minor	Moderate	Major			a) A floating attenuator or
Positive Impact					Wave	b) A seabed mounted
Negative Impact						c) A horizontal axis turbine with
					Tidal	d) Open Centre tidal

Matrix 1 Cumulative Assessment Matrix

Question to Reader:

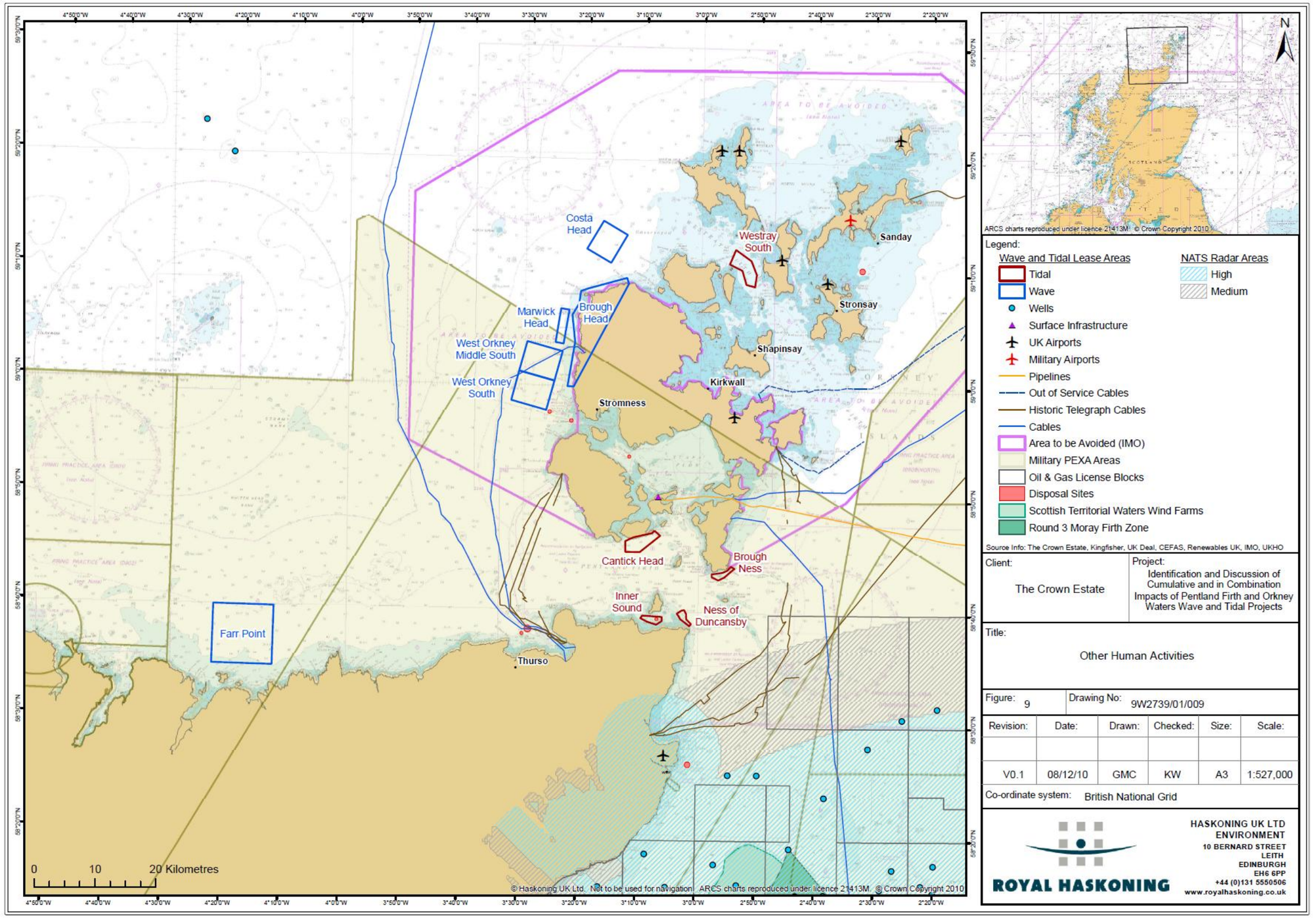
Q4. Do you agree that all the issues listed above in Section 7 should be 'scoped in'? If not, please provide comments.

8 ISSUES TO BE SCOPED OUT

Table 8-1 below identifies those receptors that are unlikely to be subject to cumulative or in-combination effects, and provides justification for their being scoped out of future CEA works.

