moray offshore renewables ltd

Environmental Statement

Technical Appendix 1.3 D - MFOWDG Cumulative Assessment Document

Telford, Stevenson, MacColl Wind Farms and associated Transmission Infrastructure Environmental Statement

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Beatrice Offshore Windfarm Ltd

moray offshore renewables ltd

Moray Firth Offshore Wind Developers Group

Cumulative Impacts Assessment Discussion Document

April 2011

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SeaEnergy RENEWABLES

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This document was produced by ERM on behalf of Moray Offshore Renewables Ltd and Beatrice Offshore Windfarm Ltd

Document Status **Final**

Revision	Date	Description	ERM Approval	BOWL Approval	MORL Approval
A1	05/04/2011	For consultation			

Table of Contents

Glossary

AIS	Automatic Identification System
BWEA	British Wind Energy Association (now known as Renewable UK)
BOWL	Beatrice Offshore Windfarm Limited
CEFAS	Centre for Environment, Fisheries & Aquaculture Science
CIA	Cumulative Impact Assessment
COWRIE	Collaborative Offshore Wind Research into the Environment
CPA	Coast Protection Act
DTI	Department for Trade and Industry
EC	European Commission
EIA	Environmental Impact Assessment
ES	Environmental Statement
FEPA	Food and Environment Protection Agency
FTOWDG	Forth and Tay Offshore Wind Developers Group
FIR	Fishing Industry Representatives
HMR	Helicopter Main Route
ICES	International Council for the Exploration of the Sea
IEMA	Institute of Environmental Management and Assessment
IFG	Inshore Fisheries Groups
IMO	International Maritime Organization
JNCC	Joint Nature Conservation Committee
LSVIA	Landscape and Visual Impact Assessment
MCA	Maritime and Coastguard Agency
MOD	Ministry of Defence
MFOWDG	Moray Firth Offshore Wind Developers Group
MMO	Marine Management Organisation
MORL	Moray Offshore Renewables Limited
MS	Marine Scotland
MSS	Marine Scotland Science
NATS	National Air Traffic Services
OFTO	Offshore Transmission Owner
PHA	Preliminary Hazard Assessment
PSR	Preliminary Surveillance Radar
RSPB	Royal Society for the Protection of Birds
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SFF	Scottish Fishermen Federation
SHETL	Scottish Hydro-Electric Transmission Ltd
SNCAs	Scottish Nature Conservation Authorities
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TMZ	Transponder Mandatory Zone
VMS	Vessel Monitoring System
ZTV	Zone of Theoretical Visibility

Executive Summary

The development of offshore wind within Scottish waters is of an unprecedented scale and the potential for cumulative impacts on environmental features has become one of the most important aspects of the consenting process for offshore wind developments. In recognition of this, the Moray Firth Offshore Wind Developers Group (MFOWDG) was formed by Beatrice Offshore Windfarm Limited (BOWL) and Moray Offshore Renewables Limited (MORL) in partnership with The Crown Estate to work collaboratively on potential regional cumulative impacts arising from their proposed offshore wind development.

Based on the responses of the recent scoping reports released by both companies and using guidance from specialist consultants, the potential cumulative impacts on the physical, biological and human environment have been identified. This report outlines and requests feedback from consultees on the proposed cumulative methodologies or approaches to cumulative methodology development that MFOWDG have developed. The preparation of the cumulative methodologies has taken into account, and incorporated where appropriate, the recent work on cumulative methodologies by the Forth and Tay Offshore Wind Developers Group (FTOWDG). The overall aim of this document is to provide details of how the Moray Firth wind farm developers propose to undertake consistent cumulative impact assessments for their respective developments.

The following table outlines the current status of the proposed methodologies that are included within the following report. MFOWDG would like to encourage stakeholders and consultees to feedback on these proposed methodologies in order to inform the finalisation of the methodologies.

Current Status of the Proposed Methodologies

Receptor	Potential Cumulative Effects	Approach to Assessment
Designated Sites	▪ Effects on site conservation objectives and status	▪ Approach addressed in other relevant sections; see Physical Processes & Geomorphology, Benthic Ecology, Fish Ecology, Marine Mammals and Ornithology
Physical Processes and Geomorphology	▪ Changes to the hydrodynamic environment (waves, tides and currents). ▪ Changes to sedimentary processes and structures (sediment composition, properties, distribution, transport pathways, bedforms). ▪ Changes to suspended sediment concentration (on a variety of spatial and temporal scales). ▪ Indirect effects of the above on other sensitive receptors (e.g. benthic or pelagic ecology, socio-economic resources).	▪ Standardised data gathering ▪ Regional methodology proposed using a standardised modelling approach ▪ One regional assessment to be prepared to be used for individual site EIAs
Benthic Ecology	▪ Permanent net reduction in the total area of original habitat. ▪ Temporary seabed disturbances and effects on fauna. ▪ Increase in abundance of sessile colonial species. ▪ Temporary fining of particulate habitats as well as smothering and scour effects on benthic fauna. ▪ Release and increased bio-availability of sediment contaminants and pollutants from accidental spills.	▪ Standardised data gathering ▪ Regional assessment methodology proposed ▪ Assessments will be done by individual developers
Fish and Shellfish Ecology	▪ Disturbance to spawning activity and juveniles (nursery areas). ▪ Barrier to/change in migratory patterns. ▪ Behavioural changes derived from EMFs associated to cables. ▪ Changes in species composition and displacement of fish and shellfish resource. ▪ Direct impact during construction. ▪ Temporary and permanent loss of habitat. ▪ Changes in prey availability and displacement of food resource.	▪ Standardised data gathering ▪ Regional assessment methodology proposed ▪ One regional assessment to be prepared to be used for individual site EIAs

Receptor	Potential Cumulative Effects	Approach to Assessment
Marine Mammals	▪ Disturbance and potential displacement. ▪ Longer term avoidance of the development area by marine mammals. ▪ Increased collision risk. ▪ Reduction of the feeding resource. ▪ Changes in prey availability.	▪ Collaborative data gathering ▪ Regional methodology proposed ▪ One regional assessment to be prepared to be used for individual site EIAs
Ornithology	▪ Collision with turbines. ▪ Disturbance/displacement. ▪ Barrier effects. ▪ Indirect effects (e.g. changes in habitat or prey supply).	▪ Standardised and collaborative data gathering ▪ Regional methodology proposed ▪ Assessments will be done by individual developers
Seascape, Landscape and Visual Character	▪ Cumulative landscape and seascape effects. ▪ Cumulative landscape and seascape effects on each receptor / character. ▪ Cumulative visual effects.	▪ Approach to regional methodology preparation proposed ▪ Assessments will be done by individual developers
Marine Archaeology and Cultural Heritage	▪ Contamination, damage or loss of archaeological remains in or on the seabed. ▪ Destabilisation of sites through changed sedimentary regimes. ▪ Effects on setting of onshore cultural heritage assets.	▪ Standardised data gathering ▪ Approach to regional methodology preparation proposed ▪ Assessments will be done by individual developers
Aviation & MOD	▪ Clutter on primary radar. ▪ Shadow effect on primary radar. ▪ Obscuration effect on primary radar. ▪ Obstruction of helicopter instrument approach procedures to Beatrice platform. ▪ Obstruction of low level helicopter routes on HMR X-Ray in icing conditions. ▪ Obstruction of search and rescue helicopter operations within the wind farms.	▪ Approach to regional methodology preparation proposed
Shipping and Navigation	▪ Re-routing of shipping. ▪ Increased collision risk (vessel to vessel and vessel to turbine) during operation as well as during high levels of activities during construction operations. ▪ Cable interactions with anchors/fishing gear. ▪ Inhibited search and rescue. ▪ Interference of turbines with marine radar impacting on navigational safety.	▪ Standardised data gathering ▪ Approach to regional methodology preparation proposed

Receptor	Potential Cumulative Effects	Approach to Assessment
Commercial Fisheries	▪ Adverse impact on commercially exploited fish and shellfish populations. ▪ Complete loss or restricted access to traditional fishing grounds. ▪ Safety issues for fishing vessels. ▪ Interference with fisheries activities. ▪ Displacement of fishing vessels ▪ Increased steaming times to fishing grounds. ▪ Presence of seabed obstacles ▪ Adverse impact on recreational fish populations.	▪ Collaborative data gathering ▪ Approach to regional methodology preparation proposed
Underwater Noise	▪ Potential effects resulting from the cumulative effects of underwater noise are considered under the relevant receptor headings; see Section 4.4, fish ecology, Section 4.5, marine mammals and Section 4.6 ornithology.	▪ Collaborative data gathering ▪ Regional methodology proposed ▪ One regional assessment to be prepared to be used for individual site EIAs
Socio-economics	▪ Contribution to renewables targets. ▪ Provision of employment.	▪ Approach to regional methodology preparation proposed
Oil and Gas, Cables & Pipelines	▪ Risk of accidental damage to existing oil and gas infrastructure. ▪ Access to platforms by helicopter. ▪ Access to platforms by vessel. ▪ Direct physical impacts due to anchoring of construction vessels. ▪ Potential cumulative effects on submarine marine cables include burial or exposure due to altered marine sediment dynamics.	▪ Approach to regional methodology preparation proposed
Onshore Traffic & Transport	▪ Changes in traffic flow to and from supply ports during construction and operational phases.	▪ Approach to assessment proposed

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1. INTRODUCTION

1.1 Background to Discussion Document

The Moray Firth Offshore Wind Developers Group (MFOWDG) has been set up as a working group composed of Beatrice Offshore Windfarm Limited (BOWL) and Moray Offshore Renewables Limited (MORL). The aim of the working group is to develop and agree common approaches to environmental data gathering and interpretation to inform the Environmental Impact Assessment (EIA), particularly the Cumulative Impact Assessment (CIA) element and other project related issues. The aim of this document is to present MFOWDG's common approach and methodology to cumulative impact assessment.

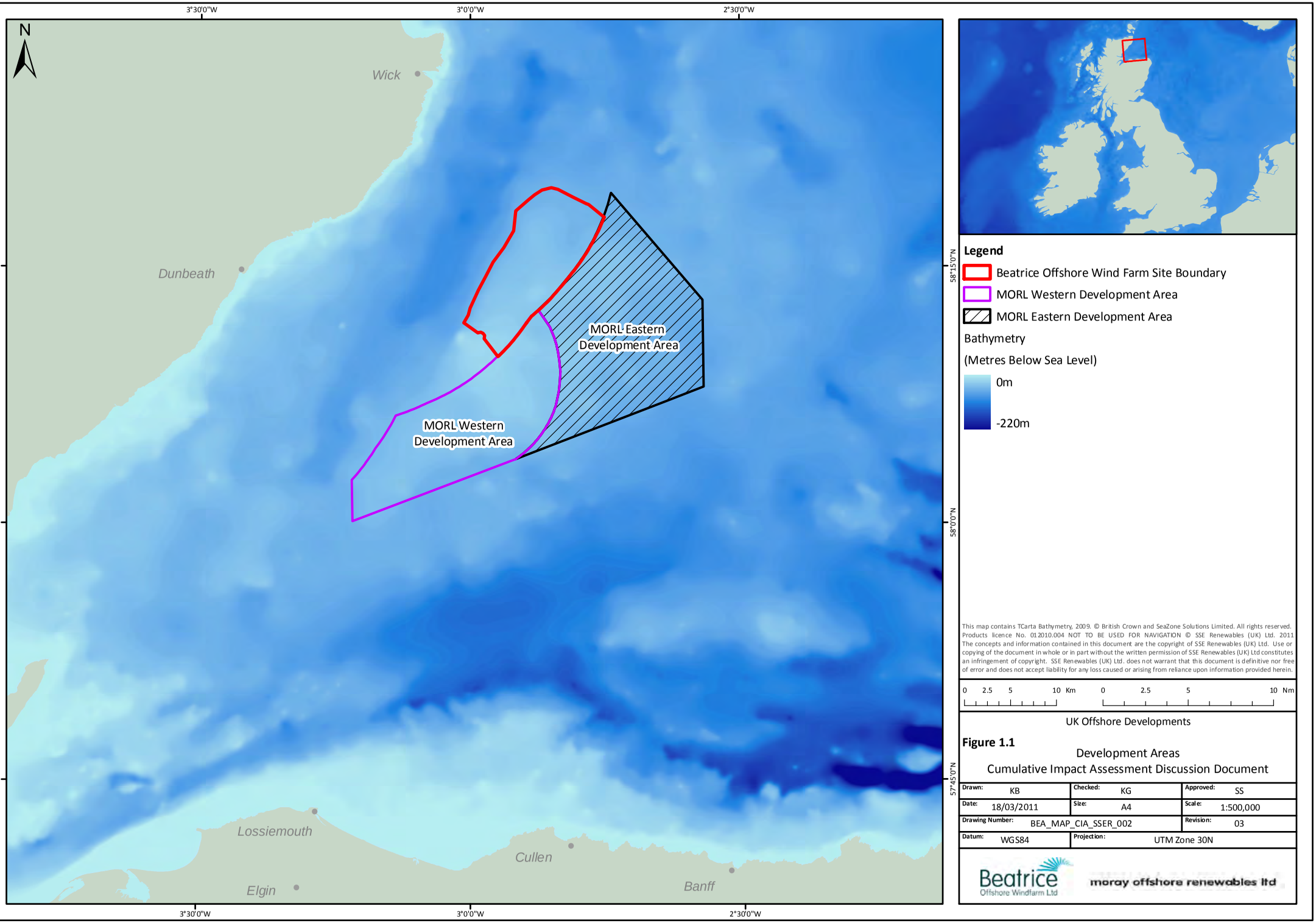
BOWL is proposing an offshore wind farm of approximately 920 MW within Scottish Territorial Waters in the outer Moray Firth. MORL was awarded a Zone Development Agreement to develop Zone 1 of the nine UK Round 3 offshore zones. MORL has identified two potential development areas, Eastern and Western. MORL is proposing an installed capacity of between 1.3 – 1.5 GW of offshore wind within the Moray Firth Round 3 zone. The Eastern Development Area is currently considered to have the higher potential for early development and is being progressed first. The BOWL and MORL sites are shown on Figure 1.1 and the anticipated developer programmes are set out in Table 1.1.1.

Given the scale, nature and proximity of these developments, the issue of cumulative impacts will be a key consideration within the Environmental Impact Assessment (EIA) process for each proposed project. This working document has been produced by MFOWDG and presents the proposed approach to undertaking cumulative impact assessment as part of the individual EIAs of the proposed wind farms. The purpose of this document is to facilitate discussion with the regulators in order to come to an agreed approach to assessing cumulative impacts.

It should be noted that both the BOWL and MORL eastern development area proposals have already been subject to formal environmental scoping exercises. This discussion document does not constitute a further formal scoping exercise under the Environmental Assessment (Scotland) Regulations (1999).

The outputs from other offshore wind farm working groups e.g. the Forth and Tay Offshore Wind Developers Group (FTOWDG) have been taken into consideration in the development of this document to ensure that the various developers and sites are applying broadly consistent approaches to assessing cumulative impacts. The FTOWDG will be consulted in relation to potential cumulative impacts.

This document presents MFOWDG's proposed methodology for cumulative impact assessment. This is based on MFOWDG's current understanding and this may change through consultation and data gathering.


3°30'0"W
3°0'0"W
2°30'0"W
58°15'0"N
58°0'0"N
57°45'0"N
N
Wick
Dunbeath
Lossiemouth
Cullen
Elgin
Banff
MORL Eastern
Development Area
MORL Western
Development Area
Legend
Beatrice Offshore Wind Farm Site Boundary
MORL Western Development Area
MORL Eastern Development Area
Bathymetry
(Metres Below Sea Level)
0m
-220m
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0 2.5 5 10 Km
0 2.5 5 10 Nm
UK Offshore Developments
Figure 1.1
Development Areas
Cumulative Impact Assessment Discussion Document
Drawn: KB
Checked: KG
Approved: SS
Date: 18/03/2011
Size: A4
Scale: 1:500,000
Drawing Number: BEA_MAP_CIA_SSER_002
Revision: 03
Datum: WGS84
Projection: UTM Zone 30N
Beatrice Offshore Windfarm Ltd
moray offshore renewables ltd

Table 1.1.1 Anticipated MFOWDG Developer Programmes

Milestones	Beatrice Offshore Wind Farm	Round 3 Zone 1, Eastern Development Area (Moray Offshore Renewables Ltd)	Round 3 Zone 1, Western Development Area (Moray Offshore Renewables Ltd)
Size (MW)	Up to 920 MW	Up to 1140 MW	Up to 360MW
MWa (km^2)	131.5	297	226
Scoping	March 2010	August 2010	TBC
EIA Design Freeze	April 2011	Q3 2011	TBC
Planning Application Submission	Q4 2011	Q2 2012	Q2 2014
Planning Decision	Q3 2012	Q2 2013	Q2 2015
Construction commencement	Q2 2014	Q2 2105	Q2 2019
First Export	Q2 2015	Q2 2016	Q2 2019

1.2 Document Objectives

The objectives of this discussion document are as follows:

- To present the approach and methodology proposed by MFOWDG for the collection of data to be used in the cumulative impact assessment;
- To present an approach and methodology to the assessment of cumulative impacts, for use by both MFOWDG developers as part of individual EIAs; and
- To invite comment from statutory and other key consultees and seek agreement of the approaches proposed by MFOWDG.

Section 5 sets out specific questions in relation to the proposed CIA. MFOWDG is particularly interested in your comments in relation to these questions.

1.3 Timescale for Consultation on the Cumulative Assessment Document

The following timeline is proposed for development and finalisation of the document:

- Consultation period – until 2 May 2011;
- Meeting with SNH/JNCC and other consultees as required – mid April 2011; and
- Incorporation of comments from consultees and finalisation of document – 30 May 2011.

1.4 Document Structure

The rest of this document is structured as follows:

Section 2 - Requirement for and definition of cumulative impact assessment
Section 3 - Receptors and potential significant cumulative effects
Section 4 - Assessment of effects
Section 5 - Consultee response template

Annex A – Methodology for Coastal Processes EIA
Annex B – Marine Mammal Data Gathering
Annex C – Ornithology – Autumn 2010 Migration Survey Report
Annex D – Underwater noise modelling method statement

Please note that all Annexes are commercial in confidence and should not be distributed outside of your organisation.

2. REQUIREMENTS AND DEFINITIONS

2.1 Requirement for Cumulative Impact Assessment

An EIA and subsequent Environment Statement must include a description of the likely significant cumulative effects of a development. This is specified in the European Commission EIA Directive (85/337/EEC as amended by 97/11/EC) and has been transposed into the various UK EIA Regulations applying to different consenting regimes.

In addition, for proposals that are likely to have a significant effect on a Natura 2000 site under the Conservation (Natural Habitats &c) Regulations 1994 (as amended) there is a requirement to assess the effects of the proposals alone and in combination with other plans or projects.

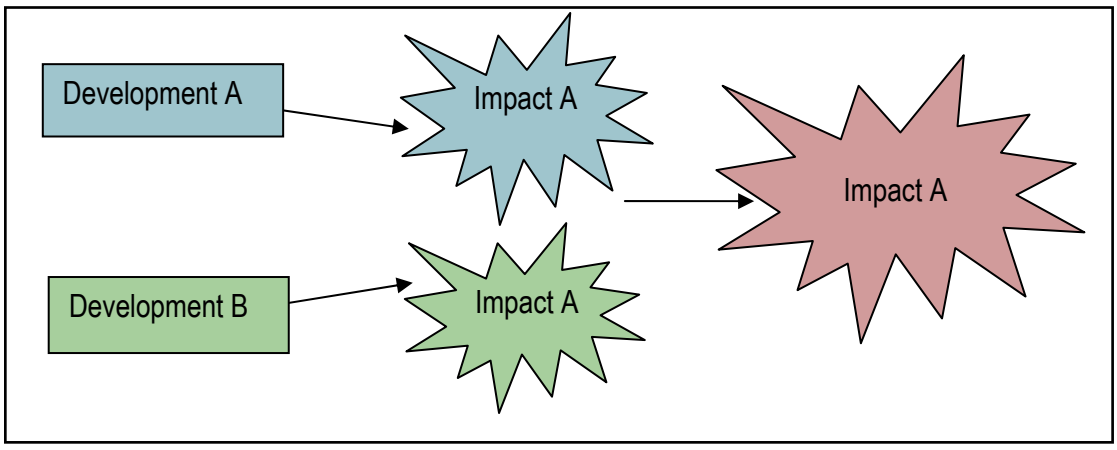
2.2 Definition of Terms

There is no single statutory definition of what a cumulative impact is, however guidance is provided as to how the term should be defined. The terms cumulative and in-combination are considered to be synonymous for the purposes of this document (1). European Commission guidance (2) provides the following definition of cumulative impacts and this is the definition used in this document.

> "Cumulative impacts are impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project"

Box 2.2.1 provides an illustration of this.

Box 2.2.1 Cumulative Impact



(1)As recommended in the SNH/JNCC response to the FTOWDG second discussion document - cumulative impacts
(2)European Commission, May 1999. Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions

"Examples of cumulative impacts are as follows:

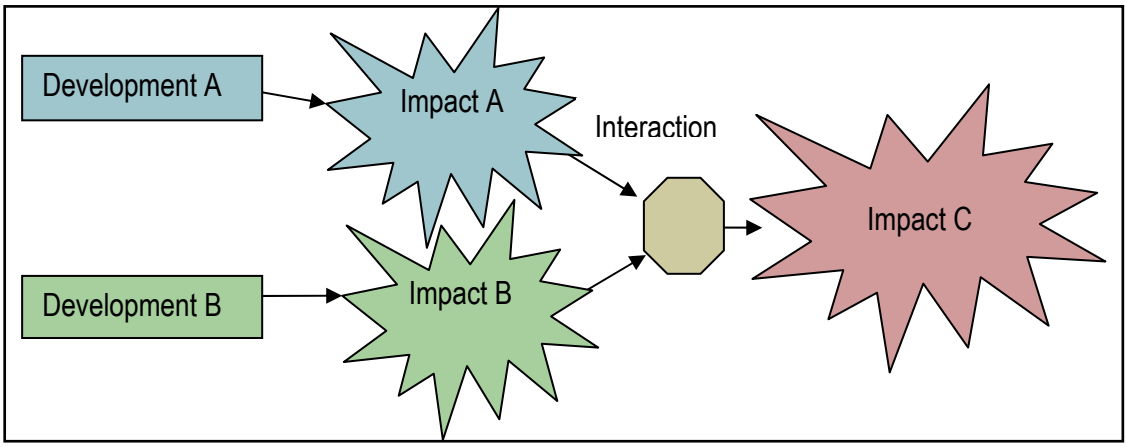
- Incremental noise from a number of separate developments;
- Combined effect of individual impacts, e.g. noise, dust and visual, from one development on a particular receptor; and
- Several developments with insignificant impacts individually but which together have a cumulative effect".

Additionally, the EC guidance refers to 'impact interactions' which themselves can combine to create a cumulative effect, defined as follows.

> "Impact interactions are the reactions between impacts whether between the impacts of just one project or between the impacts of other projects in the area".

Box 2.2.2 provides an illustration of this.

Box 2.2.2 Impact Interaction



Do you agree that the terms in-combination and cumulative impacts should be considered to have the same meaning in relation to HRA and EIA respectively?

2.3 The Differences Between Habitat Regulations Assessment and EIA

EIA requires each developer to identify both positive and negative impacts on the environment resulting from a development and to identify those impacts that are considered significant.

Habitats Regulations Appraisal (HRA) requires each developer to provide specific information to support decisions about whether their development, alone or in-combination, is likely to have a significant effect on the qualifying features of a European or Ramsar site or a European Protected Species. The decision must be based on whether the proposed development could undermine the conservation objectives of the site and affect site integrity. The information provided would then focus on these issues.

The approach proposed for the assessment of cumulative effects as part of both the HRA and EIA processes are set out in relevant topic sections (see Section 4.2 physical processes and geomorphology, Section 4.3 benthic ecology, Section 4.4 fish and shellfish ecology, Section 4.5 marine mammals and Section 4.6 ornithology.

2.4 EIA Assessment Criteria

A set of standardised cumulative impact assessment criteria will be defined by the MFOWDG in consultation with relevant consultees.

Relevant guidance will be used if available on a receptor by receptor basis. If guidance is not available, standard criteria will be used. These criteria will be agreed through specific consultations with relevant consultees.

2.5 Rochdale Envelope Approach and Project Extents

It is recognised by regulators that within the offshore wind industry some final design details will not be available to the EIA team at the time of application submission. For example, due to technological advances it is not certain what specific type or size of wind turbine would be best suited to a site until closer to the construction phase. Given this uncertainty it is accepted by regulators and consenting bodies that a 'Rochdale envelope' can be created, within which an EIA team can assess the maximum extents of the design parameters within which a consenting body can constrain a developer.

Both BOWL and MORL are working to define their individual Rochdale envelopes from which to undertake each EIA and HRA supporting documentation. Each of these envelopes will be used to progress the cumulative assessments.

The development of the offshore transmission infrastructure (i.e. export cable and onshore substations) works required to support the respective generating stations being proposed by BOWL and MORL is still in an early stage for both companies. However, MFOWDG recognise that these works will contribute to the overall cumulative impact of the proposed developments. These works will therefore be considered within the cumulative assessment methodologies to be presented within the Environmental Statements. Further information on the offshore transmission infrastructure process is available in the BOWL and MORL generating station scoping reports (1).

2.6 Developments and Activities to be Taken into Account in Cumulative Impact Assessment

Developments and activities that will be taken into account in the cumulative impact assessment are as listed below. The area of search will vary depending on each environmental topic.

(1) Beatrice Offshore Windfarm Ltd, Environmental Scoping Report, 12 March 2010
Moray Offshore Renewables Ltd, Environmental Impact Assessment Scoping Report, 2010

- Existing developments or ongoing activities;
- Any development under construction;
- Any development or activity which has been consented by the relevant Competent Authority but is not yet under construction or ongoing; and
- Any specific development or activity which is proposed, but has not yet been submitted for consenting (e.g. a proposed offshore wind farm which is at the pre-application stage).

It is the intention that the cumulative impact assessments will be undertaken and reported within each separate ES submitted by BOWL and MORL.

EIAs are undertaken at a fixed point in time and cannot take into account possible future developments for which information is not available. It is for the proponents of any future developments or activities to undertake an assessment of impacts of activities along with cumulative impacts arising from developments which are operational, under construction, consented or known to be in planning at that time.

Other developments that may be constructed in the vicinity of BOWL/MORL will not be as advanced in the development or planning process but will be reasonably foreseeable. These projects will be included at a commentary level only in ES, as detailed information on these projects is unlikely to be available.

Excluded from the assessment are possible future developments or activities which are not yet proposed (i.e. the consenting process has not been initiated) or for which there is insufficient information to allow an assessment to be undertaken (e.g. potential future licensing rounds for offshore wind or potential future oil and gas industry activities).

Specific developments and activities to be considered are expected to include the following.

- Marine Renewables Projects
  - Beatrice Offshore Wind Farm
  - Individual sites within the MORL Eastern Development Area
  - MORL Western Development Area
  - Marine energy developments in the Pentland Firth and Orkney waters as relevant to the receptor under assessment
  - Proposed SHETL hub
  - Forth and Tay offshore wind developments
  - Aberdeen Offshore Wind Farm
  - Beatrice Demonstrator Turbines

- Cables
  - MORL Offshore Export Cable and onshore infrastructure (OFTO)
  - BOWL Offshore Export Cable and onshore infrastructure (OFTO)
  - Proposed Viking SHETL cable and onshore infrastructure
  - SHEFA telecoms cable

- Oil and gas Industry Infrastructure
  - Beatrice and Jacky platforms and associated infrastructure
  - The proposed Polly well
  - The proposed Caithness and PA Resources infrastructure for existing leases

- Other marine stakeholders in the Moray Firth
  - Navigation and shipping
  - Military activities
  - Aviation
  - Commercial fisheries: UK scallop fisheries, Moray Firth seine net fishery, etc
  - Marine and port developments within the Moray Firth
  - Dredging and sea disposal within the Moray Firth

- Other onshore elements of the MORL and BOWL projects relevant to the offshore environment
  - MORL onshore met mast
  - Other onshore renewables projects within defined and agreed study area (see Section 4.6 Ornithology and Section 4.7 SLVIA)

The purpose of Table 2.6.1 is to summarise activities to be considered according to the receptor and to provide a starting point for discussions to agree study area extent. Clearly, both the MORL and BOWL wind farm proposals will feature as cumulative developments in respective EIAs, these are not presented in the table.

Along the horizontal axis of the table are existing, proposed or reasonably foreseeable development types and activities that may result in a cumulative impact when considered alongside the BOWL or MORL wind farms. Receptors are set out along the vertical axis. Boxes are shaded when a cumulative impact is considered possible. Where appropriate, some initial comment is provided on the extent of the study areas.

Do you agree with the developments and activities to be considered during the cumulative impact assessment? Are there additional developments that should be considered?

Table 2.6.1 Activities to be Taken Into Account in Cumulative Impact Assessment

Developments and Activities to be included in Cumulative Impact Assessment

Receptor	Developments and Activities										
	Other offshore wind farms	Subsea Cables	Pentland Firth Marine Energy	Military Activities (excl Aviation)	Shipping	Civil and Military Aviation	Commercial Fisheries	Marine and Port Development	Dredging and Sea Disposal	Oil and Gas Development	Onshore wind farms
Physical Processes and Geomorphology								Within 8 km of site or cable route (i.e. <1 tidal excursion)	Within 8 km of site or cable route (i.e. <1 tidal excursion)	Should consider new infrastructure if planned (if none scope out). Contaminants may also need to be considered.	
Benthic Ecology	Unlikely to be necessary given species found at BOWL and MORL sites		Unlikely to be necessary given species found at BOWL and MORL sites					Within 8 km of site or cable route (i.e. <1 tidal excursion)	Within 8 km of site or cable route (i.e. <1 tidal excursion)		
Fish and Shellfish Ecology	Depending on species under consideration		Depending on Species under consideration					Area depending on species and specific location of the development	Moray Firth Area		
Marine Mammals								Study area dependent on species and will reflect species mobility	Study area dependent on species and will reflect species mobility		

Receptor	Developments and Activities										
	Other offshore wind farms	Subsea Cables	Pentland Firth Marine Energy	Military Activities (excl Aviation)	Shipping	Civil and Military Aviation	Commercial Fisheries	Marine and Port Development	Dredging and Sea Disposal	Oil and Gas Development	Onshore wind farms
Ornithology	Depending on species under consideration		Depending on Species under consideration					Area depending on species and specific location of the development	Area depending on species and specific location of the development	Consider new infrastructure if any is planned	
Seascape, landscape and visual character											
Marine Archaeology and Cultural Heritage											
Aviation and MOD Including Radar											
Shipping and Navigation											
Commercial Fisheries	Limited to specific fisheries and operational range of vessels		Limited to specific fisheries and operational range of vessels						Extent of study area dependent upon location of sites relative to fishing grounds		
Underwater Noise											
Socio-economics											
Oil and Gas infrastructure, sub sea cables											
Onshore traffic and Transport											

Do you have any comments on Table 2.6.1?

2.7 Information Sharing

Table 2.7.1 presents a matrix illustrating where the MORL and BOWL projects are collaborating in terms of information sharing.

Table 2.7.1 Collaborative Approaches and Opportunities Matrix

Topic Area	Same contractor for both BOWL and MORL	Agreement on data collection methodology & assessment	Agreement on data standards	Undertake work package as one team?	
				Share data collected	Share results
	Yes No	Yes No	Yes No	Yes No	Yes No
CONSENTING TASKS - Wind Farm EIA					
Physical Environment					
Physical Processes / Sediment and Water Quality	Yes	Yes	Yes	Yes	Yes
Biological Environment					
Ornithology - boat based survey	No	Yes	Yes	Yes	Yes
Ornithology - other survey type	No	Yes	Yes	Yes	Survey type dependent
Benthic Ecology	No	Yes	Yes	If relevant	If relevant
Fisheries studies (natural)	Yes	Yes	Yes	Yes	Yes
Marine Mammals - boat based	No	Yes	Yes	Yes	Yes
Marine mammals - other survey type	Yes	Yes	Yes	Yes	Yes
Underwater Noise Assessment	Yes	Yes	Yes	Yes	Yes
Human Environment					
Shipping, Navigation & Safety	Yes	Yes	Yes	Yes	Yes
Fisheries studies (commercial)	Yes	Yes	Yes	Yes	Yes
Seascape, Landscape and Visual Study	Possible	Yes	Yes	Possible	Possible
Socioeconomics & Tourism Desk Study	Possible	Yes	n/a	Possible	Possible
Marine Archaeology and Cultural Heritage	Yes	Yes	Yes	Yes	Yes
Aviation and MoD	No	n/a	n/a	Yes	Yes

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3. POTENTIAL RECEPTORS AND EFFECTS

There is the potential for specific receptors to experience significant cumulative effects. These are set out in Table 3.1.1 alongside potential cumulative effects. Section 4 provides the proposed approach and methodology for assessment of potential cumulative effects.

Table 3.1.1 Receptors and Potential Cumulative Effects

Receptor	Potential Cumulative Effects
Physical	
Physical Processes and Geomorphology	▪ Changes to the hydrodynamic environment (waves, tides and currents). ▪ Changes to sedimentary processes and structures (sediment composition, properties, distribution, transport pathways, bedforms). ▪ Changes to suspended sediment concentration (on a variety of spatial and temporal scales). ▪ Indirect effects of the above on other sensitive receptors (e.g. benthic or pelagic ecology, socio-economic resources).
Underwater Noise	▪ Potential effects resulting from the cumulative effects of underwater noise are considered under the relevant receptor headings; see Section 4.4, fish ecology, Section 4.5, marine mammals and Section 4.6 ornithology.
Biological Environment	
Marine mammals	▪ Disturbance and potential displacement. ▪ Longer term avoidance of the development area by marine mammals. ▪ Increased collision risk. ▪ Reduction of the feeding resource. ▪ Changes in prey availability.
Ornithology	▪ Collision with turbines. ▪ Disturbance/displacement. ▪ Barrier effects. ▪ Indirect effects (e.g. changes in habitat or prey supply).
Benthic ecology	▪ Permanent net reduction in the total area of original habitat. ▪ Temporary seabed disturbances and effects on fauna. ▪ Increase in abundance of sessile colonial species. ▪ Temporary fining of particulate habitats as well as smothering and scour effects on benthic fauna. ▪ Release and increased bio-availability of sediment contaminants and pollutants from accidental spills.
Fish and Shellfish Ecology	▪ Disturbance to spawning activity and juveniles (nursery areas). ▪ Barrier to/change in migratory patterns. ▪ Behavioural changes derived from EMFs associated with cables. ▪ Changes in species composition and displacement of fish and shellfish resource. ▪ Direct impact during construction. ▪ Temporary and permanent loss of habitat. ▪ Changes in prey availability and displacement of food resource.

Receptor	Potential Cumulative Effects
Nature Conservation Designated Areas	▪ Potential effects on the qualifying features of these sites are discussed under the relevant sections of this document. ▪ Effects on sub-tidal and intertidal habitats – see Section 4.3. ▪ Effects on migratory fish – see Section 4.4. ▪ Effects on marine mammals – see Section 4.5. ▪ Effects on birds – see Section 4.6.
Human Environment	
Landscape, seascape and visual impacts	▪ Cumulative landscape and seascape effects. ▪ Cumulative landscape and seascape effects on each receptor / character. ▪ Cumulative visual effects.
Archaeology and cultural heritage	▪ Contamination, damage or loss of archaeological remains in or on the seabed. ▪ Destabilisation of sites through changed sedimentary regimes. ▪ Effects on setting of onshore cultural heritage assets.
Commercial fisheries	▪ Adverse impact on commercially exploited fish and shellfish populations. ▪ Complete loss or restricted access to traditional fishing grounds. ▪ Safety issues for fishing vessels. ▪ Interference with fisheries activities. ▪ Displacement of fishing vessels. ▪ Increased steaming times to fishing grounds. ▪ Presence of seabed obstacles. ▪ Adverse impact on recreational fish populations.
Shipping and navigation	▪ Re-routing of shipping. ▪ Increased collision risk (vessel to vessel and vessel to turbine) during operation as well as during high levels of activities during construction operations. ▪ Cable interactions with anchors/fishing gear. ▪ Inhibited search and rescue. ▪ Interference of turbines with marine radar impacting on navigational safety.
Aviation / MOD	▪ Clutter on primary radar. ▪ Shadow effect on primary radar. ▪ Obscuration effect on primary radar. ▪ Obstruction of helicopter instrument approach procedures to Beatrice platform. ▪ Obstruction of low level helicopter routes on HMR X-Ray in icing conditions. ▪ Obstruction of search and rescue helicopter operations within the wind farms.
Socio- economics	▪ Contribution to renewables targets. ▪ Provision of employment.
Onshore traffic and transport	▪ Changes in traffic flow to and from supply ports during construction and operational phases.
Oil and gas infrastructure including aviation and subsea cables	▪ Risk of accidental damage to existing oil and gas infrastructure. ▪ Access to platforms by helicopter. ▪ Access to platforms by vessel. ▪ Direct physical impacts due to anchoring of construction vessels. ▪ Potential cumulative effects on submarine marine cables include burial or exposure due to altered marine sediment dynamics.

Are the effects identified in Table 3.1.1 appropriate and are you aware of any other effects that should be considered?

Two receptors have been of removed from the cumulative assessment as it is considered that they will not experience significant cumulative effects. These are provided in Table 3.2.1.

Table 3.2.1 Proposed Receptors to be Removed

Receptor	Reason removed
Marine Waste Disposal	There are four marine disposal sites between Burghead and Macduff to the south of the Beatrice oil field. Due to the coastal locations and the distances from the wind farm sites it is considered that there will be no significant impacts on/from these sites during construction, operation or decommissioning of the Wind Farm. It is therefore considered that this topic area be scoped out of the CIA.
Radio and Microwave Telecommunications	No impacts on radio and microwave telecommunication links are anticipated.

Do you agree with the receptors that have been removed from the cumulative impact assessment?

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4. ASSESSMENT OF EFFECTS

4.1 Nature Conservation Designated Sites

The development of the wind farm sites has the potential to impact upon the integrity and conservation objectives of existing Natura 2000 sites and Ramsar sites. These are illustrated on Figure 4.1. Sites of Special Scientific Interest (SSSI) will also be taken into account where relevant to receptor studies.

Potential effects on the qualifying features of these sites are discussed under the relevant sections of this document:

- Effects on sub-tidal and intertidal habitats – see Section 4.2 & 4.3;
- Effects on migratory fish – see Section 4.4;
- Effects on marine mammals – see Section 4.5; and
- Effects on birds – see Section 4.6.

Special Areas of Conservation, Special Protected Areas, Ramsar sites and SSSIs that will be taken into account during the cumulative impact assessment are set out in Table 4.1.1.

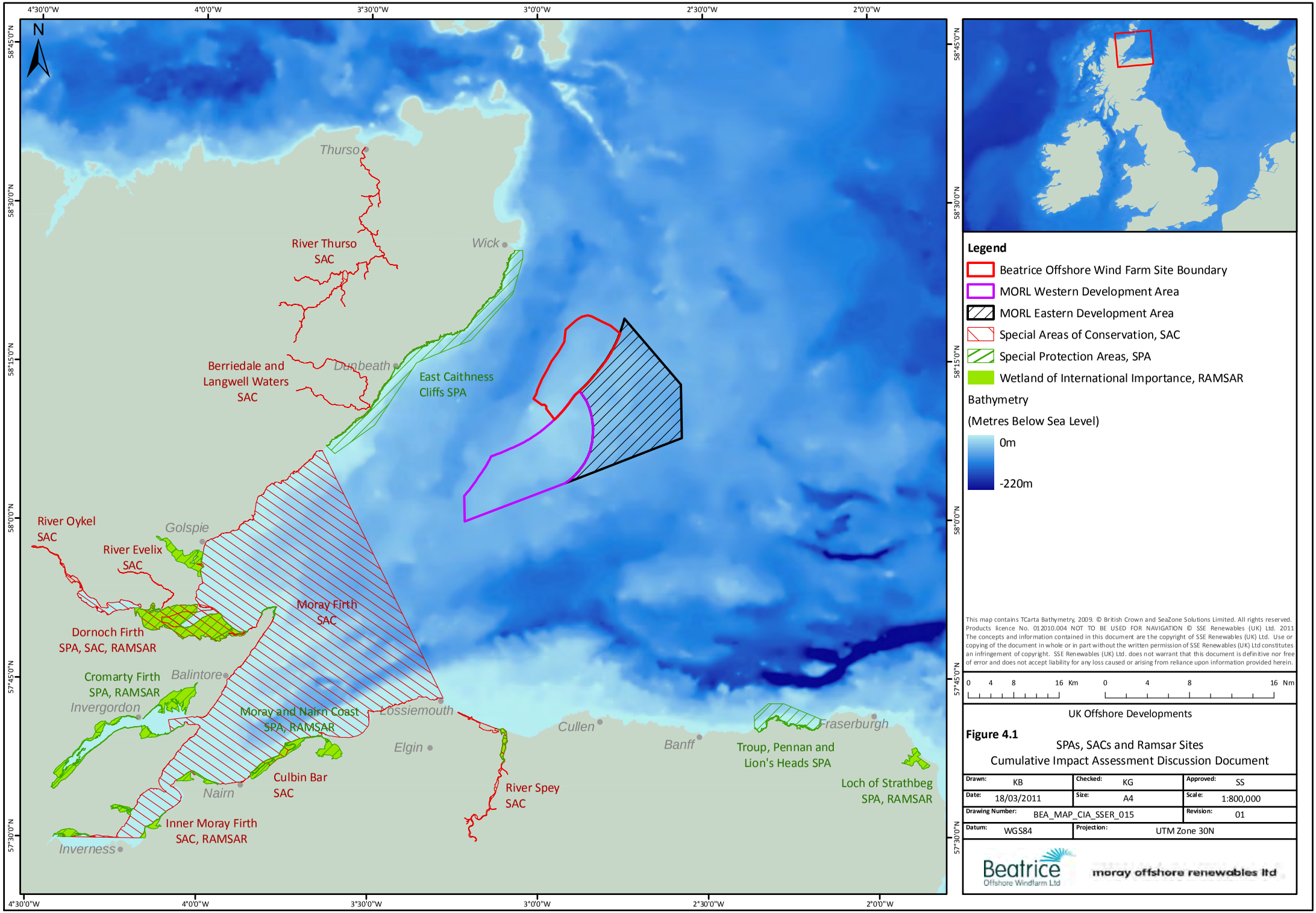
Table 4.1.1 Designated Sites Relevant to Cumulative Impact Assessment

SACs	SPAs	Ramsar	SSSIs
Moray Firth	Loch of Strathbeg	Loch of Strathbeg	Loch Fleet
Dornoch Firth	Troup, Pennan and Lion's Head	The Moray and Nairn Coast	Morrich More
Berriedale and Langwell,	The Moray and Nairn Coast	The Inner Moray Firth	Tarbat Ness
Culbin Bar	The Inner Moray Firth	Cromarty Firth	Culbin Sands, Culbin Forest and Findhorn Bay
River Oykel	Cromarty Firth	The Dornoch Firth	Spey Bay
River Moriston	Dornoch Firth and Loch Fleet		Cullen to Stakeness Coast
River Spey	East Caithness Cliffs		Cromarty Firth
River Evelix	North Caithness Cliffs		Loch of Strathbeg
River Thurso			Gamrie and Pennan Coast
			Berriedale Cliffs

4.2 Physical Processes and Geomorphology

4.2.1 Specialist Advisor

Both MORL and BOWL have commissioned the services of ABPmer to complete the EIA exercise and provide advisory services.


4°30'0"W
4°0'0"W
3°30'0"W
3°0'0"W
2°30'0"W
2°0'0"W
58°45'0"N
58°30'0"N
58°15'0"N
58°0'0"N
57°45'0"N
57°30'0"N
N
Thurso
Wick
River Thurso SAC
Berriedale and Langwell Waters SAC
Dunbeath
East Caithness Cliffs SPA
River Oykel SAC
Golspie
River Evelix SAC
Moray Firth SAC
Dornoch Firth SPA, SAC, RAMSAR
Cromarty Firth SPA, RAMSAR
Balintore
Invergordon
Moray and Nairn Coast SPA, RAMSAR
Lossiemouth
Elgin
Culbin Bar SAC
Nairn
Inner Moray Firth SAC, RAMSAR
Inverness
River Spey SAC
Cullen
Banff
Troup, Pennan and Lion's Heads SPA
Fraserburgh
Loch of Strathbeg SPA, RAMSAR
Legend
Beatrice Offshore Wind Farm Site Boundary
MORL Western Development Area
MORL Eastern Development Area
Special Areas of Conservation, SAC
Special Protection Areas, SPA
Wetland of International Importance, RAMSAR
Bathymetry
(Metres Below Sea Level)
0m
-220m
This map contains TCarta Bathymetry, 2009. © British Crown and SeaZone Solutions Limited. All rights reserved. Products licence No. 012010.004 NOT TO BE USED FOR NAVIGATION © SSE Renewables (UK) Ltd. 2011 The concepts and information contained in this document are the copyright of SSE Renewables (UK) Ltd. Use or copying of the document in whole or in part without the written permission of SSE Renewables (UK) Ltd constitutes an infringement of copyright. SSE Renewables (UK) Ltd. does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein.
0 4 8 16 Km
0 4 8 16 Nm
UK Offshore Developments
Figure 4.1
SPAs, SACs and Ramsar Sites
Cumulative Impact Assessment Discussion Document
Drawn: KB
Checked: KG
Approved: SS
Date: 18/03/2011
Size: A4
Scale: 1:800,000
Drawing Number: BEA_MAP_CIA_SSER_015
Revision: 01
Datum: WGS84
Projection: UTM Zone 30N
Beatrice Offshore Windfarm Ltd
moray offshore renewables ltd

4.2.2 Guidance Documents

There are currently a number of specific guidance documents available to inform the approach and these will be considered during the cumulative impact assessment on physical processes. The guidance that will be considered will include the following:

- Cefas, 2004. Offshore Wind Farms: Guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements, Version 2, June 2004 (1);
- Cefas, 2010. Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA Licence Conditions (2);
- ABPmer and HR Wallingford for COWRIE, 2009. Coastal Process Modelling for Offshore Wind farm Environmental Impact Assessment: Best Practice Guide (3);
- ABPmer, HR Wallingford and CEFAS for COWRIE, 2010. Further review of sediment monitoring data (4);
- EMEC and Xodus AURORA, 2010. Consenting, EIA and HRA Guidance for Marine Renewable Energy Developments in Scotland. Parts 1-4 (5);
- MCA, August 2008. Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues. MCA Guidance Note MGN371 (6); and
- Surfers Against Sewage, 2009. Guidance on Environmental Impact Assessment of offshore renewable energy development on surfing resources and recreation. pp 63 (7).

4.2.3 Baseline

The EIA scoping reports from both MORL and BOWL present a summary baseline description of the following as they occur naturally:

- Wind and wave climate;
- Tidal regime (water levels and currents);
- Predicted effects of climate change;
- Geology and seabed sedimentary deposits;
- Seabed sediment mobility; and
- Suspended sediment concentrations.

Desk-top studies undertaken by BOWL and MORL as part of the individual EIA requirements have indicated that the internal structure of the Smith Bank comprises erosion resistant glacial till deposits (poorly sorted gravels and sands) and other relatively stable geological sequences (e.g. as reported in Holmes *et al.,* 2004 (8)). This means that the bank as a morphological

(1)Available online http://www.cefas.co.uk/publications/files/windfarm-guidance.pdf (accessed 14th January 2011).
(2)Available online http://www.cefas.co.uk/publications/miscellaneous-publications/strategic-review-of-offshore-wind-farm-monitoring-data-associated-with-fepa-licence-conditions.aspx (accessed 14th January 2011).
(3)Available online http://www.offshorewindfarms.co.uk/Pages/Publications/Archive/Other/Coastal_process_modell6f6d2c53/ (accessed 14th January 2011).
(4) Available online http://www.offshorewindfarms.co.uk/Pages/Publications/Latest_Reports/Data/A_further_review_of_se2087e393/ (accessed 14th January 2011).
(5)Available online http://www.scotland.gov.uk/ (accessed 14th January 2011).
(6)Available online http://www.mcga.gov.uk/c4mca/mgn371.pdf (accessed 14th January 2011).
(7)Available online http://www.sas.org.uk/pr/2009/pdf09/eia-1.pdf (accessed 14th January 2011).
(8)Holmes R., Bul;at J., Henni P., Holt J., James C., Kenyon N., Leslie A., Lond D., Morri C., Musson R., Pearson s., and Stewart H. (2004) DTI Strategic Environmental Assessment Area % (SEA5): Seabed and Superficial Geology and Processes. Commercial Report CR/04/064N.

feature is largely relic and inherently stable. A relatively thin sand veneer is observed across parts of the bank (order tens of centimetres to a few meters thick).

The historical and newly measured tidal and wave climate data show that the tidal regime is largely insufficient to induce frequent mobility of these sands but that intermittent storm wave action may cause energetic sediment resuspension (but not necessarily directional sediment transport). Measurements of suspended sediment concentrations have been observed to significantly increase during storm events, but not in response to the spring-neap tidal cycle.

The draft findings of geophysical surveys undertaken for the BOWL site and separately for the MORL Round 3 zone (OSIRIS, pers. comm.) also did not indicate the significant presence of active tidal current related sedimentary bedforms. Instead, the indicators of long-term sediment transport direction (buried slope angles in the sub-surface geophysical data) suggest that, once resuspended by waves, sediment tends to move down slope under gravity and off the crest of the bank, rather than in the direction of the tidal axis or the dominant wave directions. Megaripple bedforms were identified in a limited area in the south of the MORL Round 3 zone but are considered likely to be relic.

4.2.4 Proposed Consultees

It is proposed that the following organisations will be consulted during the scope refinement and ongoing cumulative impact assessment:

- Marine Scotland;
- SNH;
- JNCC;
- Historic Scotland;
- RSPB;
- The RYA; and
- Ports and Harbours Authorities within the Moray Firth.

4.2.5 Potential Effects

The potential effects of an offshore wind farm development on the physical environment are generally considered to result from periods of construction or decommissioning activities and over the operation lifetime of the wind farm from direct interaction between the submerged part of the wind turbine structures and the physical environment. Guidance in this respect (CEFAS, 2004) summarises the potential effects of primary concern as set out below:

- Changes to the hydrodynamic environment (waves, tides and currents);
- Changes to sedimentary processes and structures (sediment composition, properties, distribution, transport pathways, bedforms);
- Changes to suspended sediment concentration (on a variety of spatial and temporal scales); and
- Indirect effects of the above on other sensitive receptors (e.g. benthic or pelagic ecology, socio-economic resources).

The impacts and the specific receptors identified for this cumulative impact assessment are the same as those identified at a site specific level. The impacts are summarised in Table 4.2.1 below.

Table 4.2.1 Summary of Identified Cumulative Coastal Process Impacts

Issue	Potential impact
Effect on tidal currents and waves: Changes to patterns of tidal currents and wave activity as a result of the presence of the turbine foundations.	Change in sediment transport pathways (suspended or bedload) affecting the form and function of the Smith Bank or other named SACs or SPAs.
	Reduction in recreational surfing wave resource in the lee of the development.
	Modification of tidal currents or wave climate affecting navigation in the area
Sediment resuspension: Increase in suspended sediment concentration during installation/seabed preparation/removal of foundations or cables, or the initial phases of seabed scouring around newly installed foundations resulting in short-term locally elevated levels of suspended sediment concentrations.	Elevated levels of suspended sediment concentration on sensitive receptors. Subsequent deposition of sediment on sensitive receptors
Footprint of turbines and installation vessels: Seabed compaction or smothering in the footprint of foundations and of any jack-up vessels used.	Mortality of sensitive marine life in directly affected areas.
Scour around turbine foundations: Scour around foundations leading to local changes in seabed sediment type and morphology.	Impact upon the stability of the turbine foundation.
	Localised loss of seabed habitat through seabed modification.

Following a programme of sediment sampling and analysis, there is no evidence of sediment contamination (e.g. metals or hydrocarbons) in either the BOWL site or MORL Round 3 zone. Therefore, potential resuspension of contaminated sediments will not be considered within the EIA with respect to the main wind farm development. However, surveys of the proposed export cable route(s) are still required and if sediment contamination is found, additional assessment of resulting impacts on water quality will be made. Assessment methodologies will be determined at a later date.