Table 8-1 Issues scoped out

Issue	Comment
Marine Benthic Ecology	The benthic habitats encountered across the lease sites vary significantly. Available data suggests that no habitats or species of conservation importance are present within the lease sites. Any impacts on benthic ecology associated with the proposed developments are expected to be site-specific and of limited significance. As such, any potential impacts will be addressed within site specific EIAs.
Other Users	Interactions between lease areas and other users will be site-specific and effects will not be felt cumulatively. Any impacts will be addressed within site specific EIAs where relevant.
Tourism and Recreation	Given the minimal and localised nature of anticipated effects, these will be addressed in site-specific EIAs. Secondary effects on tourism and recreation associated with seascape, landscape and visual character, and potential beneficial socio-economic impacts, will be addressed under those topic headings.
*** Traffic and Transport**	ON HOLD – AWAITING PROJECT INFORMATION. Wave and tidal projects are in their early development stages and it is not known to what extent traffic and transport will be impacted by proposals. It is currently anticipated that construction, maintenance and decommissioning activity will be largely via access from the sea; however, re-assessment may be required when details of new grid works become clear.


Costa Head
Westray South
Sanday
Stronsay
Marwick Head
Brough Head
West Orkney Middle South
West Orkney South
Shapinsay
Kirkwall
Stromness
Cantick Head
Brough Ness
Inner Sound
Ness of Duncansby
Farr Point
Thurso
0 10 20 Kilometres
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Legend:
Wave and Tidal Lease Areas
Tidal
Wave
Wells
Surface Infrastructure
UK Airports
Military Airports
Pipelines
Out of Service Cables
Historic Telegraph Cables
Cables
Area to be Avoided (IMO)
Military PEXA Areas
Oil & Gas License Blocks
Disposal Sites
Scottish Territorial Waters Wind Farms
Round 3 Moray Firth Zone
NATS Radar Areas
High
Medium
Source Info: The Crown Estate, Kingfisher, UK Deal, CEFAS, Renewables UK, IMO, UKHO
Client: The Crown Estate
Project: Identification and Discussion of Cumulative and in Combination Impacts of Pentland Firth and Orkney Waters Wave and Tidal Projects
Title: Other Human Activities
Figure: 9
Drawing No: 9W2739/01/009
Revision: V0.1
Date: 08/12/10
Drawn: GMC
Checked: KW
Size: A3
Scale: 1:527,000
Co-ordinate system: British National Grid
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Question to Reader:

Q4. Do you agree that the issues listed in the table above should be 'scoped out'? If not, please provide comments.

9 FUTURE ASSESSMENT

This document has identified a number of potential cumulative and in-combination effects that should be further assessed. The methods by which effects can be assessed will need to be discussed and agreed with statutory bodies and key stakeholders, and the developers will need to determine to what extent they can work collaboratively to address potential regional effects. Within the sections above, recommendations have been made with regard to where data gathering and assessment may best be undertaken on an individual site basis, or collaboratively across a wider study area that encompasses more than one of the PFOWSA sites.

Assessment methods will need to be specific to the PFOWSA developments, though could learn much from the ongoing CEA works being undertaken by the offshore wind industry in Scotland.

9.1 Following Studies

It is proposed that the next stage of this assessment process take the form of an initial series of topic / issue focussed papers. Each paper would focus on the following requirements of further assessment:

- Identification of appropriate geographical scale for the study. The issues identified for further study have differing characteristics and the required scale of study will vary. For example the study area for commercial fisheries investigations may differ considerably from that for ornithology;
- Agreement as to a practicable and yet worthwhile time frame for any study. The main developer aim will be to have data to support applications for consent with Marine Scotland, as part of an Environmental Statement, or as separate supporting studies. It is important therefore, that the timeframe over which data collection and processing is undertaken is balanced between collection of sufficient data to draw meaningful conclusions, and the need for those data and analysis to be available in a timely manner.
- Agreement as to the method(s) to be used to collect and analyse data, and how those data and analysis will be presented.

The following topic areas are proposed for initial studies:

- **Ornithology**. To including consideration of distribution and behavioural data collection as well as connectivity between designated sites. Use of the data collected by TCE as an enabling action should be a priority.
- **Shipping and Navigation**. To include consideration of navigational risk as a result of staged development of the zone and potential 'knock on' displacement effects on other users, such as commercial fisheries;
- **Marine Mammals**. Use of the data collected by TCE as an enabling action should be a priority. To including consideration of distribution and behavioural data as much as is possible.
- **Commercial Fisheries.** As the main user group of many of the proposed development area, a study should aim to collect and present data on distribution and activity. Data from this study will link closely to Shipping and Navigation.

It is anticipated that the papers outlined above would be developed in consultation with PFOW developers and would provide sufficient information to form the basis for development of invitations to tender for the works described.

If each topic paper is to contribute to assessment of cumulative effects within a CEA, it will be necessary for the party undertaking the assessment to also have in place a description of the developments within the PFOWSA against which to assess impacts. It is appreciated that Pentland Firth and Orkney Waters developers do not themselves know fully the location, scale and nature of their developments, and it is therefore proposed that a 'Rochdale Envelope' approach is taken to description of the scale, distribution and nature of potential development within the PFOWSA. A paper outlining a hypothetical development scenario will be developed in co-operation with the developers, to facilitate completion of CEA.

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