In addition to statutory requirements to maintain water quality in some locations within the wider Moray Firth, the potential for direct or indirect impacts on sensitive ecological or socio-economic receptors will also be considered.

4.2.6 Study Area

The study area within which effects and impacts will be considered from a coastal processes perspective will include the wider Moray Firth region in order to take into consideration any likely far-field effects on wave and tidal processes and the potential for dispersion and settlement of sediments re-suspended during the construction phases of the projects. In the modelling, the highest spatial resolution will be applied to the near field area, i.e. within and immediately adjacent to the wind farm site boundaries and along any cable route options. An

adequate level of spatial detail, following best practice in this regard, will be maintained in other far field areas to investigate potential transmission of effects to the location of identified sensitive receptors (e.g. SAC's, SPA's, etc).

4.2.7 Data Gathering

Requirements for new data collection have been determined on the basis of a detailed historical data gap analysis. This study concluded that sufficient data exist to characterise the wider Moray Firth region in terms of coastal processes; however, it was also found that additional data are needed to inform the more detailed understanding of processes required within the site boundaries. Other types of receptor and scheme information are also required to guide and inform the impact assessment process.

In addition to collating the identified historic data, specific new data collection and information gathering has been undertaken as follows. Metocean deployments are shown on Figure 4.2.

- Metocean survey (winds, waves and tides, including the locations shown in Tables 4.2.2 and 4.2.3);
- Geophysical surveys (bathymetry and seabed characterisation);
- Sedimentary characterisation surveys (sediment type, naturally occurring levels of sediment resuspension and sediment contamination levels);
- Information regarding the location and nature of any sensitive receptors that might be affected by changes to the physical marine environment; and
- A project design specification from each developer, detailing the most realistic estimate of the type, number and locations of turbine foundations and the likely methods and scheduling of construction, etc.

Table 4.2.2 BOWL Metocean Survey Equipment Deployment

Location	Equipment	Lat	Lon	Deployment Date	Recovered
1	Wave buoy	58° 19.00' N	002° 50.75' W	11/02/2010	Presently ongoing
2	AWAC*	58° 17.80' N	002° 46.60' W	10/02/2010	15/06/2010
3	AWAC*	58° 10.75' N	002° 57.00' W	10/02/2010	15/06/2010

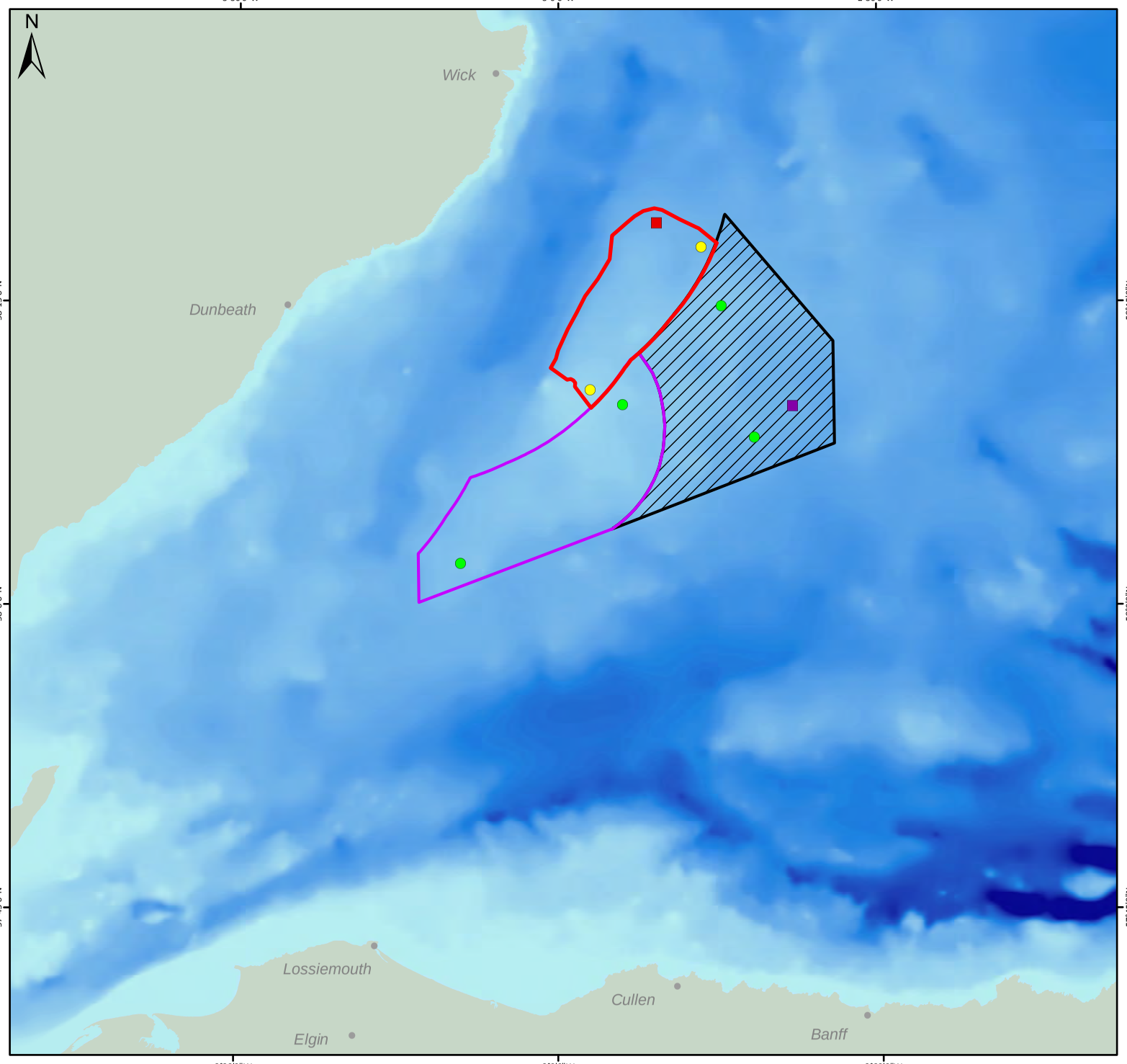
* Acoustic Wave And Current (AWAC) devices provide measurements of the tidal current profile, tidal water levels and waves. AWAC's were also deployed in conjunction with nearbed suspended sediment monitors.

Table 4.2.3 MORL Metocean Survey Equipment Deployment

Location	Equipment	Lat	Lon	Deployment Date	Recovered
1	Wave buoy	58° 9.94' N	002° 38.05' W	15/06/2010	Presently ongoing
2	AWAC*	58° 14.89' N	002° 44.73' W	27/07/2010	13/12/2010
3	AWAC*	58° 8.39' N	002° 41.70' W	27/07/2010	27/01/2011
4	AWAC*	58° 2.17' N	002° 9.12' W	27/07/2010	7/01/2011
5	AWAC*	58° 10.02' N	002° 54.02' W	27/07/2010	14/02/2011

* Acoustic Wave And Current (AWAC) devices provide measurements of the tidal current profile, tidal water levels and waves. AWAC's were also deployed in conjunction with nearbed suspended sediment monitors.

Are you aware of any additional data sources that should be considered in the assessment?



Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Western Development Area
- MORL Eastern Development Area
- Beatrice Wave Buoy
- MORL Wave Buoy
- Beatrice AWAC
- MORL AWAC

Bathymetry

(Metres Below Sea Level)

0m

-220m

0 2.5 5 10 Km 0 2.5 5 10 Nm

UK Offshore Developments

Figure 4.2

Metocean Deployments

Cumulative Impact Assessment Discussion Document

Drawn:	KB	Checked:	KG	Approved:	SS
Date:	29/03/2011	Size:	A4	Scale:	1:500,000
Drawing Number:	BEA_MAP_CIA_SSER_017			Revision:	02
Datum:	WGS84	Projection:	UTM Zone 30N		

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4.2.8 Assessment Methodology

The cumulative assessment is expected to assess the cumulative impact of the following developments:

- BOWL generating station;
- MORL western development area generating stations;
- MORL eastern development area generating stations;
- BOWL OFTO cable;
- MORL OFTO cable;
- Proposed SHETL cable;
- Proposed SHETL hub;
- Any relevant port and harbour developments in the Moray Firth;
- Proposed Polly well;
- Dredging and sea disposal in the Moray Firth; and
- Pentland Firth marine energy developments.

A detailed methodology has been developed in conjunction with Marine Scotland and its advisors to address the identified coastal process issues (presented in Annex A). A revised draft of this methodology including all scoping responses is under preparation. Methodologies have been developed, in accordance with the available best practice guidance, for the following:

- The collection of new environmental data to supplement gaps identified in the historical data record;
- The creation and use of numerical modelling tools to inform baseline environmental understanding and quantitative assessment of development impacts; and
- The analysis and interpretation of model results to quantify the identified potential impacts of the scheme on sensitive receptors.

The modelling tools and proposed methodologies are appropriate for and will be consistently applied to both single scheme and cumulative studies. To facilitate this, the model will be developed using the metocean data collected by both MORL and BOWL.

All assessments will be quantitatively made using numerical modelling tools (the DHI MIKE software suite) that encompass a regional scale extent (see Figure 4.3). These tools will be informed by and tested against the historic and newly collected data presently being compiled. A 'present day' condition will provide a baseline against which to measure the magnitude of any impacts. Activities with the potential to cause an impact associated with phases of construction, operation, re-powering and decommissioning will also be simulated, including single scheme, cumulative and in-combination scenarios. Figure 4.3 illustrates the underlying mesh cells used in the formation of the tidal model.

4.2.9 Presentation of Results

Assessments of cumulative and in-combination studies, as well as individual schemes, will be presented in the ES's as the predicted effect of the scheme(s) on the identified sensitive receptors, in the context of their particular sensitivity and the naturally occurring variability in the baseline environment. Assessments in the ES's will be supported by more detailed technical annex reports, which will also provide more details of the data, modelling tools and methodologies used.

4.3 Benthic Ecology

4.3.1 Specialist Advisor

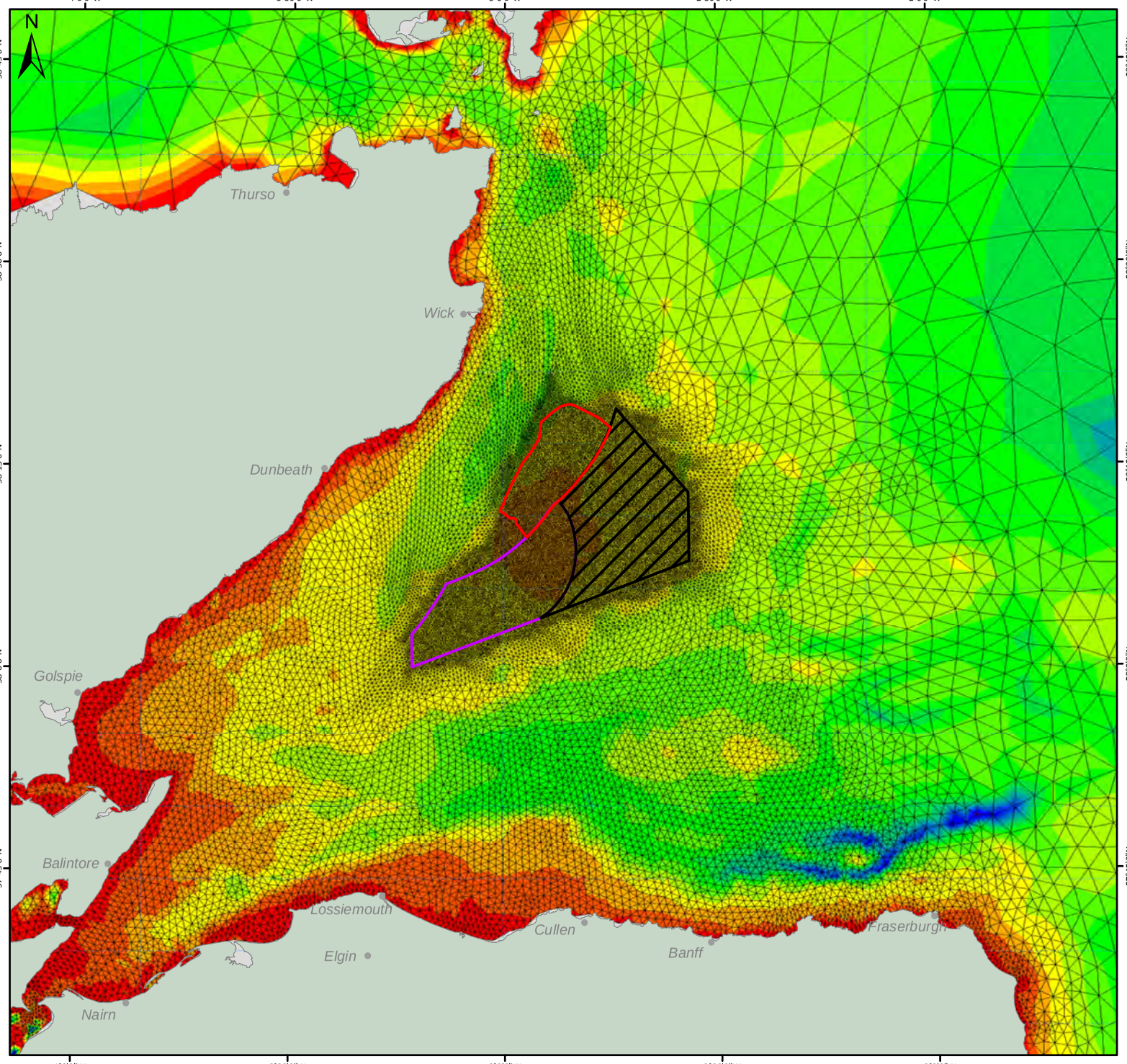
CMACS Ltd has been commissioned by BOWL to assess potential effects of the proposed Beatrice Offshore Wind Farm on benthic communities. EMU Ltd has been commissioned by MORL to undertake the respective assessment. This is clearly a topic area where both specialist consultancies would liaise to ensure a consistent approach to the respective wind farm assessments and the cumulative impact assessment.

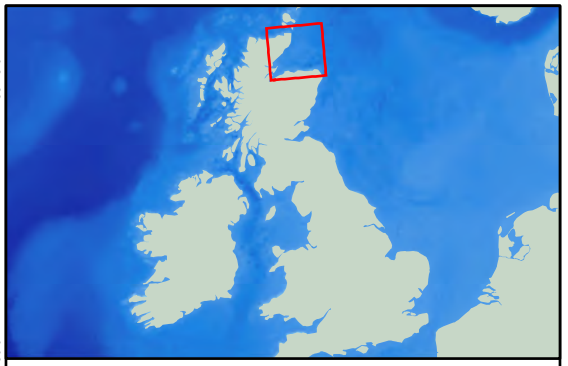
4.3.2 Guidance Documents

The methods outlined by King *et al.* (2000) (1) for cumulative impact assessment on birds were identified by Blythe Skyrme (2010) (2) to be generally of use for cumulative impact assessment of fisheries. They appear likely also to be broadly applicable for benthic ecology and will be used as appropriate. As suggested for many subject areas within the above studies, most or all of the impacts anticipated here (see Section 4.3.5) are likely to be assessable using simple additive effects. Other guidance documents to standardise data gathering and assessment methodologies across the developments include the following:

- Cefas, 2004. Offshore Wind Farms: Guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements, Version 2, June 2004 (3);
- Cefas, 2010. Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA Licence Conditions (4);
- IEEM (2010). Guidelines for Ecological Impact Assessment in Britain and Ireland. Marine and Coastal (5); and
- Boyd, S.E. (compiler) (2002) Guidelines for the conduct of benthic studies at aggregate dredging sites. U.K. Department for Transport, Local Government and the Regions, London and Cefas, Lowestoft.

(1)King, S., Maclean, I., Norman, T. and A. Prior, 2009. Developing guidance on ornithological cumulative impact assessment for offshore wind farm developers. COWRIE Ltd.
(2)Rob Blyth-Skyrme, Ichthys Marine Ecological Consulting Ltd, 2010. Developing guidance on fisheries cumulative impact assessment for wind farm developers. Available online http://www.offshorewindfarms.co.uk/Assets/Fisheries%20cumulative%20impacts%20asse
(3)Available online http://www.cefas.co.uk/publications/files/windfarm-guidance.pdf (accessed 14th January 2011).
(4)Available online http://www.cefas.co.uk/publications/miscellaneous-publications/strategic-review-of-offshore-wind-farm-monitoring-data-associated-with-fepa-licence-conditions.aspx (accessed 14th January 2011).
(5)Available online http://www.ieem.net/ecia.asp





Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Western Development Area
- MORL Eastern Development Area

Bathymetry (Metres Below Sea Level)

- Above -14
- -28 - -14
- -42 - -28
- -56 - -42
- -70 - -56
- -84 - -70
- -98 - -84
- -112 - -98
- -126 - -112
- -140 - -126
- -154 - -140
- -168 - -154
- -182 - -168
- -196 - -182
- -210 - -196
- Below -210
- Undefined Value

0 3.5 7 14 Km

0 3.5 7 14 Nm

UK Offshore Developments

Figure 4.3

Regional Detail of the Draft Tidal Model Flexible Mesh Design

Cumulative Impact Assessment Discussion Document

Drawn:	KB	Checked:	KG	Approved:	SS
Date:	18/03/2011	Size:	A4	Scale:	1:750,000
Drawing Number:	BEA_MAP_CIA_SSER_004			Revision:	03
Datum:	WGS84	Projection:	UTM Zone 30N		

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4.3.3 Baseline

Baseline benthic ecological conditions have been described within the MORL scoping study (MORL, 2010 (1)) and the pre-survey data review and gap analysis (Emu Ltd., 2010 (2)) and the BOWL scoping study (BOWL, 2010 (3)) and pre-survey method statement (CMACS, 2010 (4)) as summarised below. Benthic surveys have been completed for the BOWL site and the MORL Eastern Development Area. Survey data for the MORL and BOWL export cable routes is expected to be collected during 2011. Initial collaboration between the BOWL and MORL specialist advisors was undertaken to ensure that data collection techniques would be compatible and that a consistent approach to site characterisation across both developments would be achieved.

Water depths throughout the Moray Firth are less than 80 m with shallowest areas occurring over the Smith Bank. The local waters are generally well mixed throughout the year with surface and bottom temperatures fluctuating between roughly 7˚C and 12˚C during winter and summer respectively although surface temperatures may be 1-1.5˚C higher during summer months. Surface and bottom salinity levels are relatively consistent throughout the year fluctuating in the outer Firth between 34.8 and 35.0 parts per thousand.

Tidal currents across the MORL and BOWL sites reach a maximum of 2 knots during mid flood and mid ebb occasions with the principal currents aligned along a north-east / south west axis (5).

Principal seabed sediment habitat types in the outer Moray Firth are shown in Figure 4.4 and include the following:

- Circalittoral and deep circalittoral coarse sediment;
- Circalittoral fine sand or circalittoral muddy sand;
- Deep circalittoral sand;
- Deep circalittoral mud; and
- Infralittoral coarse sediment.

Local sediments comprise coarse and medium sand together with shelly gravel with occasional outcrops of rock. These support typical faunal assemblages including the urchin *Echinocyamus pusillus*, the bivalve *Tellina pygmaea*, and the polychaetes *Travisia forbesi* and *Ophelia borealis* (6).

Annelids are the dominant phylum present in terms of numbers of species represented at the Smith Bank followed by molluscs, crustaceans, and echinoderms. Epifaunal communities are characterised by sponges, the keel worm *Pomatoceros* sp., barnacles, the erect bryozoan *Flustra foliacea*, the anemone *Bolocera tuediae* and the crab *Hyas coarctatus*.

(1)MORL (2010). Developing Wind Energy in the Outer Moray Firth. Environmental Impact Assessment Scoping Report. Eastern Development Area.
(2)Moray Firth Offshore Wind Farm Zone Benthic Ecology Data Review and Gap Analysis. Report No. 10/J/1/03/1730/1043 to Moray Offshore Renewables Ltd. dated Sept 2010.
(3)ERM Ltd (2010) Beatrice Offshore Windfarm Ltd Environmental Scoping Report, 12 March 2010.
(4)CMACS Ltd (2010). Beatrice Offshore Wind Farm Benthic Characterisation Survey. Method Statement. J3151 BOWL (Benthic Survey Statement) v5.
(5)Adams, J.A. & Martin, J.H.A. (1986). The hydrography and plankton of the Moray Firth. Proceedings of the Royal Society of Edinburgh, 91B, 37-56.
(6)Talisman Energy UK Ltd. (2006). Beatrice wind farm demonstrator project. Environmental Statement. DTI Reference No. D/2875/2005.

The site specific surveys will further enhance the current understanding of the distribution of seabed sediment habitats and associated communities present to support the respective EIA processes. They have been designed to also investigate (including mapping) the degree to which coarser material, including boulders, overlie the predominantly sandy/gravelly seabed, and to describe the associated epifaunal communities.

4.3.4 Proposed Consultees

Cumulative effects methodologies relevant to the consideration of benthic ecology will be developed in consultation with the following consultees.

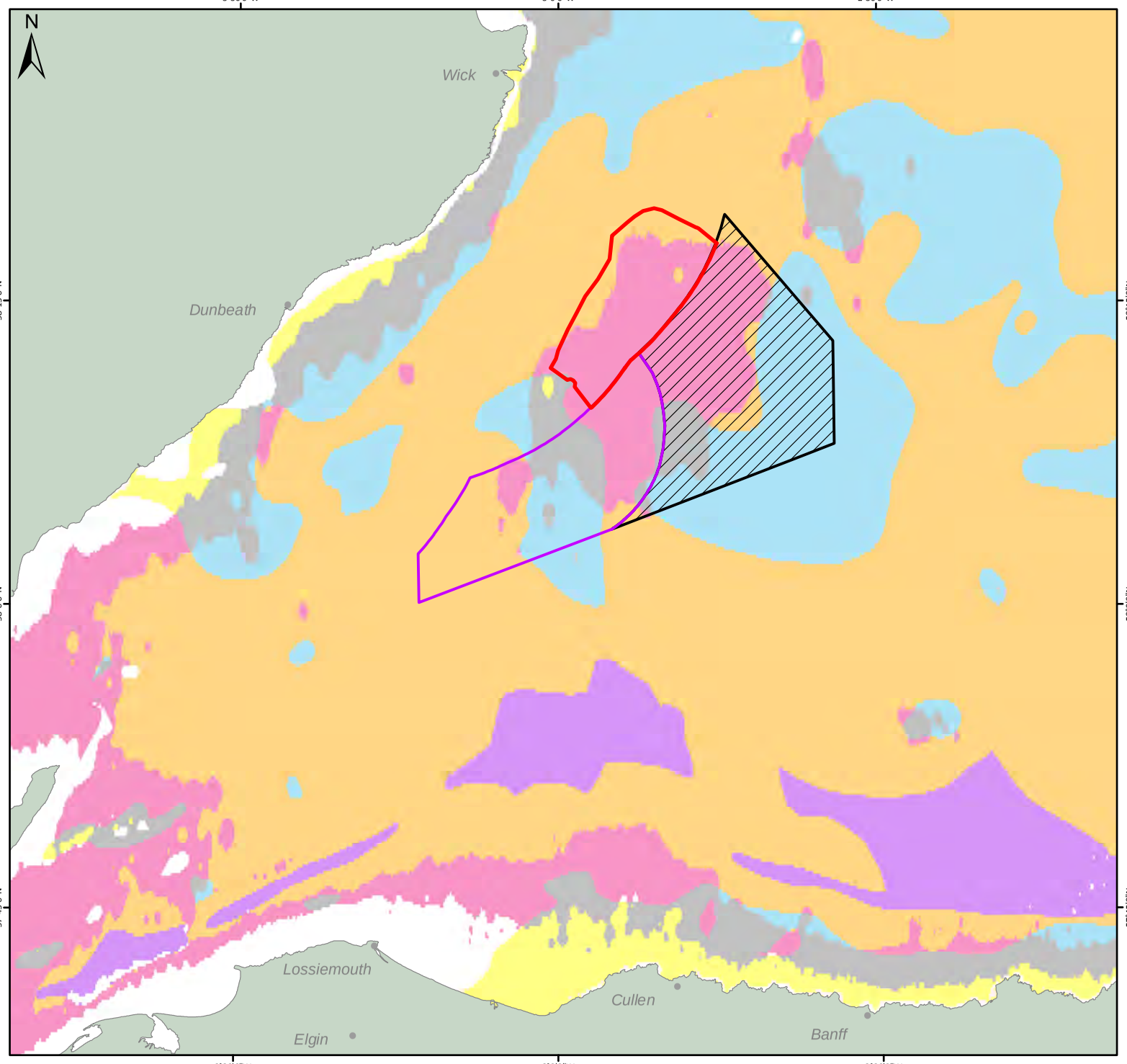
- Marine Scotland;
- SNH; and
- JNCC.

4.3.5 Potential Effects

Table 4.3.1 presents a summary of potential direct and indirect impacts of offshore wind farms on benthic ecology.

Table 4.3.1 Impact Types and Anticipated Related Effects on Benthos

Project Activity	Potential Effect
Direct – ▪ Installation of turbine foundations, ▪ Scour protection material ▪ Installation of inter-turbine cables. ▪ Placement of spud legs and/or anchors on the seabed.	▪ Permanent net reduction in the total area of original habitat as a result of the placement of the turbine and associated scour protection material on to the seabed.
	▪ Temporary seabed disturbances and effects on fauna as a result of cable laying activities. Recovery of habitat and species is forecast to occur following cessation of the disturbance.
	▪ Increase in abundance of sessile colonial species as a result of colonisation of hard structures.
Indirect - ▪ Re-distribution of fine sediments rising from construction activities ▪ Changes to hydrodynamic regime / erosion & accretion rates.	▪ Temporary fining of particulate habitats as well as smothering and scour effects on benthic fauna.
	▪ Habitat and associated community change as the result of the introduction of hard structures and subsequent colonisation by encrusting and attaching fauna.
	▪ Release and increased bio-availability of sediment contaminants and pollutants from accidental spills.



Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Western Development Area
- MORL Eastern Development Area

Predicted EUNIS Habitats

(Source: MESH Project Partners 2004-2008)

- Circalittoral coarse sediment
- Circalittoral fine sand or circalittoral muddy sand
- Deep circalittoral coarse sediment
- Deep circalittoral mud
- Deep circalittoral sand
- Infralittoral coarse sediment

0 2.5 5 10 Km 0 2.5 5 10 Nm

UK Offshore Developments

Figure 4.4

Classified MESH Habitats

Cumulative Impact Assessment Discussion Document

Drawn:	KB	Checked:	KG	Approved:	SS
Date:	18/03/2011	Size:	A4	Scale:	1:500,000
Drawing Number:	BEA_MAP_CIA_SSER_005			Revision:	03
Datum:	WGS84	Projection:	UTM Zone 30N		

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Noise and vibration associated with piling and vessel movement activities are not known to affect benthic macro-invertebrates: there is no evidence to suggest significant adverse effects on seabed invertebrate communities.

Accidental spillages of pollutants into the marine environment will be addressed within each specific EIA and mitigated through the respective construction and operational environmental management plans. It is therefore proposed that effects associated with accidental spillages into marine waters can be scoped out of the cumulative assessment.

Heating effects of cables have not been shown to be capable of noticeably affecting seabed communities and it is therefore proposed that this is also scoped out of the cumulative assessment.

Levels of sediment contaminants are low across the MORL and BOWL development areas suggesting no adverse effect on benthos as a result of the release contaminants arising from construction activities. It is therefore proposed that sediment contaminants are also scoped out of the cumulative assessment process although site specific concerns for the BOWL development cannot yet be ruled out.

Do you agree that the potential release of contaminants and accidental spillages can be scoped out of the cumulative impact assessment?

4.3.6 Study Area

There needs to be an agreement with the regulators on the spatial limits to be included within the CIA. MFOWDG's preliminary suggestion for benthic ecology spatial limit is the whole Moray Firth but this is likely to be refined following review of the results of the assessment of potential cumulative effects on sediment and coastal processes.

There is clearly a close tie between benthic ecology and sediments. Given this, much of the assessment of wider effects on sediments will be taken from the physical processes assessment. This benthic assessment will subsequently assess the effects of any identified potential changes to sediments upon the benthic ecology.

Do you have any comments on the proposed study area?

4.3.7 Data Gathering

Definitely needed:

The benthic ecology surveys for both developments have been undertaken following Cefas Guidelines (Cefas, 2004 (1)) and guidelines to the aggregate industry (Boyd *et al.*, 2002 (2)). Geophysical survey data and the findings of the gap analyses were used to underpin a series

(1)Cefas (2004). Offshore wind farms. Guidance note for environmental impact assessment in respect to FEPA and CPA requirements. V2 June 2004. Prepared by Cefas on behalf of MCEU.
(2)Boyd, S.E. (compiler) (2002) Guidelines for the conduct of benthic studies at aggregate dredging sites. U.K. Department for Transport, Local Government and the Regions, London and Cefas, Lowestoft.

of impact hypotheses and to inform the survey arrays. Field sampling methods, final survey design and sample treatments have been agreed with Marine Scotland.

The surveys for the BOWL site and the MORL Eastern Development Area were undertaken in October 2010 with the exception of BOWL beam trawl surveys which were carried out in November 2010 along with a very small amount of additional camera survey. The survey locations are illustrated on Figure 4.5.

Community structure will be investigated using industry standard statistical multivariate routines (PRIMER v6.0). Biological relationships with the physical environment and processes will be assessed to help explain the key physical influences on seabed communities. The intention is for each MFOWDG developer to share benthic datasets for the purposes of the cumulative assessment.

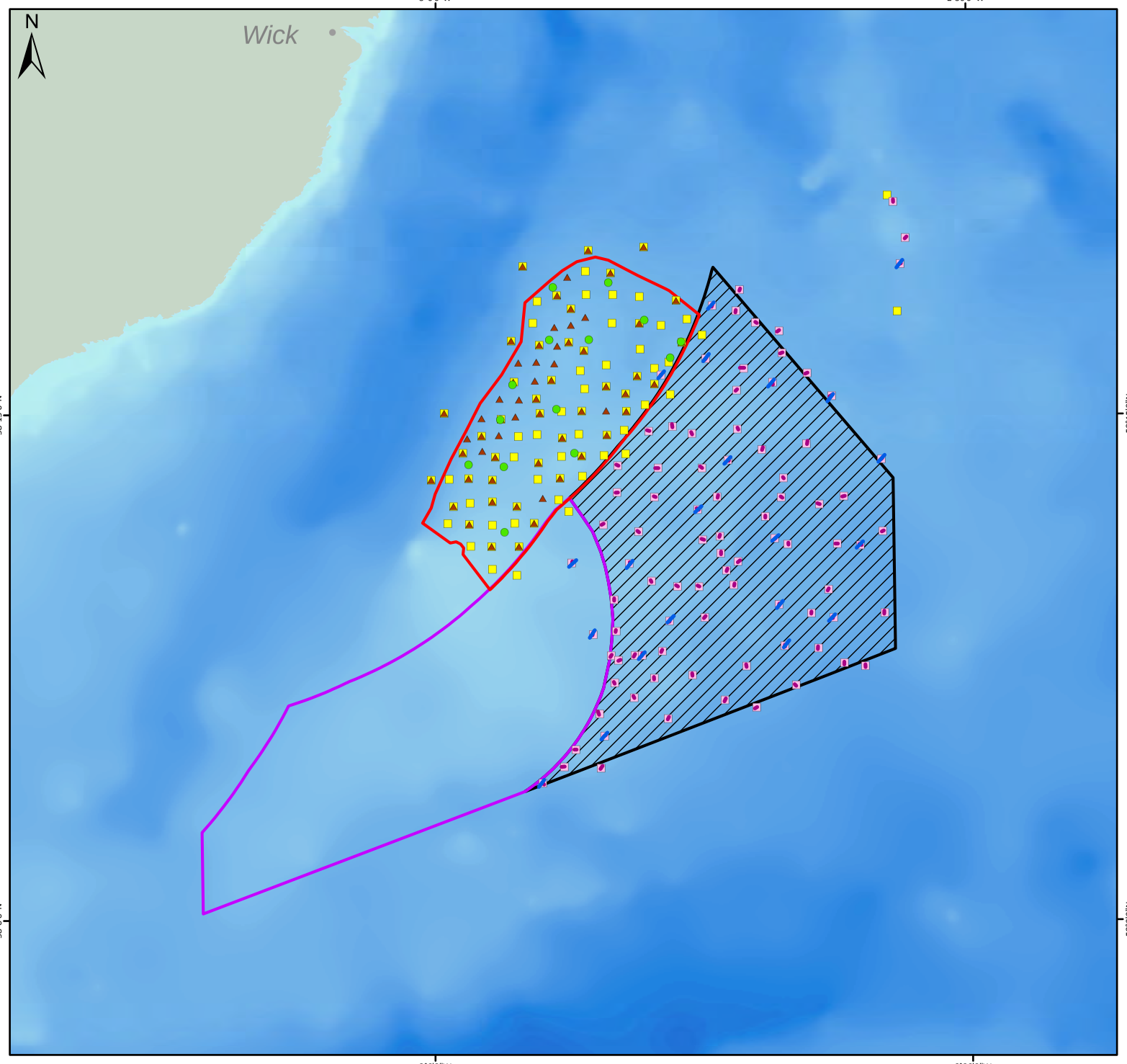
It is anticipated that a key data output from this process will be the distribution and extents of classified biotopes. Developers will liaise closely on standardising classification and mapping techniques to ensure a consistent approach for cumulative assessment (see Section 4.3.8).

The broad location and scale of each of the main seabed communities identified in all of the proposed development areas and, if possible, the surrounding areas will be described. It will be determined at an early stage whether each of the specialist advisors will be describing the seabed in similar or compatible terms (e.g. biotopes or Eunis codes). Initial discussions have now suggested that biotopes are the preferred method (see Section 4.3.8).

The area of each seabed community that is likely to be impacted will need to be estimated for each development. The main impacts are likely to be: a) permanent loss to turbine foundations and scour protection; and b) disturbance due to installation activities such as anchoring or cable laying.

Possibly needed:

Depending upon what is found in the site specific surveys: distribution of important, rare, or sensitive species (if not already covered adequately by assessment at the community level; for example, biogenic reef forming species such as *Sabellaria spinulosa* or *Modiolus modiolus*, if present in significant amounts, can be expected to be adequately assessed at the biotope level). No evidence of biogenic reef forming organisms has so far been found during the BOWL or MORL surveys.



Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Western Development Area
- MORL Eastern Development Area
- BOWLTrawl Sites
- BOWL Camera Sites
- BOWL Grab Sites
- MORL Grab Sites
- MORL Trawl Sites
- MORL Camera Sites

Bathymetry

(Metres Below Sea Level)

0m

-220m

0 1.5 3 6 Km 0 1.5 3 6 Nm

UK Offshore Developments

Figure 4.5

Benthic Survey Locations

Cumulative Impact Assessment Discussion Document

Drawn:	KB	Checked:	KG	Approved:	SS
Date:	23/03/2011	Size:	A4	Scale:	1:300,000
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Datum:	WGS84	Projection:	UTM Zone 30N		

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If any significant wider effects upon sediments are identified by the coastal processes assessment then these will also be taken into account, hence coastal processes assessment may be needed to feed into this assessment. The likely colonisation potential of the proposed turbine foundations and substructure and any scour protection features would be valuable. Some insight into this is provided by Picken (1986) (1) who investigated fouling organisms on artificial structures within the Moray Firth including structures at the Beatrice Field. Picken described a rich and diverse community comprising 33 species of algae, barnacles, hydroids, tubeworms and ascidians and provides an account of the succession of the different groups of encrusting and attaching species. These studies are useful as they provide opportunity to predict the rate and nature of colonisation of monopiles and other structures by fouling organisms at the wind farm sites.

Data from the wider area that would be required from literature search – seabed communities in the wider Moray Firth, principally from Hartley and Bishop (1986) (2) and from any more recent Beatrice oil-field related studies; SEA studies DTI (2004), SAC related surveys (SNH) and the STW SEA (3) .

Data from the commercial fisheries specialists on the levels and the nature of fishing activity in the area will also be used.

Table 4.3.2 Ecological Survey Requirements

Survey Requirement	Implementation
0.1m^2 grab sampling	Acquisition of quantitative data for sediment particle size and biological analyses
2 m scientific beam trawl	Collection of semi-quantitative data for assessment of sessile and mobile megafaunal assemblages.
Drop down video	Assessment of hard seabed substrates or sensitive features where grab sampling is inappropriate.
0.04m^2 Shipek sampling or 0.1m^2 Hamon grab sampling	Collection of surface seabed sediment samples for contaminants analyses

Are you aware of any additional data sources that should be considered in the assessment?

4.3.8 Assessment Methodology

Biotope and Habitat Maps

Biotopes will be the principal biological unit for assessment of predicted cumulative effects. Considerable species and biotope level sensitivity information exist on the MarLin website and this will be a principal data source underpinning cumulative effects assessment.

Biotopes will be defined from a synthesis of the physical and biological data and comparison with the UK Marine Habitat Classification system (Connor *et al.,* 2004) (4). Classified biotopes,

(1)Picken, G.B. (1986). Moray Firth marine fouling communities. Proceedings of the Royal Society of Edinburgh, 91B, 213-220.
(2)Hartley, J.P. and Bishop, J.D.D. 1986. The macrobenthos of the Beatrice Oilfield, Moray Firth. Scotland. Proceedings of the Royal Society of Edinburgh.
(3)Strategic Environmental Assessment (SEA) of the Draft Plan for Offshore Wind Energy in Scottish Territorial Waters, Scottish Government 2010
(4)Connor, D.W. Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O. & Reker, J.B., (2004). The Marine Habitat Classification for Britain and Ireland. Version 04.05. [On-line] Peterborough: Joint Nature Conservation Committee.

including infaunal and overlying epifaunal biotopes, will be mapped within a GIS with the extents of the boundaries interpolated using available acoustic data drawn from the geophysical surveys. There will be considerable liaison between the MORL and BOWL specialist advisors to ensure consistent approach to biotope classification and mapping. It has been agreed that a single biotope map will be produced covering the MORL and BOWL developments.

To assist standardisation of the final biotope classifications between developers it is proposed to investigate the possible use of the MEPF ALSF 'Bioscribe' tool (Hooper *et al*., 2011) (1). The advantage of this tool is that it will remove any subjectivity from the classification process enabling a standard and confident approach to biotope identification across both developments.

Project Details

The project details including specifications for the proposed installed infrastructure will be available at the initial EIA stage to inform each site specific assessment. It is proposed that developers will share design project details to inform the cumulative assessment.

Overall, the developments to be considered in the cumulative impact assessment are expected to be as the following;

- BOWL generating station;
- MORL Eastern Development area;
- MORL Western Development area;
- BOWL OFTO cable;
- MORL OFTO cable;
- Proposed SHETL cable;
- Proposed SHETL hub;
- Any relevant port and harbour developments in the Moray Firth;
- Relevant oil and gas activites;
- Dredging and sea disposal in the Moray Firth; and
- Commercial fisheries.

Assessing the Potential Effects of Direct Impacts

The overall extent of direct cumulative impacts will be quantified on the basis of the project design specifications and proposed installed infrastructure. This quantifiable footprint will then be used to determine the total area of habitat lost or temporarily disturbed and assessed within the context of the wider habitat availability. Only those habitats or biotopes common to both BOWL and MORL sites will be taken forward for cumulative assessment.

(1) Hooper, G.J., Barfield, P.D., Thomas N.S. and Capasso, E. Redefining biotopes at a regional scale and development of a Biotope matching decision support tool. First published 2011. Published by the MALSF. Emu Ltd Report No. 11/J/1/03/1552/1103.

Assessing the Potential for Indirect Effects

Outputs of the predictive modelling from the sediment and coastal processes assessment will be used to identify those areas that are likely to be affected by indirect effects. These include areas predicted to be influenced by the re-distribution of disturbed sediments or predicted to be affected in terms of changes to sediment processes. These areas will be quantified and mapped within a GIS with those benthic ecological features encompassed therein taken forward for cumulative impact assessment.

The developers will collaborate as to their understanding of the extents of indirect effects and sharing of model and GIS mapping outputs.

Assessing the Potential Impact of Colonisation

Historic studies have already characterised the rate and succession of colonisation of hard structures by biofouling organisms within the locale. The sensitivity of local biotopes to similar colonisation of infrastructure by these biofouling communities will be assessed.

Table 4.3.3 Summary of Benthic Ecology Methods and Activities Agreed Between Developers

Method/Activity	Status
Benthic survey	Comparable methods to be used for field data acquisition. Data to be shared between developers. Use of the same reference area.
Biotope and habitat mapping	Collaborative mapping exercise for the purposes of the cumulative assessment and using the ALSF database tool to standardise classification across developments.
Assessment of direct effects	Developers to share project design specifications to inform the assessment.
Assessment of indirect effects	Developers to share results of the sediment processes assessment and model outputs.
Assessment of potential colonisation	Developers to share project design specifications to inform the assessment.

Do you have any comments on the proposed assessment methodology?

4.3.9 Presentation of Results

Each identified cumulative effect will be described and assessed within the ES for each site. Standard IEEM guidelines will be used to determine impact significance and certainty criteria in collaboration with MFOWDG, Marine Scotland, SNH and JNCC.

Receptors will be assessed in terms of their tolerance and recoverability to each impact type using data drawn from MarLIN as well as previous experience from other industries, such as the aggregates industry, to further enhance the EIA.

4.4 Fish and Shellfish Ecology

4.4.1 Specialist Advisor

Both MORL and BOWL have commissioned the services of Brown and May Marine Ltd. to undertake the fish ecology impact assessments.

4.4.2 Guidance Documents

Guidance specific to fish ecology CIA is not currently available. As is suggested in the benthic ecology section (see Section 4.3), the methods described in King *et al.,* (2009) for birds will be adapted and broadly used for fish ecology, providing a form of general guidance. It is recommended, however, that in the absence of specific guidance, the final approach and methodology be agreed with Marine Scotland Science.

4.4.3 Designated Sites Relevant to Cumulative Impact Assessment

As described in section 4.1 above, the development of the MORL and BOWL sites have the potential to cumulatively impact upon the integrity and conservation objectives of two Special Areas of Conservation. Details of these Natura 2000 sites are provided below in Table 4.4.1.

Table 4.4.1 Designated Sites Relevant to Marine Mammal Cumulative Assessment

SAC	Qualifying Species Relevant to the Assessment
Berriedale & Langwell Waters	Salmon
River Oykel	Salmon and freshwater pearl mussel
River Evelix	Freshwater pearl mussel
Spey River	Salmon, sea lamprey and freshwater pearl mussel

Under the European Habitats Directive, any 'plan or project' that has the potential to adversely affect the conservation objectives of a Natura 2000 site will be subject to an Appropriate Assessment that is carried out by the Competent Authority (in this case Marine Scotland). Both MORL and BOWL are collecting baseline data to inform an Appropriate Assessment for migratory fish species and associated species as part of the cumulative impact assessment.

4.4.4 Baseline

The Moray Firth provides a suitable habitat and sustains a wide range of important fish and shellfish species, both ecologically and commercially in a local and national context.

Migratory fish and species of conservation importance (salmon, sea trout, eels, sea and river lamprey) could potentially transit the area and in some cases use it as a feeding ground.

It should be noted the importance of the sandeel populations in the area, as they are a key prey item, not only for fish species but also for birds and marine mammals. In addition, as shown in Table 4.4.2, the Moray Firth is considered an area of high intensity in terms of spawning for this species (Ellis *et al.*, 2010).

Similarly, the potential for impacts on spawning herring in the grounds to the north of the BOWL and MORL sites, will be considered, given the high sensitivity of this species to noise, and the fact that herring depend on the presence of an adequate substrate (preferably coarse gravel) on which to spawn.

The Moray Firth is also known to be used by a number of species as a spawning and / or a nursery ground. The species using the area for these purposes are listed in Table 4.4.2 below. This includes spawning times (Coull *et al*., 1998) and intensity of spawning/nursery activity (Ellis *et al.*, 2010). The spawning grounds of some of these species are illustrated in Figure 4.6.

Table 4.4.2 Species with Spawning and Nursery Grounds in the Moray Firth

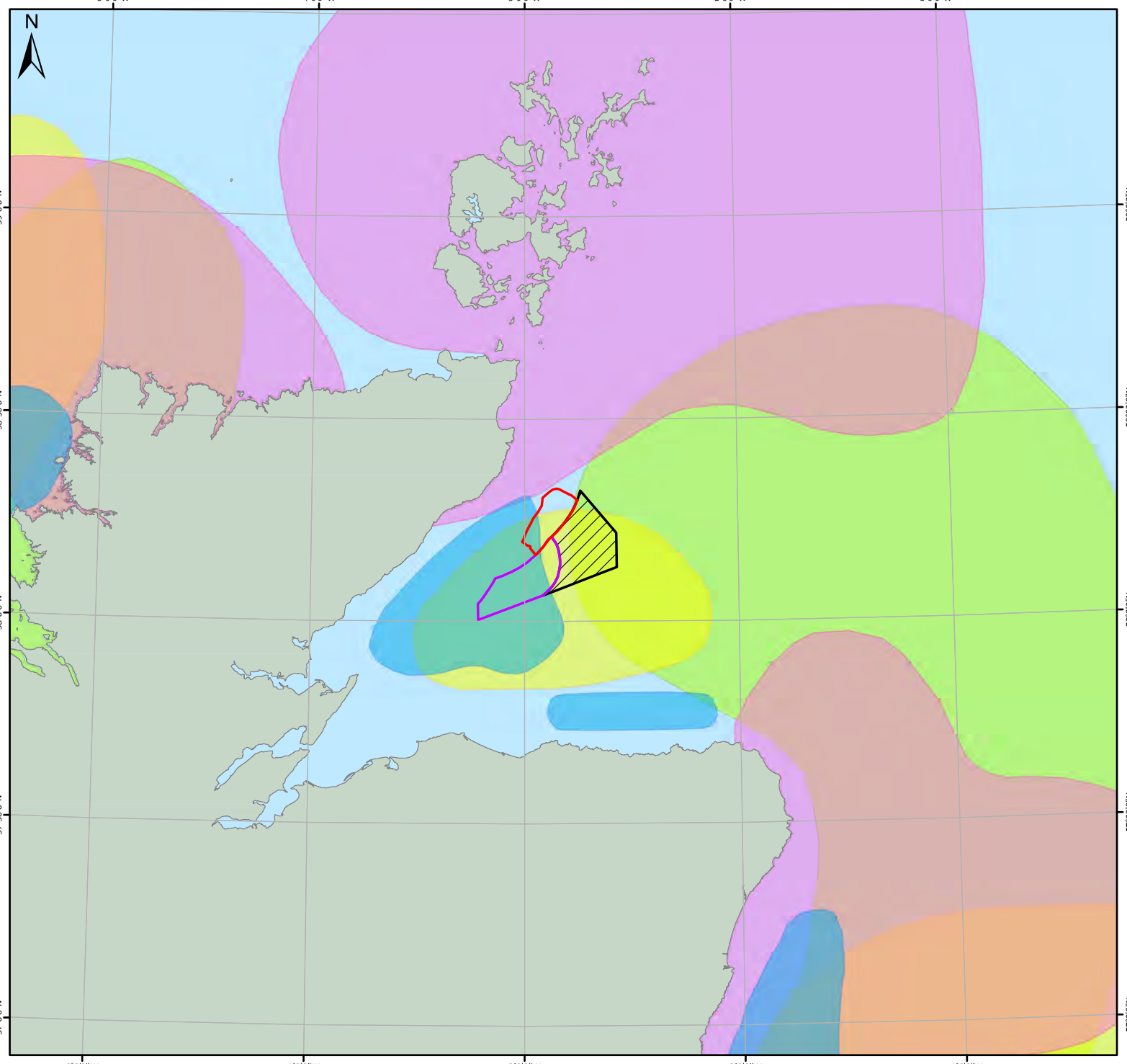
Species	Spawning Area												Nursery Area
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Plaice	*	*											
Sandeels													
Whiting													
Cod		*	*										
Herring													
Nephrops				*	*	*							
Lemon Sole													
Sprat					*	*							
Spotted Ray	n/a												
Thornback Ray	n/a												
Spurdog	n/a												
Blue Whiting	n/a												
Ling	n/a												
Hake	n/a												
Anglerfish	n/a												
Mackerel	n/a												
Haddock	n/a												
Saithe	n/a												

Source: Coull *et al*., 1998 and Ellis *et al*., 2010
(red=high intensity; green=low intensity; orange: undefined intensity;(*)=peak spawning)

An indication of the relative abundance and importance of the principal commercial species in the Moray Firth, based on landings values by weight (tonnes) from the ICES rectangle where the Beatrice Offshore Wind Farm and the Moray Firth Round 3 zone are located (45E6 & 45E7) is provided in Table 4.4 3 below.

Table 4.4.3 Annual Landings by Weight (tonnes) from ICES Rectangle 45E6 & 45E7

Species Group	Annual Landings by Weight (tonnes) (average 2000-2009)	Species	Annual Landings by Weight (tonnes) (average 2000-2009)
Shellfish	1297.0	Scallops	809.8
		Edible Crab	178.9
		Nephrops	127.9
		Whelks	55.5
		Squid	53.3
		Velvet Crab	45.9
		Lobsters	19.7
		Other	5.9
Bony Fish (Teleosts)	491.3	Haddock	318.4
		Monks or Anglers	50.0
		Herring	44.3
		Whiting	19.8
		Cod	15.4
		Megrim	9.3
		Horse Mackerel	8.2
		Plaice	8.0
		Other	17.9
Elasmobranches	5.3	Spurdog	2.7
		Skates and Rays	2.3
		Portuguese Dogfish	0.1
		Other	0.2
Other	2.7	Other or mixed Demersal	2.4
		Roes	0.4



Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Eastern Development Area
- MORL Western Development Area
- ICES Rectangles (DIFRES, 2010)

Spawning Grounds (Coull et al,1998)

- Plaice
- Herring
- Cod
- Whiting

0 10 20 40 Km

0 5 10 20 Nm

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Figure 4.6

Spawning Grounds of Herring, Plaice, Cod and Whiting
Cumulative Impact Assessment Discussion Document

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Date:	18/03/2011	Size:	A4	Scale:	1:1,500,000
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Datum:	WGS84	Projection:	UTM Zone 30N		

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4.4.5 Proposed Consultees

The following organisations will be consulted to seek agreement of species to be assessed, identification of key grounds, definition of populations and distributions and likely sources of cumulative impact:

- Marine Scotland;
- SNH;
- JNCC; and
- District Salmon Fishery Boards and Trusts.

4.4.6 Potential Effects

The principal potential effects to be considered from a cumulative point of view are as follows:

- Disturbance to spawning activity and juveniles (nursery areas);
- Barrier to/ change in migratory patterns;
- Behavioural changes derived from EMFs associated to cables;
- Changes in species composition and displacement of fish and shellfish resource;
- Direct impact during construction;
- Temporary and permanent loss of habitat; and
- Changes in prey availability and displacement of food resource.

4.4.7 Study Area

There needs to be an agreement with the regulators on the spatial limits to be included within the cumulative impact assessment. MFOWDG's preliminary suggestion for fish ecology spatial limit is the whole Moray Firth but this is likely to be refined following review of the results of the impact assessment.

A summary of the potential spatial extent of key impacts for the principal species groups and individual species likely to require assessment from a cumulative point of view is given in Table 4.4.4 below.

It should be noted that the potential spatial extent of cumulative impact will in many cases vary depending on species specific sensitivities, location of spawning/nursery/feeding grounds, species specific lifecycles, etc. In addition, at this early stage, with baseline and impact assessments for the individual MORL and BOWL sites yet to be completed, the information provided below should only be taken as a rough guide to the potential spatial extent of impacts.

Table 4.4.4 Predicted Potential Spatial Extent of Cumulative Impact

Receptor	Potential Impacts	Potential Sources: Construction/Operation	Potential Spatial Extent of Impact
Salmon and Sea trout	Disturbance/barrier to migration	EMFs	Regional (East and North coast of Scotland)
		Construction noise and vibration (piling)	
		Physical presence of turbines	
	Temporary and permanent change in prey availability/loss disturbance of feeding grounds	Construction noise and vibration (piling)	
		Changes in habitat/substrate	
		EMFs	
		Increased sediment concentrations/sediment deposition	
Herring	Disturbance during spawning	Construction noise and vibration (piling)	Regional (Buchan/Shetland sub-stock)
		Increased sediment concentrations	
		Changes in substrate/loss of spawning area	
Sandeels	Temporary loss of habitat	Direct Impact (e.g. jack up legs)	Moray Firth
	Permanent loss of habitat	Changes in habitat/substrate	
	Disturbance to spawning	Construction noise and vibration (piling)	
		Increased sediment concentrations/sediment deposition	
Shellfish species	Permanent or temporary loss of habitat/displacement	Construction noise and vibration (piling)	Moray Firth
		Increased sediment concentrations/sediment deposition	
		Changes in substrate	
		EMFs (little evidence for most species)	
		Direct impact (e.g. jack up legs)	
	Changes in larval dispersion and spat settlement?	Presence of turbines (changes in hydrodynamic regime, coastal processes?)	
Elasmobranches	Behavioural impacts: effects on migration? feeding?	EMFs	Moray Firth
Other migratory species and species of conservation importance	Disturbance/barrier to migration? Permanent or temporary loss of feeding grounds, nursery areas?	Construction noise and vibration (piling)	Moray Firth
		EMFs	

Receptor	Potential Impacts	Potential Sources: Construction/Operation	Potential Spatial Extent of Impact
Other species with spawning grounds	Disturbance during spawning	Construction noise and vibration (piling)	Moray Firth
		Increased sediment concentrations/deposition of sediment	
Species with nursery grounds	Disturbance, temporary/permanent loss of nursery area	Increased sediment concentrations/sediment deposition	Moray Firth
		Noise and vibration (piling)	

4.4.8 Data Gathering

The principal data and information used to assess potential cumulative impacts on the fish ecology will be the same as those required for the site specific impact assessments. These can be summarised as follows:

- MMO Fisheries Statistics: landings by value and weight;
- Review of the ecology, distribution and importance of the principal fish and shellfish species;
- Review of the species potentially using the area as a spawning/nursery ground, feeding ground and overwintering area. Assessment of the importance of the grounds and the potential for equally suitable grounds to be accessible to these species;
- Review of potential routes and behaviour of migratory species;
- Review of data and results from fish and shellfish surveys undertaken in the area, including adult and juvenile fish surveys, larval and egg surveys, etc;
- The benthic ecology baseline and impact assessments;
- The commercial fisheries baseline and impact assessments; and
- The results of the noise modelling.

In addition to the information detailed above, the results of any site specific surveys that may be undertaken by MORL and BOWL (e.g. benthic surveys, commercial fisheries observer trips, etc) will be reviewed.

Depending on the species and the specific effect under consideration, information may be needed from additional developers as well as MORL and BOWL. As explained in Section 4.4.6, the study area under consideration will vary depending on a number of factors. The number of additional developments which may have to be considered in the cumulative impact assessment is dependent on the scale of the study area defined for each potential effect and/or species sensitivity.

Are you aware of any additional data sources that should be considered in the assessment?

4.4.9 Assessment Methodology

The different construction / decommissioning and operation schedules of development projects with potential to result in a cumulative effect will greatly affect the assessment of cumulative

impacts. Depending on these, cumulative impacts could occur on a spatial or on temporal scale. On a spatial scale, impacts could occur where different developments are being constructed at the same time, causing a cumulative impact upon the fish and shellfish ecology in terms of the extent of the area and the fish and shellfish resource being simultaneously disturbed; temporal cumulative effects could occur with the construction of different developments taking place in successive years, on the basis of the continuous extent of time that fish and shellfish species are being disturbed.

The basis of the assessment process is anticipated to include the following:

- Identification of activities / developments potentially resulting in a cumulative effect upon each receptor;
- Identification of the aspects of each activity/development that may result in an effect (e.g. underwater noise) upon each receptor (e.g. migratory species, spawning herring, etc);
- Definition of the extension of cumulative impact study areas for each effect on a receptor specific basis; and
- Review of site specific and cumulative impact assessment is undertaken for each activity / development, where available.

The developments to be considered in the cumulative impact assessment are expected to be as follows:

- BOWL generating station;
- MORL Eastern Development area;
- MORL Western Development area;
- BOWL OFTO cable;
- MORL OFTO cable;
- Proposed SHETL cable;
- Proposed SHETL offshore hub;
- Any relevant port and harbour developments in the Moray Firth;
- Relevant oil and gas activities;
- Dredging and sea disposal in the Moray Firth;
- Commercial fisheries;
- Marine energy development in the Pentland Firth and Orkney waters; and
- Relevant military activities.

4.4.10 Data Analysis and Standardised Assessment of Effects in EIA

For the potential cumulative effects be addressed and assessed it will be required that standard procedures on information gathering, data analysis (e.g. noise modelling) and survey methodologies (e.g. gear used) be implemented by the developers.

Site specific impact assessments carried out for BOWL and MORL will, where possible, be integrated to facilitate the assessment of cumulative effects by each developer. In order to enable this, MORL and BOWL will be required to do the following:

- Take a common, standardised approach to assessing the effects of the projects in the EIA; and
- Share project information and programmes as such information becomes available.

Do you have any comments on the proposed assessment methodology?

4.4.11 Presentation of Results

The presentation of findings will be standardised for the MORL and BOWL projects in order to facilitate assessment of cumulative effects. Cumulative effects will be considered using standardised impact assessment criteria, which will be agreed by the MORL and BOWL project teams, and in consultation with Marine Scotland.

4.5 Marine Mammals

4.5.1 Specialist Advisor

BOWL and MORL are working closely with each other and specialist groups such as the University of Aberdeen (Lighthouse Field Station) and SMRU, in order to ensure a consistent approach to the impact assessments for marine mammals. BOWL and MORL are working with University of Aberdeen and SMRU Ltd on wider research in the Moray Firth in order to fill data gaps. The details of this work are described below in Section 4.5.8.

Natural Power has been commissioned by MORL to work with the University of Aberdeen and SMRU Ltd in assessing the impact of the proposed development at the MORL Round 3 Zone on marine mammals, and to produce the marine mammal chapter of their EIA. BOWL is yet to appoint a consultant for this role.

Liaison with those groups carrying out assessments at neighbouring sites, e.g. the FTOWDG and the wave and tidal developers within the Pentland Firth and Orkney waters will also be crucial.

4.5.2 Guidance Documents

The methods outlined by King *et al*., (2009) (1) for cumulative impact assessment on birds are of general use for cumulative impact assessment as are the IEEM guidelines (2). MFOWDG are also aware that Marine Scotland is currently drafting guidance on European Protected Species within Scottish Territorial Waters with input from SNH. Similarly, JNCC are currently preparing guidance applicable to Round 3 Zones (3). All four guidance documents will be used as appropriate.

(1)King, S., Maclean, I.M.D., Norman, T. and Prior, A. 2009. Developing guidance on ornithological cumulative impact assessment for offshore wind farm developers. COWRIE.
(2)Guidelines for ecological impact assessment in Britain and Ireland. Marine and coastal. IEEM 2010.
(3)The protection of marine European Protected Species from injury and disturbance: Guidance for the marine area in England and Wales and the UK offshore marine area. DRAFT report by the Joint Nature Conservation Committee, Natural England and Countryside Council for Wales. October 2010.

4.5.3 Designated Sites Relevant to Cumulative Impact Assessment

As described in section 4.1 above, the development of the MORL and BOWL sites have the potential to cumulatively impact upon the integrity and conservation objectives of two Special Areas of Conservation. Details of these Natura 2000 sites are provided below in Table 4.5.1.

Table 4.5.1 Designated Sites Relevant to Marine Mammal Cumulative Assessment

SAC	Qualifying Species Relevant to the Assessment
Inner Moray Firth	Bottlenose dolphin
Dornoch Firth and Morrich More	Common/harbour seal and otter

Under the European Habitats Directive, any 'plan or project' that has the potential to adversely affect the conservation objectives of a Natura 2000 site will be subject to an Appropriate Assessment that is carried out by the Competent Authority (in this case Marine Scotland). Both MORL and BOWL are collecting baseline data to inform an Appropriate Assessment upon bottlenose dolphin and common / harbour seal as part of the cumulative impact assessment.

4.5.4 Baseline

The Moray Firth is home to two resident cetacean species (harbour porpoise and bottlenose dolphin), one species which is seasonally abundant (minke whale), and a further ten or so species which occur on a less predictable basis (1). Of these ten species, some (common dolphin, white-beaked dolphin, Risso's dolphin) are sighted in the Moray Firth more often than others (white-sided dolphin, killer whale, long-finned pilot whale, humpback whale, fin whale, sperm whale, northern bottlenose whale). As detailed above, the Inner Moray Firth has been designated as an SAC for bottlenose dolphins. Generalisations can be made about the distribution patterns of the three key cetacean species:

- Harbour porpoises are the most commonly encountered species, being seen throughout inshore and offshore waters of the Moray Firth;
- Minke whales are the second most commonly sighted species in offshore waters, although there is some evidence that this may be a relatively recent situation; and
- Almost all bottlenose dolphin sightings occur within 15 km of the coast within the Inner Moray Firth SAC or in the coastal strip along the southern Moray Firth coast. Most sightings of dolphins in the offshore waters of the outer Moray Firth are common, white-beaked or Risso's dolphins.

Two pinniped species are resident in the Moray Firth (grey and common/harbour seals). Grey seals haul out at intertidal sites between foraging trips and breed on beaches (or in caves) above the high water mark along the Helmsdale coastline in autumn. Common/harbour seals use intertidal haul out sites to rest between foraging trips, breed (June / July) and moult (August / September). Part of the Dornoch Firth has been designated as an SAC for common/harbour seals.

(1)Reid, J.B., Evans, P.G.H. and Northridge, S.P. 2003. Atlas of cetacean distribution in north-west European waters. JNCC. 76 pp.

4.5.5 Proposed Consultees

It is proposed that the following organisations will be consulted during the scope refinement and ongoing cumulative impact assessment:

- Marine Scotland;
- SNH;
- JNCC;
- Whale and Dolphin Conservation Society (WDCS); and
- Ministry of Defence.

4.5.6 Potential Effects

The following are perceived to be the main potential impacts on marine mammals as a result of wind farms in the marine environment:

- Disturbance and potential displacement as a result of elevated construction and operational noise;
- Increased collision risk due to construction and maintenance traffic;
- Reduction of the feeding resource due to effects on prey of noise, vibration and habitat disturbance; and
- Changes in prey availability due to infrastructure presence and changes in fishing activity.

These impacts may be site-specific, but they also have the potential to be cumulative. Long term avoidance is not considered to be a potential cumulative effect

Do you agree that long term avoidance is not likely to be a potential cumulative impact?

4.5.7 Study Area

The area over which cumulative impacts will be considered will develop during this consultation process. As well as encompassing the MORL and BOWL sites, and a suitable "buffer", it will be necessary to consider the area over which animals that use the Moray Firth range. For example, bottlenose dolphins using the Moray Firth range as far afield as the Firths of Forth and Tay, and sometimes even further afield. For harbour porpoises, all animals occurring in the North Sea may be considered as being part of one population/stock (1). As a consequence, MFOWDG propose that the initial study area extend out with the Moray Firth for these highly mobile species.

These considerations will affect which other developments need to be included within the scope of the cumulative impact assessment.

Do you have any comments on the proposed study area?

(1)Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F. and Øien, N. 2002. Abundance of harbour porpoises and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology 39: 361-376.

4.5.8 Data Gathering

Desk-based reviews have been commissioned by both BOWL and MORL to inform their respective scoping documents and approach to data gathering to establish the use of the Moray Firth by marine mammals.

As a consequence of these studies, the University of Aberdeen and SMRU Ltd have been commissioned by MFOWDG to carry out specific research to fill the data gaps which were identified. The details of the work commissioned and an interim progress report are provided in Annex B of this document. While some of the work is based solely on data collected as part of the MORL / BOWL funded studies (2010 - 2011), data collected during the Beatrice Demonstrator (2005 - 2007) and DECC (2009 - 2010) studies carried out by the University of Aberdeen are also being used. The work relates to the provision of data to facilitate the following objectives:

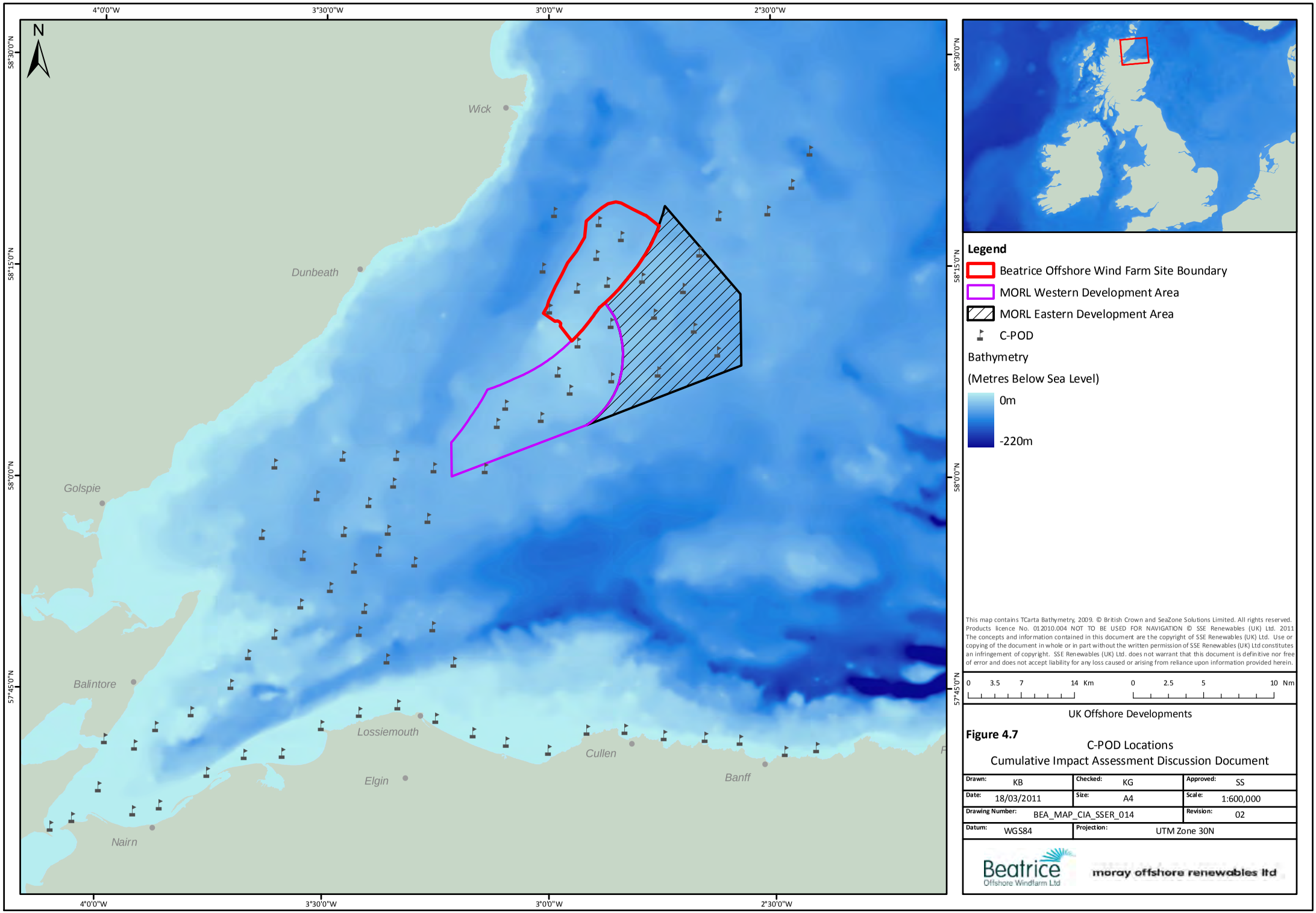
- Characterising the sites with respect to the marine mammal species present and detailing seasonality and year to year variability in occurrence;
- Assessing the density of animals at the proposed sites; and
- Assessing the likelihood of exchange between local SACs and the proposed wind farm sites.

The site characterisation objective is being met through analysis of existing University of Aberdeen data and collection of new data from passive acoustic monitoring devices (C-PODs). C-POD locations are illustrated on Figure 4.7.

The density assessment objective is being met through an intensive series of aerial line-transect surveys which were carried out by the University of Aberdeen in August and September 2010. These data will allow direct estimates of cetacean density within the BOWL and MORL sites. Use of these data in regional-scale habitat association models will allow the density of cetaceans in surrounding areas to be predicted.

Assessing the likelihood of exchange between local SACs and the proposed MORL and BOWL wind farm sites is relevant for bottlenose dolphins and common/harbour seals, both of which have local SACs as described above. SMRU/SMRU Ltd are developing a new approach using data from Ecological Acoustic Recorders (EARs) deployed at the proposed wind farm sites. The acoustic recordings made by these devices can be analysed to determine which species emitted the noise and thus the proportion of dolphin whistles across the Moray Firth that can be attributed to bottlenose dolphins vs. other dolphin species. Data collected during deployment of six EARs across the Moray Firth will be used to assess the probability that dolphins detected are bottlenose dolphins/other candidate dolphin species. This work will be complemented by an analysis of visual sightings from aerial and boat surveys.

In a separate package of works, the likelihood of exchange between the common/harbour seal SAC and the proposed wind farm sites is being assessed by SMRU Ltd using existing seal telemetry and habitat data.


4°0'0"W
3°30'0"W
3°0'0"W
2°30'0"W
58°30'0"N
58°15'0"N
58°0'0"N
57°45'0"N
N
Wick
Dunbeath
Golspie
Balintore
Lossiemouth
Elgin
Cullen
Banff
Nairn
Legend
Beatrice Offshore Wind Farm Site Boundary
MORL Western Development Area
MORL Eastern Development Area
C-POD
Bathymetry
(Metres Below Sea Level)
0m
-220m
This map contains TCarta Bathymetry, 2009. © British Crown and SeaZone Solutions Limited. All rights reserved. Products licence No. 012010.004 NOT TO BE USED FOR NAVIGATION © SSE Renewables (UK) Ltd. 2011 The concepts and information contained in this document are the copyright of SSE Renewables (UK) Ltd. Use or copying of the document in whole or in part without the written permission of SSE Renewables (UK) Ltd constitutes an infringement of copyright. SSE Renewables (UK) Ltd. does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein.
0 3.5 7 14 Km
0 2.5 5 10 Nm
UK Offshore Developments
Figure 4.7
C-POD Locations
Cumulative Impact Assessment Discussion Document
Drawn: KB
Checked: KG
Approved: SS
Date: 18/03/2011
Size: A4
Scale: 1:600,000
Drawing Number: BEA_MAP_CIA_SSER_014
Revision: 02
Datum: WGS84
Projection: UTM Zone 30N
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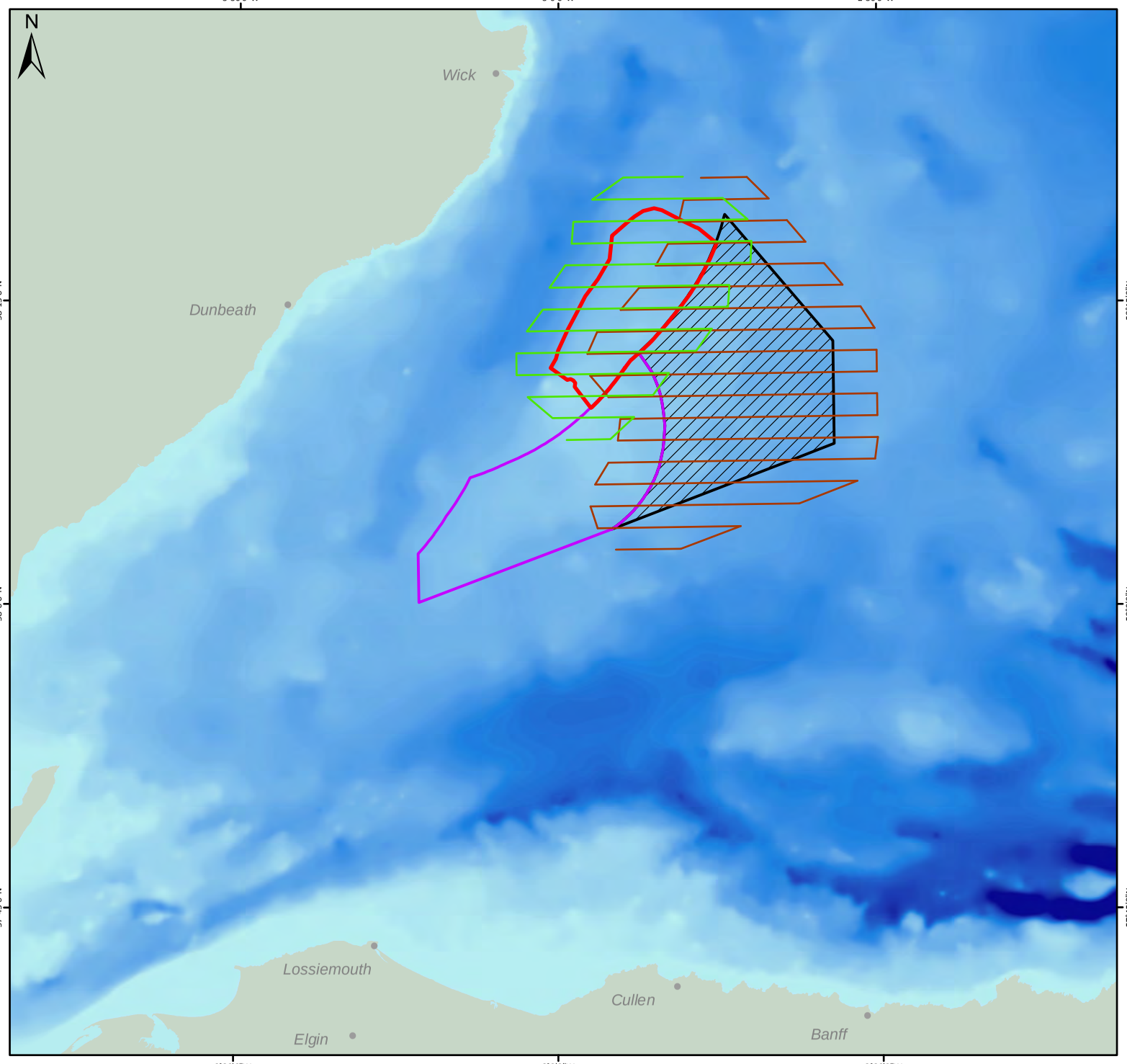
In addition to the work described above, dedicated marine mammals observers are present during boat-based surveys being carried out on a monthly basis over the BOWL and MORL development sites (plus relevant buffer zones). IECS has been commissioned to undertake the marine mammal part of surveys of the BOWL development site; Natural Power has been commissioned to do the same for the MORL Eastern Development Area sites. Surveys of the sites are being carried out separately but the data will be pooled. Transect routes are illustrated on Figure 4.8. Boat survey data from both BOWL and MORL surveys are also being integrated with available aerial survey data for the cetacean habitat association modelling being conducted by the University of Aberdeen.

An integrated approach will be taken to modelling underwater noise to assess the potential impacts of construction and operation at both the BOWL and MORL sites. Details of the modelling to be undertaken by Subacoustech can be found in Section 4.12 and Annex D. The extensive series of noise measurements made during the construction of the Beatrice Demonstrator (1) will be used in the construction and calibration of the model.

Are you aware of any additional data sources that should be considered in the assessment?

(1)Bailey, H., Senior, B., Simmons, D., Rusin, J., Picken, G. and Thompson, P.M. 2010. Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. Marine Pollution Bulletin 60: 888-897.



Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Western Development Area
- MORL Eastern Development Area
- Beatrice Marine Mammal Boat Based Survey Transect
- MORL Marine Mammal Boat Based Survey Transect

Bathymetry

(Metres Below Sea Level)

0m

-220m

0 2.5 5 10 Km 0 2.5 5 10 Nm

UK Offshore Developments

Figure 4.8

Marine Mammal Boat Based Survey Transects
Cumulative Impact Assessment Discussion Document

Drawn:	KB	Checked:	KG	Approved:	SS
Date:	18/03/2011	Size:	A4	Scale:	1:500,000
Drawing Number:	BEA_MAP_CIA_SSER_011			Revision:	03
Datum:	WGS84	Projection:	UTM Zone 30N		

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4.5.9 Assessment Methodology

The survey data and information discussed above will be shared by both BOWL and MORL.

For each of the potential impacts outlined above, the following methods of assessment are being developed for site EIA work. The outcomes will input into the cumulative and in-combination impact assessment work (when the impacts will be extended to large scale phased construction and operational impacts).

Disturbance and Potential Displacement as a Result of Elevated Construction and Operational Noise

Marine mammal species density and distribution data will be used to model population densities across the MORL and BOWL sites over time. Information on noise levels from previous piling activity from other wind farm sites and relevant activities will be used to model the severity of noise of piling operations over distance within the Moray Firth. These model outputs will be assessed in relation to audiograms and species density to quantify the potential level of impact on species during multiple phased construction and operational works. The potential for impacts will also be assessed with regard to the time of year so that levels of impact may be assumed with regard to different seasonal patterns of use.

This assessment will also take into account any potential displacement resulting from noise from the following:

- BOWL generating station;
- MORL Eastern Development area;
- MORL Western Development area;
- BOWL OFTO cable;
- MORL OFTO cable;
- Relevant oil and gas activities;
- Proposed SHETL hub;
- Proposed SHETL cable
- Port and harbour developments in the Moray Firth;
- Relevant military activity;
- Other relevant offshore renewable development outside the Moray Firth;
- Dredging and sea disposal in the Moray Firth; and
- Marine energy developments in the Pentland Firth and Orkney waters.

Increased Collision Risk Due to Construction and Maintenance Traffic

Marine mammal species density and distribution data will be used to model population densities across the MORL and BOWL sites. The number of vessels required during construction and operation will be estimated. These data will be used to estimate collision risk with regard to the time of year so that levels of impact may be assumed with regard to different seasonal patterns of use. Where available, the results of the study will be cross-referenced against information from existing wind farms, and information on baseline traffic levels in the Moray Firth.

This study will also take into account any traffic associated with proposed petroleum industry development, the planned OFTO cables, SHETL cable and hub.

Reduction of the Feeding Resource Due to Effects on Prey of Noise, Vibration and Habitat Disturbance

The extent to which marine mammal species feed within the MORL and BOWL sites will be assessed using marine mammal distribution and density data, data on and literature accounts of foraging habits (there are more data for seals than cetaceans), habitat maps and data/literature on the density and distribution of prey within the sites. The potential impact of construction and operation on habitats and prey distribution and availability will be determined using information from the literature (including audiograms for noise-sensitive fish and marine benthic species, where they are available) and specialist knowledge. This information will then be used to assess the potential impact on the foraging habits of marine mammals.

Other developments to be included in this study will include the following:

- OFTO cables for BOWL and MORL;
- SHETL cable;
- Proposed SHETL hub;
- Proposed petroleum industry development;
- Other wind farms not in the Moray Firth; and
- Marine energy developments in Pentland and Orkney waters.

Changes in Prey Availability Due to Infrastructure Presence and Changes in Fishing Activity

The potential for bio-fouling and long-term changes in prey availability for marine mammals will be estimated using baseline survey information on biota and evidence gathered for the Fish Ecology assessment (see Section 4.4). The potential for changes in fishing activity and the density and abundance of fish species within the wind farm sites will also be estimated from baseline data and evidence gathered for the commercial fisheries assessment (see Section 4.11). The potential for interaction between the impacts of changes in commercial fishing activity and bio-fouling will also be assessed. The potential impacts on prey species will be related to known foraging behaviour of marine mammal species recorded within the proposed development area.

In addition to the proposed wind farms within the Moray Firth, other developments to be included are:

- Existing and proposed oil and gas industry infrastructure;
- Proposed SHETL hub; and
- Commercial fisheries.

Do you have any comments on the proposed assessment methodology?

4.5.10 Presentation of Results

Findings from the research activities described above will be presented in technical reports to BOWL and MORL in order to inform the EIA process.

4.6 Ornithology

4.6.1 Specialist Advisors

BOWL has commissioned RPS as their lead ornithological advisors (which will include production of the ES chapter and technical report) and IECS to undertake seabird surveys of the development site plus a relevant buffer zone. MORL has commissioned Natural Power to undertake the ornithological assessment for their site. RPS and Natural Power are working together on common aspects of the assessment of ornithology, including cumulative impacts.

4.6.2 Guidance Documents

The key guidance document for cumulative impacts on birds is King *et al.,* (2009). This document sets out the current best practice approach for determining which species, protected sites (e.g. SPAs) and developments should be considered.

4.6.3 Baseline

The Moray Firth is host to internationally-important numbers of breeding seabirds, over-wintering waterbirds (seaducks, diving ducks, divers, grebes and waders), and provides important feeding areas for species on passage during spring and autumn migration. As recognition of this, there are a number of areas designated for their nature conservation value with respect to ornithological interests throughout the firth. These include international-level Special Protection Areas (SPAs) and Ramsar sites, and national Sites of Special Scientific Interest (SSSIs). The nearest designated site to both proposed developments is the East Caithness Cliffs SPA, which lies approximately 10.7 and 19.95 km to the north-west of the Beatrice site and MORL Eastern Development Area respectively. Further information is provided in the scoping reports.

4.6.4 Proposed Consultees

It is proposed that the following will be consulted during the scope refinement and ongoing cumulative impact assessment:

- SNH;
- JNCC; and
- RPSB.

4.6.5 Potential Effects

The potential effects of offshore wind farms on birds can be summarised as:

- Collision with turbines;
- Disturbance/displacement, including that produced due to construction noise;
- Barrier effects; and
- Indirect effects (e.g. changes in habitat or prey supply).

These effects may operate at individual offshore wind farm sites, cumulatively between a number of offshore and possibly onshore wind projects or in-combination with other non-wind farm activities (e.g. the oil and gas industry).

4.6.6 Study Area

The cumulative study area will be species-dependant, but for wide ranging species it may cover waters from Orkney in the north to the Firth of Forth in the south to take account of bird migration and general species mobility. The region may need to be extended for certain species (e.g. individual migratory species or those with a large foraging range) and may also include onshore areas where appropriate.

'Reasonably foreseeable' projects to be taken into account have been identified as follows:

- BOWL generating station;
- MORL western development area generating stations;
- MORL eastern development area generating stations;
- BOWL OFTO cable;
- MORL OFTO cable;
- Proposed SHETL cable;
- Proposed SHETL hub;
- Marine energy development in the Pentland Firth and Orkney waters;
- Dredging and sea disposal in the Moray Firth;
- Relevant oil and gas activities;
- Firth of Forth and Tay (all projects); and
- Aberdeen Offshore Wind Farm.

It should be noted that Bell Rock, Forth Array and the 'medium term' options outlined in Marine Scotland's current Strategic Environmental Assessment (SEA) of the Draft Plan for Offshore Wind Energy in Scottish Territorial Waters have been scoped out of this assessment as these are not considered to be 'reasonably foreseeable' i.e. no data are likely to be available.

For particularly wide-ranging species such as gannet, or migratory species such as geese and swans, where the effects of other wind farms, including onshore developments and other Round 3 zones, may need to be taken into account additional sites will be considered on a case by case basis.

Advice will be sought from the Statutory Nature Conservation Agencies (SNCAs) regarding the identification of any major onshore projects which are constructed 'but have yet to exert a predicted effect'.

Collision and barrier effects are fairly specific to wind farms, therefore no non-wind farm projects will be considered in the cumulative assessment of these effects.

In relation to disturbance/displacement and indirect effects on habitat and prey species, there could be potential for cumulative effects with non wind farm projects, such as other marine renewable projects (e.g. wave and tidal), although this has yet to be demonstrated. This will be kept under review and considered in relation to particular species on a case-by-case basis. Information on the availability of data and/or site assessments undertaken in time for consideration in the MORL / BOWL CIA will be sought from the Pentland Firth Developers Group. Dredging and sea disposal, marine and port development, oil and gas development and commercial fishing will also be considered where relevant.

Data Gathering

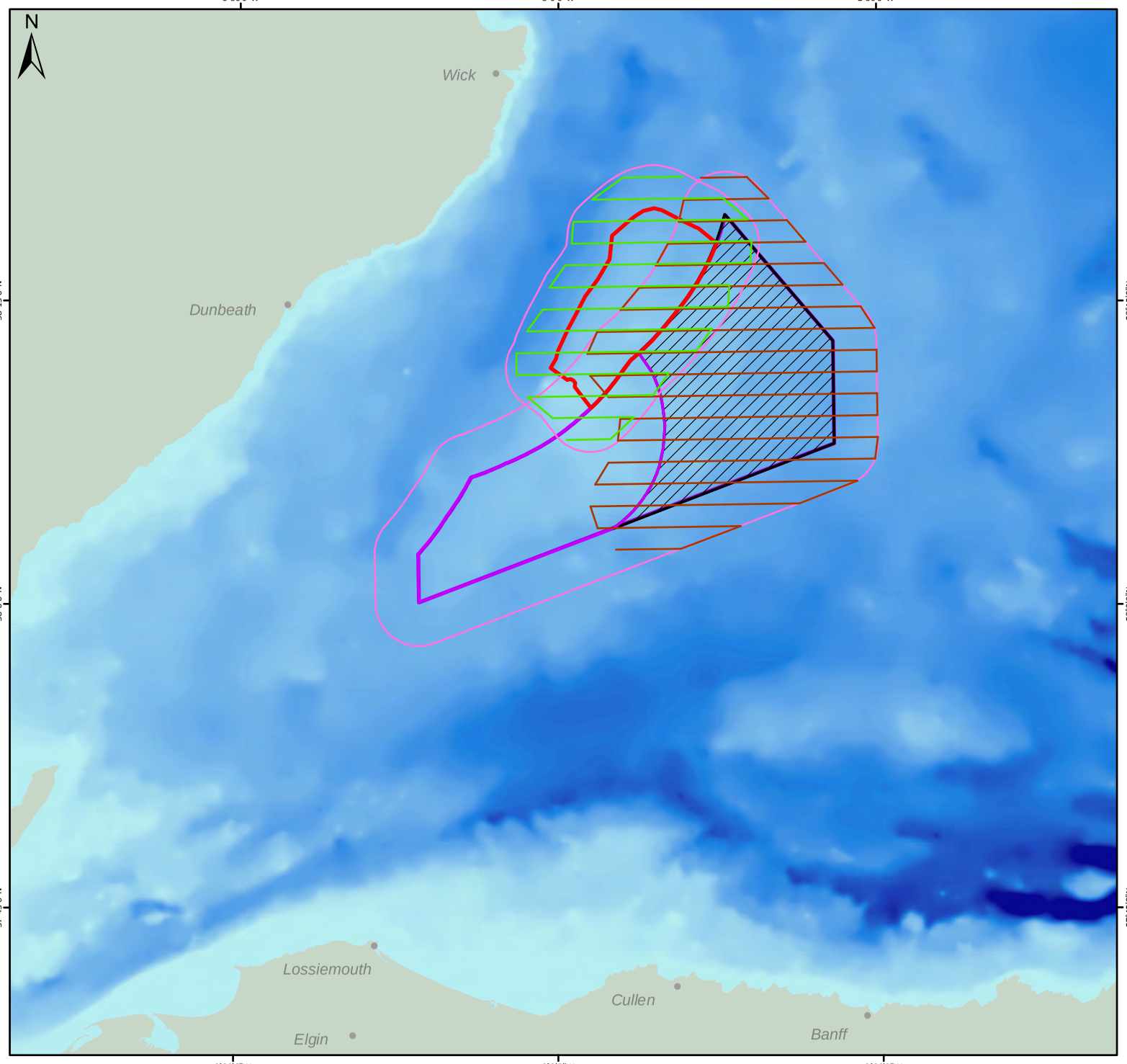
Data collected for the MORL and BOWL EIAs will form the basis of cumulative impact assessment and additional data gathering will not be required. The data that is being collected includes the following:

- Boat-based survey data collected at least once per month over a two-year period;
- Aerial survey data during 2009-10;
- Additional migration surveys using coastal and boat-based observations;
- Bird tagging; and
- Wider Moray Firth aerial surveys (MORL only at present).

The Crown Estate enabling actions have already ensured that aerial bird survey data are collected in a consistent manner across the Moray Firth Round 3 zone and the Beatrice site. The methodology used for the Moray Firth zone has varied: in the first instance HiDef conducted digital video surveys (Summer 2009), while the 2009 - 10 winter surveys were carried out by WWT using visual observations.

The boat-based methodologies used for the two sites follow the same methods based on European Seabirds At Sea (ESAS) methods as modified for offshore wind farms (Camphuysen *et al.,* 2004, Maclean *et al.,* 2009). The methods for the two sites are described in detail in the scoping reports. The datasets and resulting assessments arising from the surveys will be shared between MORL and BOWL. Ornithology boat based survey transects are illustrated on Figure 4.9.

The migration surveys were undertaken during autumn 2010 (mid-September to mid-November) and will be repeated in Spring 2011 (mid-March to mid-May). The boat-based observations were/will be undertaken during the above ESAS-based surveys. The coastal observations were/will be undertaken for a total of 16 days per season from each of four locations (Sarclet Head, Duncasby Head, Rosehearty, and Whitehills). Full details of the methodologies are provided in the autumn 2010 Migration Survey Reports (see Annex C). The data arising from these surveys has been shared by MORL and BOWL.



Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Western Development Area
- MORL Eastern Development Area
- Buffer Zone - 4km
- Beatrice Ornithology Boat Based Survey Transect
- MORL Ornithology Boat Based Survey Transect

Bathymetry

(Metres Below Sea Level)

0m

-220m

0 2.5 5 10 Km 0 2.5 5 10 Nm

UK Offshore Developments

Figure 4.9

Ornithology Boat Based Survey Transects
Cumulative Impact Assessment Discussion Document

Drawn:	KB	Checked:	KG	Approved:	SS
Date:	18/03/2011	Size:	A4	Scale:	1:500,000
Drawing Number:	BEA_MAP_CIA_SSER_012			Revision:	03
Datum:	WGS84	Projection:	UTM Zone 30N		

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4.6.7 Assessment Methodology

The significance of each impact will be assessed according to the number of birds affected as a proportion of the relevant population and taking account of the species' conservation status.

Population estimates for SPA species will be taken from the Natura 2000 standard data form unless more recent and robust data are available. Agreement will be sought from SNCAs on the use of these latter data. It is accepted that the process of assigning birds to SPA populations across the study region is likely to be complex owing to the number of SPAs with the same qualifying and assemblage species.

Advice will also be sought from SNCAs on how to determine the local and regional population size for non-SPA species. For these species, it may be possible, using population modelling, for thresholds of impact to be agreed with SNCAs. For SPA species, this may not be possible and this is discussed further in Section 4.6.9.

Collision Risks

Cumulative collision risk can be calculated by summing collision numbers from each individual wind farm. The total number would then be presented as a percentage of the relevant population or populations (e.g. local, regional, national) and also a percentage change in background mortality rate. Where effects are expected to be significant, they should be discussed in the context of the life history of the species. In some cases a population modelling approach may be required.

In order that collision risk estimates are comparable, similar methods of calculation should be used for the two sites. The approach to be used will be discussed with SNCAs but is likely to follow a variation of the SNH's Band Model (http://www.snh.gov.uk/strategy/renewable/sr-we00a1.asp).

Disturbance and Displacement

Disturbance and displacement will be assessed by summing the number of individuals of each species which may be disturbed or displaced for consideration in relation to the relevant population (e.g. local, regional, national) and discussed in the context of the species conservation status. These assessments will require predictions of the levels of disturbance and displacement which may occur. These predictions will be informed by studies conducted elsewhere and in discussion with SNCAs. The assessment will consider the potential for disturbance and displacement which may arise due to construction, operation and decommissioning activities. Agreement will also be needed on the level at which the impact is deemed to become insignificant (e.g. the percentage of the population affected).

Barrier Effects

Barrier effects are likely to be minimal for most migratory species, with many taking far-field avoidance of wind farms with minimal effects on energy budgets (Speakman *et al*., 2009). For these species it is anticipated that qualitative assessments will be sufficient. Where effects are expected to be significant (e.g. for avoidance of multiple wind farms on a migration route or

regular avoidance such as where the wind farms lie between feeding areas and roosting sites) quantitative assessments, incorporating estimates of elevated energy demands may be appropriate (e.g. Masden *et al.,* 2009). These will be undertaken on a species specific basis (Masden *et al.,* 2010).

*Indirect Effect*s

Construction effects on seabird prey species may have indirect effects on birds, an effect which may be more pronounced if there is concurrent construction over large areas. The potential for such effects will be assessed following an approach similar to that used for estimating disturbance and displacement. This will incorporate assessments of the possible changes to prey distributions and abundance, derived from studies conducted elsewhere and in discussion with SNCAs. Details of appropriate species and techniques would be discussed and agreed at each stage with the relevant stakeholders. Noise modelling is being undertaken by Subacoustech, this will include an assessment of the potential impacts of noise on diving seabird species.

4.6.8 SPAs, Impact Assessment and Habitats Regulations Appraisal

For SPAs relevant to the Moray Firth region, both developers will provide specific information as part of Habitats Regulations Appraisals. This information will support decisions about whether their development(s), alone or in-combination, is likely to have a significant effect on the qualifying features of an SPA and any adverse impact on site integrity. This will be based on whether the proposed development will undermine the conservation objectives of the site.

Table 4.6.1 Summary of Ornithology Methods and Activities Agreed Between Developers

Method/Activity	Status
Boat-based survey methods	Common methods based on Camphuysen *et al.,* 2004 and Maclean *et al*., 2009. The datasets arising from the surveys and resulting assessments will be shared between MORL and BOWL.
Aerial surveys	WWT information collected for The Crown Estate will be shared.
Migration surveys	Undertaken collaboratively and data shared.
Density calculations	Common approaches to be agreed.
Collision risk modelling	Common approaches to be agreed. The subsequent assessment will be shared between MORL and BOWL.
Disturbance/displacement assessment	Common approaches to be agreed. The subsequent assessment will be shared between MORL and BOWL.
Barrier effects assessment	Common approaches to be agreed. The subsequent assessment will be shared between MORL and BOWL.
Indirect effects assessment	Common approaches to be agreed. The subsequent assessment will be shared between MORL and BOWL.

*The sharing of assessments will depend on submission timetables: the assessment shared by MORL may comprise a draft assessment.

4.6.9 Presentation of Results

Tables summarising the significance of cumulative effects for each sensitive receptor at each site will be produced to summarise each category of effect, i.e. collision risk,

disturbance/displacement etc. The cumulative effects should be discussed based on the magnitude of the impact in relation to the local, regional, and national populations and should reach a summary conclusion stating whether the cumulative effect is significant or not significant. In order for results to be comparable, it will be important for MORL, BOWL and the SNCAs to agree on definitions of sensitivity, magnitude of effect and impact significance.

These final tables will be produced during EIA for the two projects. A draft 'long list' of bird receptors for initial consideration of cumulative impacts is provided in Table 4.8. This list will be refined following the approach detailed in King *et al*. (2010), based on a step-by-step assessment of risks. This will result in the determination of a final list of sensitive bird receptors from the 'long list', for which a full assessment will be conducted.

Table 4.6.2 Long List of Bird Receptors

Species	Displacement/ disturbance	Collision	Barrier effects	Indirect effects	SPA feature with site-interaction potential?+	Use of site*
Whooper swan	none	low-medium	low	none	yes	W, P
Pink-footed goose	none	low-medium	low	none	yes	W, P
Greylag goose	none	low-medium	low	none	yes	W, P
Barnacle goose	none	low	low	none	yes	W, P
Wigeon	none	low	low	none	no	W, P
Teal	none	low	low	none	no	W, P
Pintail	none	low	low	none	no	W, P
Eider	none	low	low	none	no	B, P, W
Scaup	none	low	low	low	yes	W, P
Long-tailed duck	low-medium	low	low	low-medium	yes	W, P
Common scoter	low-medium	low	low	low-medium	yes	W, P
Velvet scoter	low-medium	low	low	low-medium	yes	W, P
Goldeneye	none	low	low	none	no	W, P
Red-breasted merganser	none	low	low	none	no	W, P
Goosander	none	low	low	none	no	W, P
Red-throated diver	low-medium	medium	low	low-medium	no	W, P
Black-throated diver	low-medium	medium	low	low-medium	no	W, P
Great northern diver	low-medium	medium	low	low-medium	n/a	W, P
Northern fulmar	medium/high	low	low	medium/ high	yes	B, W
Sooty shearwater	low-medium	low	low	low-medium	n/a	p
Manx shearwater	low-medium	low	low	low-medium	yes	P
Storm petrel	low-medium	low	low	low-medium	n/a	P

Species	Displacement/ disturbance	Collision	Barrier effects	Indirect effects	SPA feature with site-interaction potential?+	Use of site*
Northern gannet	medium	medium	low	medium	yes	B, P
Cormorant	low	low	low	low	no	B, W
European shag	low	low	low	low	no	B, W
Slavonian grebe	low	low	low	low	no	W
Osprey	none	low	low	none	no	P
Peregrine falcon	none	low	low	low	no	P
Oystercatcher	none	low	low	none	no	P
Knot	none	low	low	none	no	P
Dunlin	none	low	low	none	no	P
Bar-tailed godwit	none	low	low	none	no	P
Curlew	none	low	low	none	no	P
Redshank	none	low	low	none	no	P
Pomarine skua	low	low	low	low	n/a	P
Arctic skua	low	low	low	low	no	P, B
Great skua	low	low	low	low	yes	B, P
Black-legged kittiwake	medium-high	medium-high	low-medium	medium-high	yes	P, B, W
Black-headed gull	low	low	low	low	no	P
Common gull	low	low	low	low	no	P
Lesser black-backed gull	low	medium	low	low	no	B, P, W
Herring gull	low	medium	low	low	yes	B, P, W
Iceland gull	low	low	low	low	n/a	W
Glaucous gull	low	low	low	low	n/a	W
Great black-backed gull	low	medium	low	low	yes	B, P, W
Common tern	low	low	low	low	no	P
Arctic tern	medium	low	low	medium	no	P
Common guillemot	medium-high	low	low-medium	medium-high	yes	B, P, W
Razorbill	medium-high	low	low-medium	medium-high	yes	B, P
Black guillemot	low	low	low	low	n/a	B, W
Little auk	low	low	low	low	n/a	P
Atlantic puffin	medium	Low	low-medium	medium	yes	B, P

*B: breeding; W: wintering; P: passage.
+ n/a specifies that there are no SPA designated for this species

Do you have any comments on the proposed assessment methodology?

4.7 Seascape, Landscape and Visual Character

4.7.1 Specialist Advisors

LDA Design has been appointed by BOWL to undertake the seascape, landscape, visual and cumulative advisory services for the Beatrice development. MORL has yet to appoint an advisor to undertake the respective assessment. This section therefore describes best practice and highlights where the BOWL and MORL advisors will need to coordinate their approach.

4.7.2 Guidance Documents

There presently exist a range of methodology guidance documents relating to the assessment of seascape, landscape and visual impacts. Some of these, such as the 'Guidelines for Landscape and Visual Impact Assessment' (IEMA, LI, second edition 2002) are generic to development, whilst others are specific to offshore wind farm developments. Key methodology guidance on cumulative assessment and the production of associated visualisation material will include the following:

- SNH, 2005. Cumulative effect of Wind farms;
- DTI, 2005. Guidance on the Assessment of Impacts of Offshore Wind Farms. Seascape and Visual Impact Report;
- SNH, 2006, albeit published in May 2007. Visual representation of Wind farms – Best Practice Guidance; and
- SNH, 2009. Siting and Designing Wind farms in the Landscape.

With the exception of the SNH 2005 document, which will be the core methodology reference for the cumulative assessment, there is limited detailed coverage of cumulative issues within other associated guidance. Neither does the SNH 2006 document on the presentation of visualisation material specifically address cumulative matters.

In addition to the above, there are a range of other sensitivity and characterisation reference documents which will be drawn upon in the undertaking of the cumulative assessment. It is also known that SNH, in conjunction with Natural England, is producing new guidance on seascape characterisation and it is anticipated that this will be available in draft in early 2011 and may thus be utilised to inform the baseline seascape character against which the cumulative assessment will be undertaken. The current seascape guidance - Maritime Ireland / Wales Interreg 1994 – 1999 Guidance 'Guide to Best Practice in Seascape Assessment' (GSA), published in March 2001 will be superseded by this emerging guidance.

The MORL and BOWL landscape consultants will coordinate to ensure that both assessments follow the same methodologies, especially in light of the recent and emerging changes to guidance.

4.7.3 Baseline

The Beatrice Offshore Wind Farm and Moray Round 3 zone lie in the outer Moray Firth. The SLVIA process for the Beatrice Offshore Wind Farm site has already started and as the Moray

Round 3 zone will be shortly commencing, it is planned that discussions with consultees on final study areas will be coordinated.

An assessment of the sensitivity and capacity of the Scottish seascape in relation to wind farms (SNH 2006) indicates that both proposed wind farm sites within the Moray Firth lie within a seascape area of medium to low sensitivity (Beatrice wind farm site) and low to negligible visibility (MORL zone). The area has a moderate to high capacity for wind farm development. This is attributed to turbines relating well to the openness of the sea and large scale seascape.

The emerging SNH/NE seascape characterisation guidance is currently being used for the Beatrice assessment following discussion and agreement with SNH and Highland Council. MORL has also been present at these meetings and it is therefore expected that that the Moray Round 3 Zone assessment will also follow the new seascape characterisation guidance, taking into account the character types established through the Beatrice assessment. Discussions between the BOWL and MORL landscape consultants will ensure a consistent approach.
On land, the SNH landscape character assessment series covers the whole of Scotland and in particular the Caithness and Sutherland (1998), Ross and Cromarty (1999), Moray and Nairn (1998), Banff and Buchan (1994) and Orkney (1998) landscape character assessments will potentially be useful in the assessment for the Beatrice Offshore Wind Farm and Moray Round 3 Zone.

The assessment of both wind farms will need to consider local residents, travellers, and workers as potentially sensitive receptors, especially for sequential cumulative effects, during the course of the SLVIA. Hill walkers and tourists are also important visual receptors in the surrounding landscapes. Other key visual receptors include those out at sea; fishing vessels, oil workers, ferry passengers, recreational sailors and those closer to the coast such as wind surfers and surfers. All of these, except those working on an oil platform, are transitory receptors, i.e., they are moving through the seascape, so sensitivity towards the types of development proposed may be reduced, although they may experience more sequential cumulative effects.

There are a number of other onshore wind farms operating, approved or currently lodged within the planning system which will need to be considered in the cumulative assessment for both sites. Also, within the vicinity of the wind farm sites the existing Beatrice demonstrator turbines, Jacky platform and Beatrice platforms add to the baseline conditions of views and seascape character.

4.7.4 Proposed Consultees

It is proposed that the following organisations will be consulted by BOWL and/or MORL depending upon the extent of the agreed respective study areas to agree the scope of the cumulative assessment:

- SNH;
- Highland Council;
- Moray Council;
- Orkney Council; and

- Aberdeenshire Council.

4.7.5 Potential Effects

Cumulative Landscape and Seascape Effects

As with the methodology for assessing landscape and seascape effects, the magnitude and significance of cumulative effects on the identified landscape designations, landscape features and seascape character units / areas are a function of the baseline sensitivity of each receptor, the number and scale of the proposed wind farms in that area and the overall size and shape of the receptor / character area. Cumulative landscape and seascape effects will be assessed for each receptor / character unit where they are affected by more than one of the proposed wind farms.

Cumulative Visual Effects

There are two principal types of cumulative effects on visual amenity, namely effects arising from combined and sequential views. In accordance with the SNH publication Cumulative Effect of Wind Farms version 2 (April 2005) these comprise the following:

- Combined views which 'occur where the observer is able to see two or more developments from one viewpoint. Combined visibility may either be in combination (where several wind farms are within the observer's arc of vision at the same time) or in succession (where the observer has to turn to see the various wind farms)'; and
- Sequential views which 'occur when the observer has to move to another viewpoint to see different developments.'

Cumulative visual effects will vary in degree depending on the factors below:

- Number and sensitivity of visual receptors;
- Duration, frequency and nature of views; and
- Relative effect of each individual wind farm with regard to visual amenity.

4.7.6 Study Area

The methodology to be employed for the cumulative assessment will follow recognised guidance. The purpose of the cumulative assessment is to consider the potential effects arising from the addition of the proposed development upon the seascape, landscape and visual environments in relation to the existing wind farm developments and other known consented and proposed wind farm developments in the area. It raises questions over thresholds of acceptable change (both spatial and temporal) and the landscape/seascape's capacity to accept change. The Guidelines for Landscape and Visual Effect Assessment (2nd edition, 2002) advises that:

> *'cumulative landscape and visual effects result from additional changes to the landscape or visual amenity caused by the proposed development in conjunction with other developments (associated with or separate to it), or*

actions that occurred in the past, present or are likely to occur in the foreseeable future'.

The study areas for the Beatrice Offshore Wind Farm and the Moray Round 3 Zone will be agreed with the key consultees listed above. Within the agreed radius, the consultees listed above will be contacted to identify existing and consented wind turbine developments, both on and offshore, as well as applications yet to be determined. For each of these schemes agreement will be reached as to whether they should be included within the cumulative assessment.

Figure 4.10 illustrates a 60 km radius study area for each of the three development areas: Beatrice Offshore Wind Farm, MORL Eastern development area, and MORL Western development area. A 60 km radius study area follows current best practice guidance(1) and should be a flexible area that may be reduced or extended where necessary depending on initial assessments and consultation.

Do you have any comments on the proposed study area?

4.7.7 Data Gathering

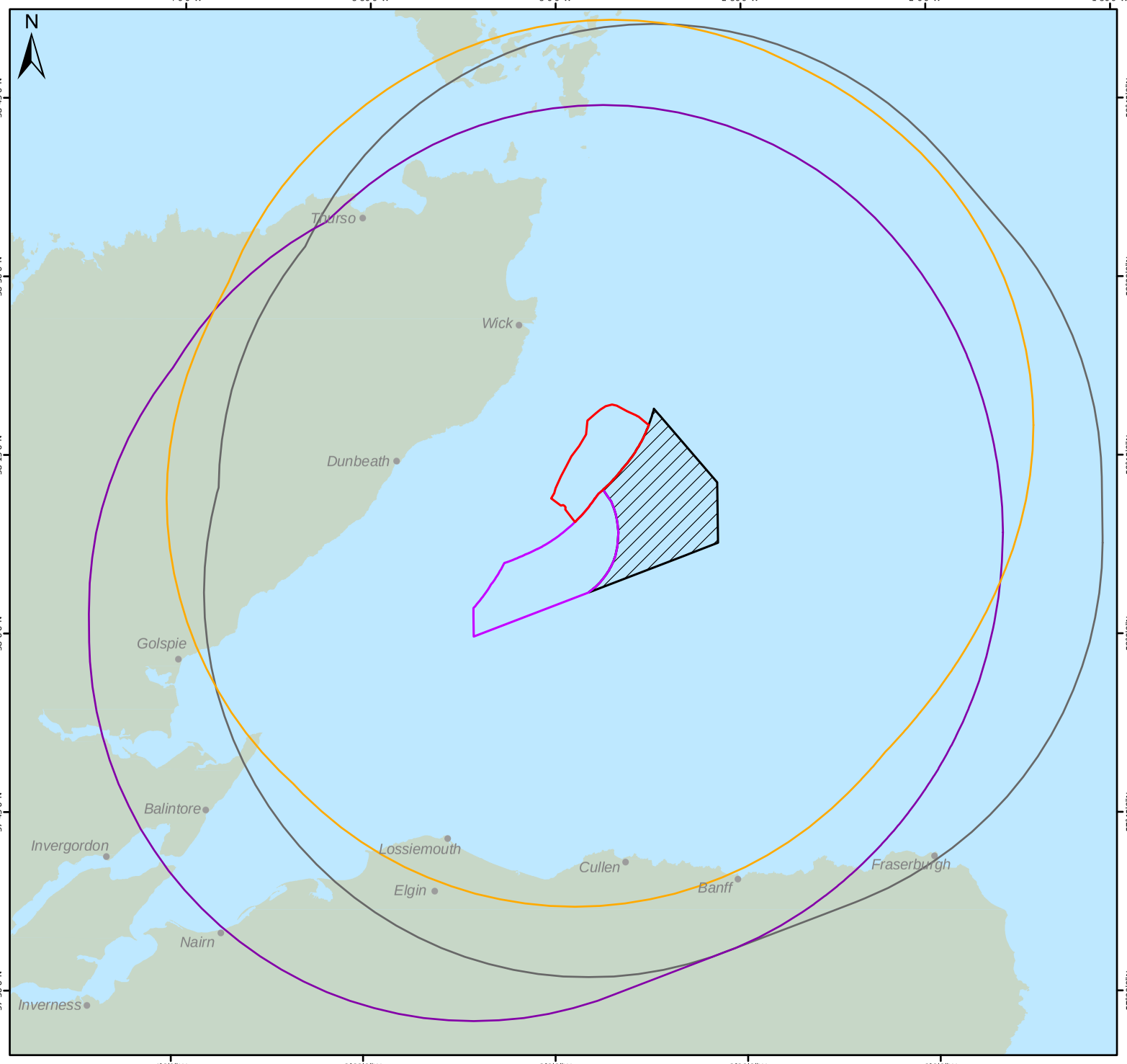
The SLVIA will be undertaken with reference to best practice guidance as discussed above. Data gathering for the cumulative assessment will build upon the data gathered for the main SLVIA and include the following:

- Data trawl for other wind farm sites within the agreed study area;
- Data trawl for other major projects (i.e. oil platforms) within the agreed study area;
- Identification of cumulative viewpoints;
- Production of cumulative Zone of Theoretical Visibility (ZTV) plans, wireframes and photomontages; and
- Fieldwork to confirm desk-based study and viewpoint descriptions.

The cumulative assessment does not address the magnitude or significance of the effects arising from each of the individual developments themselves, but looks at the seascape, landscape and visual effects arising from the combination of the turbines at the proposed offshore wind farm with one or more other wind farm developments within the parameters identified.

The cumulative assessment examines the same groups of seascape / landscape and visual receptors as the assessment for the main scheme, though different viewpoints may be used in order to better represent the likely range of effects arising from the combination of schemes. The assessment will be informed by cumulative ZTVs, showing the extent of visual effects of the schemes in different colours to illustrate where visibility of more than one development may theoretically arise. Cumulative wireframes will be prepared which show each of the developments in different colours so that they are each readily identifiable. Cumulative

(1) Guidance: Cumulative Effect of Windfarms, SNH, 2005



Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Western Development Area
- MORL Eastern Development Area
- Beatrice Wind Farm Site Boundary Buffer - 60km
- MORL Western Development Area Buffer - 60km
- MORL Eastern Development Area Buffer - 60km

0 4 8 16 Km 0 4.5 9 18 Nm

UK Offshore Developments

Figure 4.10

SLVIA Cumulative Study Area
Cumulative Impact Assessment Discussion Document

Drawn:	KB	Checked:	KG	Approved:	SS
Date:	18/03/2011	Size:	A4	Scale:	1:850,000
Drawing Number:	BEA_MAP_CIA_SSER_013			Revision:	02
Datum:	WGS84	Projection:	UTM Zone 30N		

Beatrice Offshore Windfarm Ltd

moray offshore renewables ltd

photomontages will also be prepared, the number and location of viewpoints will be agreed with the relevant consultees.

With the large number of wind farms in the Highlands, Moray and Aberdeenshire area, sequential effects are also acknowledged as an important part of the cumulative assessment.

Are you aware of any additional data sources that should be considered in the assessment?

4.7.8 Assessment Methodology

Given the proximity of the Beatrice Offshore Wind Farm and Moray Round 3 Zone the landscape consultants for both sites will seek to coordinate a cumulative approach that is consistent with current best practice for agreement with the relevant consultees.

Do you have any comments on the proposed approach to the assessment methodology?

4.7.9 Presentation of Results

The significance of cumulative effects of the proposed changes will be determined by the sensitivity of the receptor and the magnitude of the change. The criteria for this will be based on the 'Guidelines for Landscape and Visual Impact Assessment', 2nd Edition (LI/IEMA 2002).

Significant effects (in terms of EIA regulations) are those that are Major or Major-Moderate. As stated within the EIA regulations, if an effect is not significant, it should not be considered as material to the decision making process. It should also be noted that whilst an effect may be significant, and therefore material in coming to a decision, that does not necessarily mean that such an impact would be unacceptable.

The Table 4.7.1 below illustrates the potential significance criteria for landscape/seascape and visual effects.

Table 4.7.1 Potential Significance Criteria

Significance of Effect	Landscape/Seascape Resource	Visual Resource / Amenity
Major	Total or major alteration to key elements, features or characteristics of the seascape or landscape, such that post development the baseline situation will be fundamentally changed	Total or major alteration to a valued view or view of high scenic quality that post development the baseline situation will be fundamentally changed
Moderate	Partial alteration to key elements, features or characteristics of the seascape or landscape, such that post development the baseline situation will be noticeably changed	Partial alteration to key views such that post development the baseline situation will be noticeably changed
Minor	Minor alteration to key elements, features or characteristics of the landscape or seascape, such that post development the baseline situation will be largely unchanged despite discernable differences	Minor alteration to key views such that post development the baseline situation will be largely unchanged despite discernable differences
Negligible	Very minor alteration to key elements, features or characteristics of the landscape or seascape, such that post development the baseline situation will be fundamentally unchanged with barely perceptible differences	Very minor alteration to key views such that post development the baseline situation will be fundamentally unchanged with barely perceptible differences
None	No effects on the landscape/seascape resource as proposals are either not visible, or are in keeping with the character and/or mitigation proposals balance any significant effects.	No effects on the visual amenity as proposals are either not visible, or are in keeping with the character and/or mitigation proposals balance any significant effects.

4.8 Marine Archaeology and Cultural Heritage

4.8.1 Specialist Advisor

Both MORL and BOWL have commissioned the services of Headland Archaeology to complete the EIA exercise and advisory services.

4.8.2 Guidance Documents

There are currently a number of specific guidance documents available to inform the approach and these will be considered during the cumulative impact assessment on archaeology and cultural heritage assets. The guidance that will be considered will include the following:

- Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy, Oxford Archaeology with George Lambrick Archaeology and Heritage, January 2008 (commissioned by COWRIE Ltd);
- Assessment of Impact on the Setting of the Historic Environment Resource – Some general considerations, Historic Scotland, 2009; and
- Managing Change in the Historic Environment – Setting, Historic Scotland, 2011.

4.8.3 Baseline

Offshore

The baseline for marine cultural heritage assets comprises three confirmed known wreck locations classified as 'live' by the UKHO within the Moray Round 3 Zone and associated 1 km buffer; three further known wrecks or obstructions lie within the Moray Zone and associated 1 km buffer that are classified as 'dead' (i.e. the identity was established initially but subsequent survey has failed to locate the wreck remains). Whilst this is the case, the preliminary assessment of marine geophysical data has identified two anomalies that may well represent at least one of the 'dead' wrecks located within the Moray Round 3 Zone and an obstruction within the 1 km buffer. There are no known wrecks or obstructions located within the Beatrice Offshore Wind Farm, although two geophysical anomalies indicate the location of a well-head associated with the Jacky gas and oil field and a further potential feature of anthropogenic origin. There are no designated or protected wrecks within either development area. In addition, initial geoarchaeological assessment of the seabed substrates has indicated negligible potential for the survival of relict landscape surfaces, features or deposits within the Beatrice Offshore Wind Farm and Moray Round 3 Zone.

Onshore

There are 142 scheduled monuments, four of which are Properties in Care, 21 Category A-listed buildings, two conservation areas and two inventory gardens or designed landscapes within 30 km of Beatrice Offshore Wind Farm and Moray Round 3 Zone. This 30 km buffer will be further refined in consultation with Historic Scotland and local planning authorities.

The scheduled monuments comprise a wide range of monument types, but in the current context the most significant are the various prehistoric burial cairns located near the coast and several stone alignments. Such monuments have specific alignments and therefore views associated with their function and in some instances there is a clear relationship between these monuments' architecture and views out over the sea. Many of the inland monuments lie outside the 30 km buffer.

Most of the Category A-listed buildings lie some distance from the coast and are unlikely to be of concern. The exception to this is Dunbeath Castle, which stands on the coast. Associated with the castle is its garden, which appears in the Inventory of Gardens and Designed landscapes. The remaining designed landscape is Langwell Lodge.

4.8.4 Proposed Consultees

It is proposed that the following organisations will be consulted during the scope refinement and ongoing cumulative impact assessment:

- Historic Scotland;
- Royal Commission on the Ancient and Historical Monuments of Scotland; and
- Highland Council Archaeology Service.

Given the large number of onshore cultural heritage assets within 30 km of Beatrice Offshore Wind Farm and the MORL Round 3 Zone, the primary concern of the consultation process will be to agree the scope of the CIA by identifying specific assets that will be considered in relation to cumulative impacts.

4.8.5 Potential Effects

The proposed wind farms may have the following cumulative effects:

- *Physical effects:* Physical effects on marine cultural heritage assets may occur with the introduction of the Beatrice Offshore Wind Farm and Moray Round 3 Zone, both individually and in combination. These may include numerous individual effects such as those related to turbine foundations and associated infrastructure; and changes in the sediment regime and scour as a consequence of the installations. These effects have potential for beneficial and adverse effects on the survival of cultural heritage assets such as known or potential wreck remains and associated debris. While it is unlikely with the BOWL and MORL developments, there is the potential for cumulative effects on submerged landscapes and deposits, perhaps spread over a wide geographical area. This will be confirmed through consultation with Historic Scotland.

- *Setting effects*: Cumulative setting effects upon onshore cultural heritage assets may result from Beatrice Offshore Wind Farm and MORL Round 3 Zone being seen in combination in views that are relevant to the setting of cultural heritage assets. Similarly, a cumulative effect may occur where onshore wind farms are visible in succession with the Moray Zone offshore wind farms from a viewpoint that is relevant to the setting of an asset.

4.8.6 Study Area

The study area within which effects and impacts will be considered from an archaeology perspective will be defined by the MORL and BOWL site boundaries, including an initial buffer zone of 1 km to take into consideration any likely dispersion and settlement of sediments during the construction phases of the projects. It should be noted that this buffer zone may be revised once data regarding turbine layout and sediment flow measurements become available. Both beneficial and adverse potential impacts will be considered.

For the purposes of assessing the cumulative impact on terrestrial cultural heritage assets, assets within 30 km of MORL or BOWL turbines will be included initially. A Zone of Theoretical Visibility (prepared as part of the Seascape, Landscape and Visual assessment) will be utilised to determine specific assets that will be considered during the cumulative assessment, the list of assets will be agreed by Historic Scotland and Highland Council Archaeology Service.

Do you have any comments on the proposed study area?

4.8.7 Data Gathering

Data will from both the MORL and BOWL project teams will be derived and gathered in the same format where possible. Information requirements are as follows:

- Geophysical data;
- Location of turbine foundations;
- Modelling results of sediment dispersion during construction;
- Modelling results of scour impacts during operation/long term;
- Cumulative Zones of Theoretical Visibility for onshore and offshore wind farms; and
- Visualisations (wireframes in the first instance).

Site visits will be undertaken to inform the setting impact assessment.

Are you aware of any additional data sources that should be considered in the assessment?

4.8.8 Assessment Methodology

Physical Impacts

The assessment of cumulative physical impacts will be undertaken using the data sources highlighted above and will assess the cumulative effect of the BOWL and the MORL sites on marine cultural heritage assets, both individually and cumulatively. Such effects will relate to changes in the movement of sediments, which may result in the uncovering or covering of assets by sediments. Hence the assessment will identify assets where this may occur and establish how widespread such areas may be in order to assess the potential for unrecorded assets to be affected.

Other developments to be included in this study will include the following:

- BOWL generating station;
- MORL Eastern Development area;
- MORL Western Development area;
- BOWL OFTO cable;
- MORL OFTO cable;
- Proposed SHETL cable;
- Proposed SHETL offshore hub;
- Relevant oil and gas activities; and
- Dredging and sea disposal in the Moray Firth.

Setting Impacts

The cumulative setting impact assessment will consider the visual effects on setting of MORL, BOWL, the onshore Burn of Whilk Wind Farm, any other onshore wind farms and proposed oil and gas infrastructure as agreed with relevant consultees. Potential cumulative effects will in the first instance be identified using the cumulative ZTVs generated for the SLVIA to identify those assets where the various proposals will be visible in combination or succession. The

assessment will then focus upon specific assets agreed with Historic Scotland and Highland Council Archaeology Service.

Other developments to be included in this study will include the following:

- BOWL generating station;
- MORL Eastern Development area;
- MORL Western Development area;
- Proposed SHETL offshore hub;
- Relevant oil and gas activities;
- Other on shore wind farms; and
- Other offshore wind farms.

Do you have any comments on the proposed assessment methodology?

4.8.9 Presentation of Results

Cumulative effects will be considered within each of the ESs produced for each development, using standardised impact assessment criteria which will be agreed with Historic Scotland and Highland Council Archaeology Service.

4.9 Aviation and MOD

4.9.1 Specialist Advisor

Scottish and Southern Energy Renewables (SSER) will be conducting an in-house assessment of potential impact of the proposed Beatrice Offshore Wind Farm on aviation interests; however, Osprey Consulting Ltd will be contracted to conduct discreet packages of work. Spaven Consulting has been commissioned by MORL to undertake the respective assessment. Both SSER internal staff, Osprey and Spaven Consulting have been liaising to ensure a consistent approach to the respective wind farm assessments and the cumulative impact assessment.

4.9.2 Guidance Documents

There is no specific guidance on the cumulative impact assessment of aviation impacts from wind farms. National Air Traffic Services (NATS) has stated that there would need to be a regional approach to a solution to mitigate cumulative effects. The MoD is likely to prefer a regional solution also.

4.9.3 Baseline

Aviation facilities with the potential to be affected by the cumulative effects of BOWL and MORL are as follows:

- NATS Allanshill primary surveillance radar;
- RAF Lossiemouth primary surveillance radar;

- Obstacle clearance for helicopter instrument approach procedures to the Beatrice platforms;
- Obstacle clearance issues for helicopters flying on Helicopter Main Route X-Ray; and
- Impacts on search and rescue helicopter operations.

4.9.4 Proposed Consultees

Consultees for cumulative aviation impacts of BOWL and MORL are as follows:

- NATS;
- Ministry of Defence;
- Ithaca/Wood Group;
- Bristow Helicopters;
- Bond Offshore Helicopters; and
- CHC Scotia.

4.9.5 Potential Effects

The potential cumulative effects of BOWL and MORL on aviation are set out below:

- Clutter on primary radar;
- Shadow effect on primary radar;
- Obscuration effect on primary radar;
- Obstruction of helicopter instrument approach procedures to Beatrice platform;
- Obstruction of low level helicopter routes on HMR X-Ray in icing conditions;
- Obstruction of search and rescue helicopter operations within the wind farms; and
- Requirement for suitable aviation lighting.

4.9.6 Study Area

The study area is a 150 km radius from the two developments, as this range is an appropriate distance to consider the operational range of long range en-route primary radar systems.

Do you have any comments on the proposed study area?

4.9.7 Data Gathering

Meteorological data are being gathered to inform the assessment of the impact of the MORL and BOWL projects on helicopter instrument approach procedures to the Beatrice platforms.

All other baseline data required to assess the military and civil aviation impact of the Beatrice Offshore Wind Farm and the MORL zone have been acquired.

4.9.8 Assessment Methodology

Other developments to be included in this study will include the following.

- BOWL generating station;
- MORL western development area generating stations;
- MORL eastern development area generating stations;
- Relevant oil and gas activities;
- Onshore wind farms; and
- Other offshore wind farms.

Cumulative impact on helicopter operations will be addressed by determining the sectors in which instrument approaches to the Beatrice platforms may be affected, followed by analysis of meteorological data to determine the frequency with which such approaches may be precluded.

In addition, potential impacts on use of Helicopter Main Route X-Ray are being addressed through consultations with helicopter operators.

Cumulative assessment of radar impacts will be based on assessing the physical extent of radar clutter and other impacts in relation to the air traffic service provider areas of operational responsibility.

Radar line of sight analysis based on initial possible turbine layouts suggest that some, but not all, of the BOWL and MORL turbines will be visible to the MoD PSR at RAF Lossiemouth and the NATS En-Route Ltd PSR at Allanshill. Taller turbine tip heights are likely to lead to higher numbers of turbines being 'visible' to the radar systems.

A feasibility and options document will be submitted to NATS to ascertain whether a Transponder Mandatory Zone (TMZ) over some or all of the turbines can mitigate the impacts on primary radar.

In conjunction, radar mitigation assessments will be undertaken to identify suitable mitigation measures should a TMZ not be feasible, or be refused on application.

Cumulative assessment of physical obstruction impacts will be based on assessing the overall extent of wind turbines presenting obstacles to specific instrument approach procedures and helicopter routes.

Meetings are to be held with the various offshore aviation stakeholders to clarify specific risks associated with the BOWL and MORL developments, and identify possible mitigation measures which are to be investigated and considered.

Do you have any comments on the proposed assessment methodology?

4.9.9 Presentation of Results

Results of the aviation cumulative assessment will be presented in graphical and text format as required.

4.10 Shipping and Navigation

4.10.1 Specialist Advisors

Both MORL and BOWL have commissioned Anatec Ltd to carry out the Shipping and Navigation Assessments. This will ensure a consistent approach to the CIA.

4.10.2 Guidance Documents

The two main guidance documents that relate to the cumulative assessment are as follows:

- Maritime and Coastguard Agency, August 2008. Marine Guidance Note 371 (M+F) Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues; and
- DTI, November 2005. Guidance on the Assessment of the Impact of Offshore Wind Farms: Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms.

In addition to the aforementioned guidelines the following will also be considered within the cumulative assessment:

- MCA Marine Guidance Notice 372, 2008. Guidance to Mariners;
- Trinity House Lighthouse Service, 2008. Guidance based on IALA Recommendation O-139 On The Marking of Man-Made Offshore Structures, 1st Edition;
- BWEA, DTI, MCA & PLA, 2007. Investigation of Technical and Operational Effects on Marine Radar Close to Kentish Flats Offshore Wind farm;
- Howard, M. and Brown, C, 2004. Results of the Electro-Magnetic Investigations and assessments of marine radar, communications and positioning systems undertaken at the North Hoyle Wind farm by QinetiQ and the MCA;
- IMO, 2002. Guidelines for Formal Safety Assessment for use in the IMO Rule Making Process (MSC/Circ.1023/MEPC/Circ.392); and
- BERR, 2007. Guidance Notes on Applying for Safety Zones around Offshore Renewable Energy Installations – Guidance Notes.

4.10.3 Baseline

A baseline assessment will be carried out to ensure there is a sound understanding of current shipping and navigational characteristics. The following list provides a sample of the information that will be obtained within this process:

- Oil and gas operations;
- Fishing activities;
- Third party pipelines and cables;
- Water depths;
- Recreational vessel activities;
- RNLI responses and shipping accidents;
- Metocean;

- General shipping; and
- Navigational aids and features.

Overall the baseline will form the basis of consultation with the shipping and navigation stakeholders in the area.

4.10.4 Proposed Consultees

The following will be consulted during the shipping and navigation cumulative impact assessment to ensure all professional views are given consideration when assessing cumulative issues:

- Maritime and Coastguard Agency;
- Ministry of Defence;
- Northern Lighthouse Board;
- Ports & Harbour Authorities in the Moray Firth;
- The RYA;
- Chamber of Shipping;
- Scottish Fishermen's Federation;
- Ithaca; and
- Wood Group.

4.10.5 Potential Effects

Assessment of potential effects on navigation will take account of both vessels transiting through the wind farm sites and those vessels transiting outside but in close proximity (hereafter referred to as Non-Transiting Vessels).

In terms of potential effects and hazards, changes in the following hazard risks (probability of occurrence & hazard consequences) may be brought about by placement of offshore wind farms (either individually or collectively). These potential effects are separated into 'hazard risks' and 'operational costs', and may include those listed in Table 4.10.1.

Table 4.10.1 Potential Effects on Shipping and Navigation

Commercial Vessels		Fishing Vessels		Recreational Craft	
Hazard Risks	Operational Risks	Hazard Risks	Operational Risks	Hazard Risks	Operational Risks
Grounding	Fuel costs	Collision	Fuel costs	Collision	Fuel costs
Collision	Time costs	Foundering	Time costs	Foundering	Time costs
Foundering		Contact	Loss of fishing grounds	Contact	Loss of sailing areas
Contact		Snagging	Loss of fishing gear		

4.10.6 Study Area

The study area will encompass the following areas:

- MORL zone;
- BOWL site;
- Other wind farm sites;
- Proposed export cable routes; and
- Construction vessel routes.

In terms of temporal boundaries the main stages of the wind farm projects will be considered.

Do you have any comments on the proposed study area?

4.10.7 Data Gathering

Shipping and navigational data sources to be used include those described below.

Maritime Data

The Department of Energy and Climate Change (DECC) provides a web site from which it is possible to download various data. The database provides information on commercial shipping, fishing and recreational craft. Data sets include shipping density, fisheries surveillance records, and recreational cruising routes, racing areas and sailing areas.

Automatic Identification System Data

Automatic Identification System (AIS) data is transmitted from vessels to improve safety, specifically collision avoidance. All ships of 300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size carry automatic identification systems (AISs) capable of providing information about the ship to other ships and to coastal authorities automatically. AIS provides information - including the ship's identity, type, position, course, speed, navigational status and other safety-related information - automatically to appropriately equipped shore stations, other ships and aircraft. In addition fishing vessels >45 m are required to carry AIS transponders.

Radar Data

A vessel can be tracked by radar to give its range, direction and speed, and from this the vessel's course can be derived. Radar has a distinct advantage over AIS as all recording equipment needed for data collection can be tested and calibrated, and is not reliant on "onboard" or third party equipment. Radar will also pick up vessels that do not carry AIS.

Vessel Monitoring Data

Satellite vessel monitoring systems (VMS) are used as part of the sea fisheries enforcement programme, to track the positions of fishing vessels 15 metres overall length and over in UK waters. It is also used to track all UK registered fishing vessels globally. VMS data for the study area can be obtained from Marine Scotland (Compliance). Data collected includes the following:

- Since 2000, two-hourly position reports from UK vessels ≥ 24 metres in length; and
- Since 2005, two-hourly position reports from UK vessels ≥ 15 metres in length.

Fishing Vessel Surveillance Data

Surveillance data of fishing vessels from fishery protection aircraft and vessels has also been collected historically, and is again available from Marine Scotland (Compliance).

UK Coastal Atlas of Recreational Boating

The Royal Yachting Association have compiled and presented a comprehensive set of charts which defined the cruising routes, general sailing and racing areas used by recreational craft around the UK coast.

Additional Desk Based Investigation

Desk based investigations into recreational craft usage can give a clear indication of recreational traffic within the proposed wind farm area. Investigation would be in line with the data used to create the RYA UK Coastal Atlas of Recreational Boating though it should be more up to date, Investigations should be based on reference material including the following:

- Standard publications
  - Almanacs
  - Charts
  - Pilots Books
- Web information
- Consultation

Surveys

The cumulative effects assessment undertaken for this area will be based on several periods of data gathered by site specific shipping and navigation surveys. These will predominantly be carried out to gather AIS data, radar data and manual logs. Shipping survey data has been collected for the following dates:

- Chartwell (2 April to 22 September 2010); and
- Gargano (2 November to 13 December 2010) and (31 December 2010 to 9 January 2011).

Project Information

For the purposes of assessing the cumulative impact on shipping and navigation there will be certain information required from both the MORL and BOWL project teams. This information may not necessarily be available at the same time from each project team. The following data will be used:

- Locations and orientation of all offshore devices;
- Types/sizes of turbines;
- Proposed mitigation measures; and
- Cable route and laying techniques.

Other projects that will also be included are as follows:

- BOWL generating station;
- MORL western development area generating stations;
- MORL eastern development area generating stations;
- The SHETL offshore hub;
- The SHETL cable;
- The BOWL OFTO cable;
- The MORL OFTO cable;
- Relevant oil and gas activities;
- Relevant military activities; and
- Dredging and sea disposal in the Moray Firth.

Are you aware of any additional data sources that should be considered in the assessment?

4.10.8 Assessment Methodology

Preliminary Hazard Assessment

Following navigational data analysis, a Preliminary Hazard Assessment (PHA) process will be undertaken in line with International Maritime Organisation guidance. The PHA is aimed at identifying all potential hazards to shipping and navigation associated with wind farm development and determining possible mitigation or risk control options. Consideration will also be given to potential effects on aids to navigation (e.g. RADAR, GPS etc).

Consultation

Consultation with a defined set of navigational stakeholders, representative of the area will be undertaken as part of the PHA process in the form of a stakeholder workshop. This will allow local users to analyse the outputs of the analysis, pass judgement and assess the hazards posed by the installations. The process will also enable the stakeholders to provide input on mitigation and risk control measures. A representative sample of stakeholders will be identified through the Navigation Risk Assessment.

Table 4.10.2 Summary of Shipping and Navigation Methods and Activities Agreed Between Developers

Method/Activity	Status
AIS and Radar Survey	Commissioned by BOWL and MORL
Regional Data Gathering	Commissioned by BOWL and MORL
Data Analysis – regional navigation assessment and consultation	Commissioned by BOWL and MORL

Do you have any comments on the proposed assessment methodology?

4.10.9 Presentation of Results

Assessment outcomes will be presented in a stand alone regional assessment report, which will provide details on optimised wind farm boundaries and risk control measures for construction, operation and decommissioning of the wind farms. It is anticipated that the report would contain the following sections:

- Introduction
- Data collection methodology
  - Commercial vessels
  - Fishing vessels
  - Recreational craft
  - Proposed developments by other companies (as above)
- Proposed site boundaries (supplied by developers)
- Proposed construction time line (supplied by developers)
- Analysis of proposed layouts
  - Track analysis(including plots and charts)
  - Gate analysis (including plots and charts)
  - Density analysis
- Preliminary hazard assessment (FSA style assessment of each possible scenario)
- Consultation
- Risk assessment (including mitigation / risk control options).

4.11 Commercial Fisheries

4.11.1 Specialist Advisor

Both MORL and BOWL have commissioned the services of Brown and May Marine Ltd. to undertake the commercial fisheries impact assessment.

4.11.2 Guidance Documents

There is currently no detailed commercial fisheries cumulative impact assessment (CIA) guidance available. In the absence of such published guidance, it is recommended that the final approach and methodology be agreed with Marine Scotland.

4.11.3 Baseline

Commercial fishing in the Moray Firth is broadly comprised of the following activities:

- Scallop fishing on and around the Smith Bank;
- *Nephrops* trawling in the southern Moray Firth;
- Seasonal squid fishery;
- Limited seine netting for whitefish, predominantly haddock, in the northern Moray Firth; and
- Inshore potting activities.

Figure 4.11 below shows the landings values (average ten years) of commercially exploited species in the Moray Firth, by ICES rectangle.

In the case of scallop dredging, the majority of vessels are considered to be 'nomadic', insofar as they will variously target grounds around the Scottish and, on occasion, UK coast. Figure 4.12 below shows the relative value of scallop grounds around the UK coast.

4.11.4 Proposed Consultees

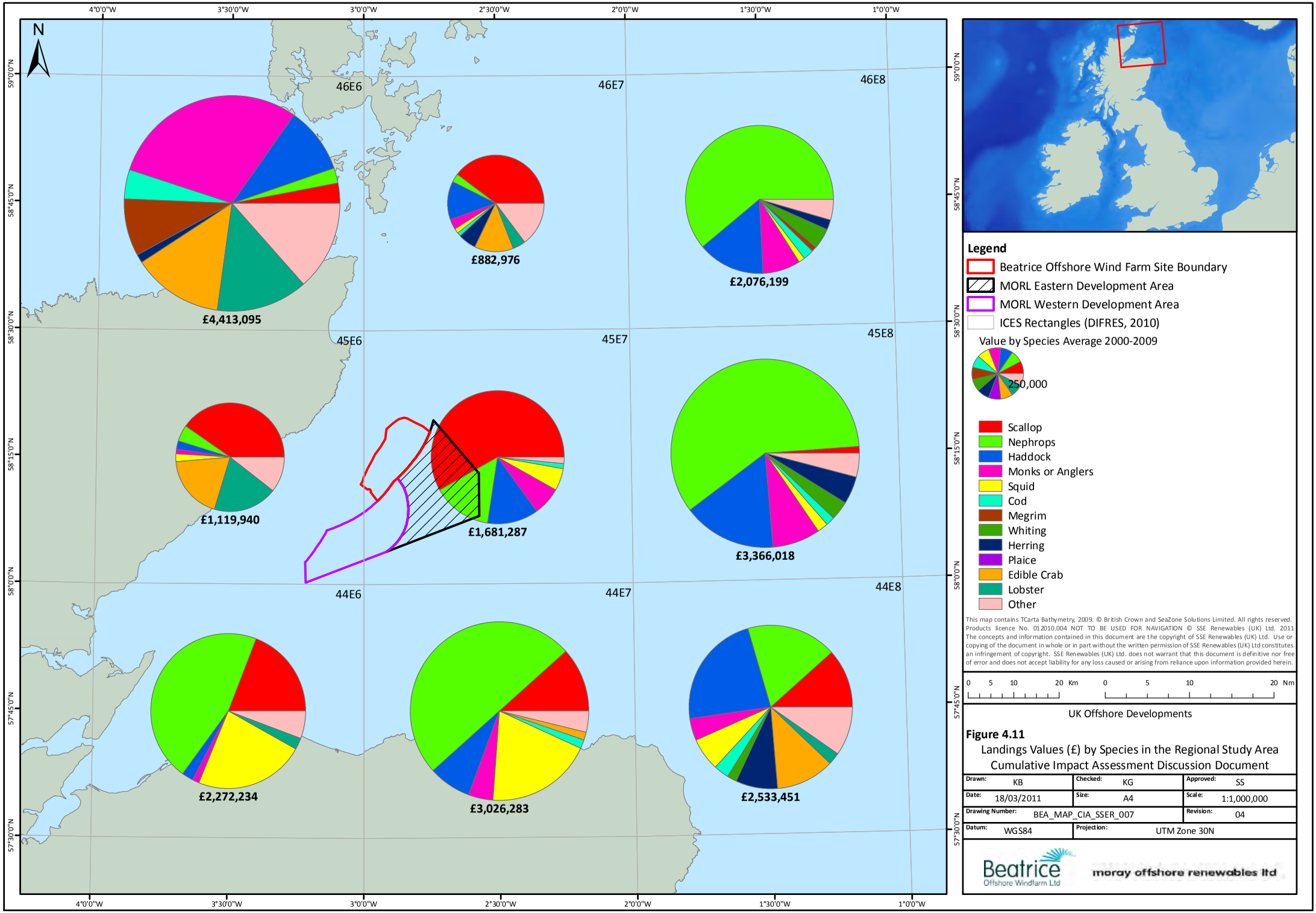
Consultation will be undertaken with the following organisations and individuals, as required:

- Marine Scotland;
- Marine Management Organisation;
- Scottish Fishermen's Federation;
- The Scallop Association;
- Inshore Fisheries Groups;
- Fishing Industry Representatives; ;and
- Any additional fisheries associations, fishermen and their representatives.

4.11.5 Potential Effects

The following potential effects of offshore wind farm development upon commercial fishing activities, as specified in the 'Offshore Wind Farms Guidance Note for Environmental Impact Assessment In Respect of FEPA and CPA Requirements (2004), are as follows:

- Implications for fisheries during the construction phase;
- Implications for fisheries when the development is completed;
- Adverse impact on commercially exploited fish and shellfish populations;
- Complete loss or restricted access to traditional fishing grounds;
- Safety issues for fishing vessels;
- Interference with fisheries activities;
- Displacement of fishing vessels;
- Increased steaming times to fishing grounds;
- Removal of obstacles on the sea bed post-construction to ensure vessel safety;
- Any other concerns raised by local fishermen and fishing organisations; and
- Adverse impact on recreational fishing stocks.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£2,533,451
Legend
Beatrice Offshore Wind Farm Site Boundary
MORL Eastern Development Area
MORL Western Development Area
ICES Rectangles (DIFRES, 2010)
Value by Species Average 2000-2009
250,000
Scallop
Nephrops
Haddock
Monks or Anglers
Squid
Cod
Megrim
Whiting
Herring
Plaice
Edible Crab
Lobster
Other
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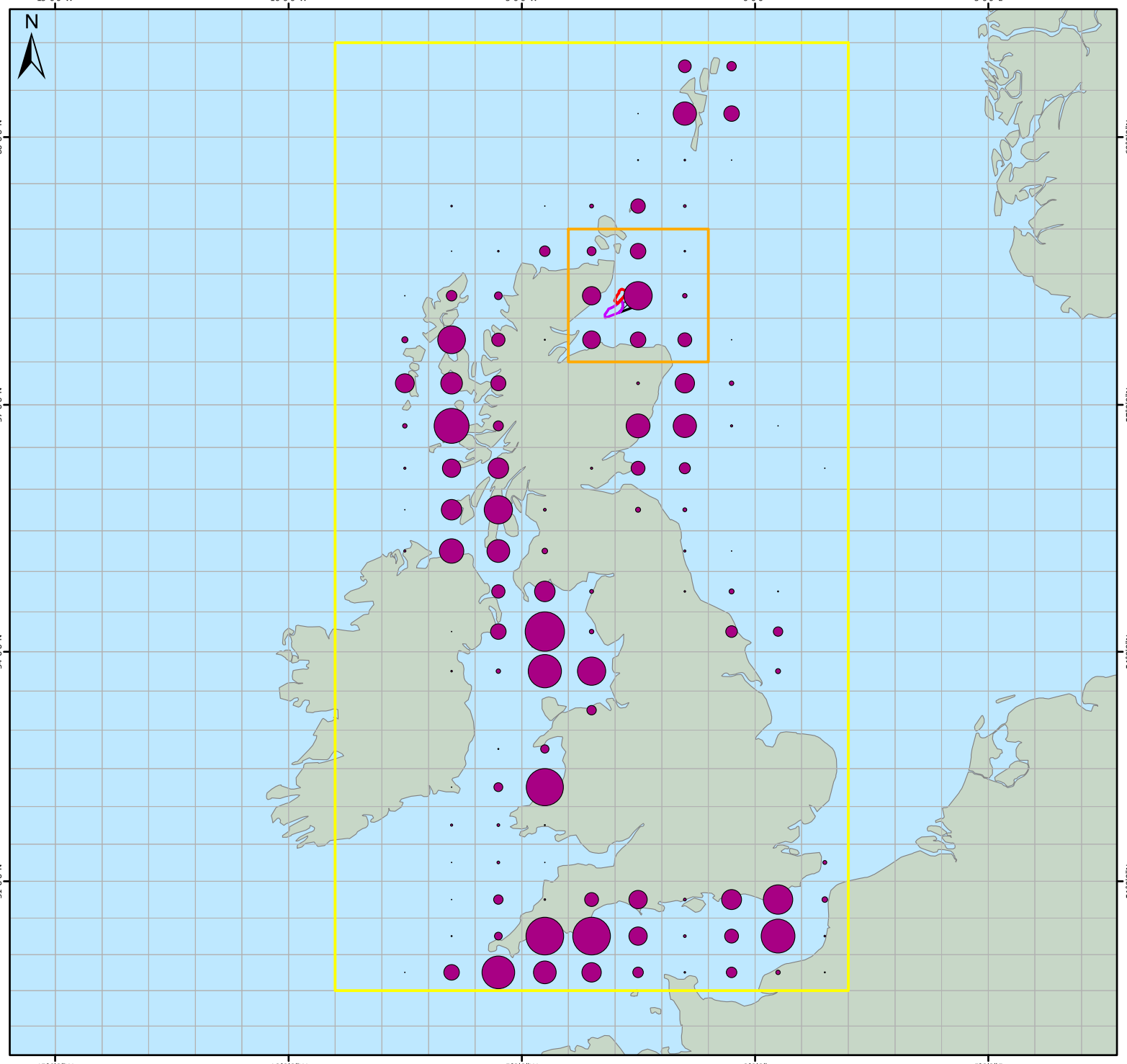
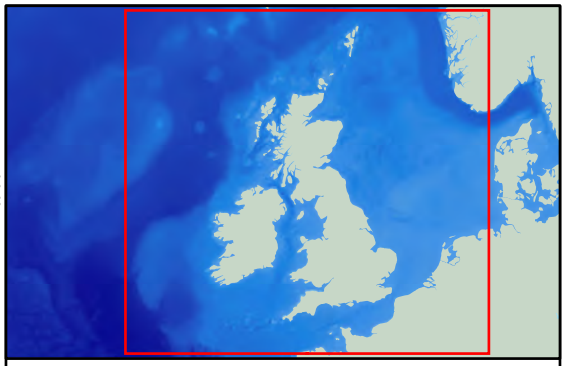
0 5 10 20 Km
0 5 10 20 Nm
UK Offshore Developments
Figure 4.11
Landings Values (£) by Species in the Regional Study Area
Cumulative Impact Assessment Discussion Document
Drawn: KB
Checked: KG
Approved: SS
Date: 18/03/2011
Size: A4
Scale: 1:1,000,000
Drawing Number: BEA_MAP_CIA_SSER_007
Revision: 04
Datum: WGS84
Projection: UTM Zone 30N
Beatrice Offshore Windfarm Ltd
moray offshore renewables ltd





Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Western Development Area
- MORL Eastern Development Area
- National Study Area
- Regional Study Area
- ICES Rectangles (DIFRES, 2010)

Relative Value (£) of Scallops, Average 2000-2009

- 800,000

0 75 150 300 Km 0 60 120 240 Nm

UK Offshore Developments

Figure 4.12

Landings Values (£) of Scallops in the UK
Cumulative Impact Assessment Discussion Document

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Date:	18/03/2011	Size:	A4	Scale:	1:13,000,000
Drawing Number:	BEA_MAP_CIA_SSER_008			Revision:	03
Datum:	WGS84	Projection:	Mercator		

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4.11.6 Study Area

Commercial fishing activities have varying geographical ranges, from the limited operational activities of the inshore potting fleet, to the UK wide activities of the scallop fleet. All fishing activities in the Moray Firth have the potential to be affected by the cumulative impact of the MORL and BOWL sites, as well as development of proposed oil and gas infrastructure, and other energy infrastructure within the Moray Firth region. In addition to this, certain vessels are also known to fish in other UK waters, such as scallop dredgers (although it is possible other towed gear fisheries may also be affected). Therefore, such fisheries sectors are likely to be affected by the wider cumulative impact from proposed offshore wind farm development, both regionally and nationally. As a result, it will be necessary to assess cumulative impacts upon these activities on a scale that includes all relevant fishing grounds around the UK.

Figure 4.13 shows the proposed regional and national study areas. The collation of data at a national level allows for the potential cumulative effects of proposed offshore wind farm developments around the UK to be assessed. Data analysis and interpretation will be more exhaustive at the regional level.

Do you have any comments on the proposed study area?

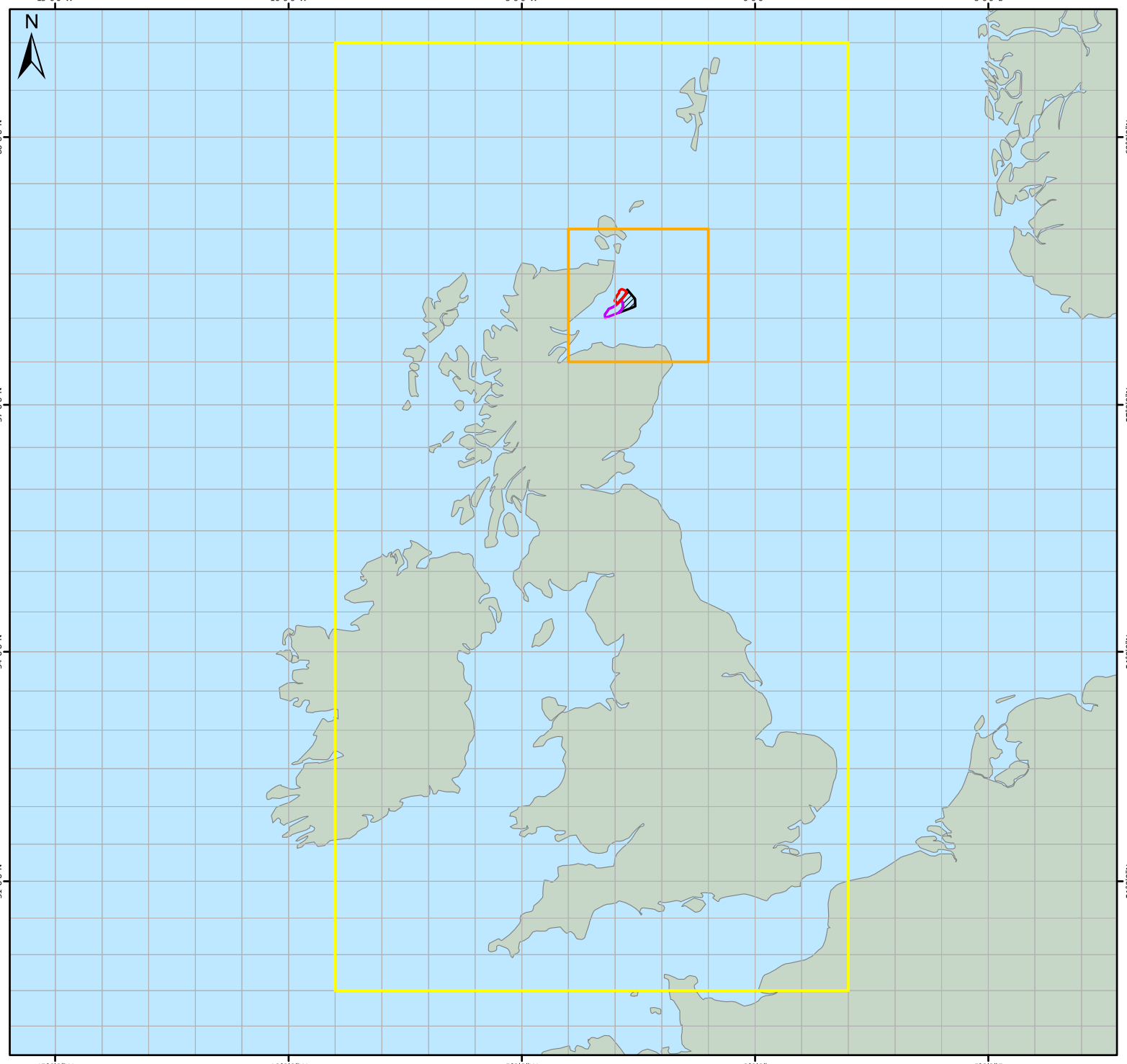
4.11.7 Data Gathering

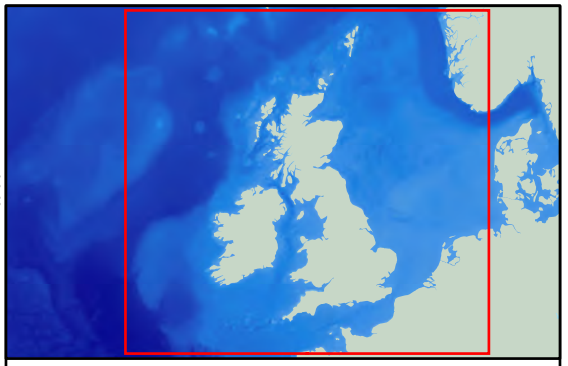
Primary data sources are listed below:

- Literature review of all available, published material;
- Marine Scotland / MMO Datasets;
- Consultation; and
- Any additional research and publications.

The data and information that will be available from MORL and BOWL will be dependent on project timescales but are anticipated to be as follows:

- Locations and specifications of turbines;
- Locations and specifications of inter array cables and export cable routes;
- Cable lay/burial method;
- Fish ecology assessment;
- Navigation assessment; and
- Proposed / agreed / existing restrictions upon fishing activities within planned / consented / operational offshore wind farms.





Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Eastern Development Area
- MORL Western Development Area
- National Study Area
- Regional Study Area
- ICES Rectangles (DIFRES, 2010)

0 75 150 300 Km 0 60 120 240 Nm

UK Offshore Developments

Figure 4.13

Regional and National Study Areas
Cumulative Impact Assessment Discussion Document

Drawn:	KB	Checked:	KG	Approved:	SS
Date:	18/03/2011	Size:	A4	Scale:	1:13,000,000
Drawing Number:	BEA_MAP_CIA_SSER_009			Revision:	04
Datum:	WGS84	Projection:	Mercator		

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The primary sources of data and information for the undertaking of the cumulative impact assessment on a regional and national scale will be as follows:

- Information provided by other wind farm developers (where available); and
- Other proposed developments in the Moray Firth region.

Are you aware of any additional data sources that should be considered in the assessment?

4.11.8 Data Analysis

Statistical Data Sets

The following statistical data sets provided by MS/MMO will be analysed:

Marine Scotland/MMO Landings Values and Effort Data

MS/MMO landings and effort data is collated by ICES rectangle. The data will be analysed and presented for the rectangles relevant to the study areas for the years 2001-2010. Where necessary for the assessment of longer term trends, additional annual data may be used. The following analysis will be undertaken:

- Information provided by other wind farm developers (where available);
- Landings values and effort data;
- Averaged landings values by rectangle by species, method and vessel length category;
- Annual landings values by species;
- Monthly (averaged) landings values by species;
- Averaged effort by method and vessel length category;
- Annual effort;
- Monthly (averaged) effort;
- Landings into ports by value; and
- Landings into ports by effort.

Marine Scotland/MMO Surveillance Sightings Data

The spatial distribution of fisheries surveillance sightings by fishing by method and nationality will be assessed. It should be noted that whilst such data provides an indication of fishing activities, it cannot describe quantitative levels due to the limited frequency of flights and patrols at sea over any given area.

Marine Scotland/MMO Satellite Tracking (VMS) Data

VMS data for over 15 m vessels (average 2005-2008) will be GIS plotted to show distribution and density. Limited data for 2009 and 2010 will be GIS plotted to show larger scale distribution and density by vessel category.

Marine Scotland Fishery Maps

This data set was produced by Marine Scotland – Science and shows the distribution of commercial fishing landings from vessels exceeding 15 m in length, by weight and by value, in the Moray Firth for the years 2007-2009.

Consultation

In addition to statistical analysis, it is expected that information gathered through consultation will describe fishing activities potentially affected by the wind farm developments and the location of fishing grounds by method. It will also assist in the identification of potential issues and specific areas/fleets with which intensive consultation may be required.

4.11.9 Assessment Methodology

Other developments to be included in this study will include the following:

- BOWL generating station;
- MORL western development area generating stations;
- MORL eastern development area generating stations;
- The SHETL cable;
- The BOWL OFTO cable;
- The MORL OFTO cable;
- The SHETL offshore hub;
- Relevant oil and gas activities;
- Other offshore wind farms;
- Shipping;
- Marine energy developments in the Pentland Firth and Orkney waters;
- Port and harbour developments in the Moray Firth;
- Relevant military activity; and
- Dredging and sea disposal in the Moray Firth.

In order to ensure consistency of approach, a review of the site specific and cumulative impact assessments undertaken for each development, where available, will be undertaken.

Each potential effect, as described above, will be considered cumulatively in the light of the established baseline. In each instance the scale of effect will be assessed relative to the sensitivity of the receptor (based upon importance and recoverability). The extent of the cumulative impact study areas for each potential effect will be defined on a receptor specific basis.

Where an impact is identified, potential mitigation measures will be evaluated with respect to their potential influence upon the residual effects.

Potential effects will be separately considered during the construction/decommissioning and operational phases of the developments. The potential effects of offshore development, planning and legislation in addition to developments in the Moray Firth will also be considered.

Construction / Decommissioning

The different construction schedules of the development projects in the Moray Firth will greatly affect an assessment of cumulative impacts. Spatial and temporal effects will influence the significance of cumulative impacts: a spatial effect will occur when developments are being constructed at the same time, which will cause a cumulative impact upon fishing in terms of the extent of the area disturbed; a temporal effect will occur with the construction of developments taking place in successive years and which will have the effect of causing a cumulative impact on fishing in terms of the extent of time fishing activities are potentially disrupted.

In addition to the construction of the developments in the Moray Firth, the construction of other Scottish or UK developments may need to be considered. This will depend on the receptor (i.e. nomadic scallop vessels).

Operation

It is considered that the potential effects arising from the operation of the BOWL and MORL developments will be spatial. As is the case in operation, in addition to the developments in the Moray Firth, the operation of other Scottish or UK developments may need to be considered. This will depend on the receptor (i.e. nomadic scallop vessels).

Standardised Assessment of Effects in EIA

Site specific impact assessments carried out for BOWL and MORL will, where possible, be integrated to facilitate the assessment of cumulative effects by each developer. In order to enable this, MORL and BOWL will be required to the following.

- Take a common, standardised approach to assessing the effects of the projects in the EIA.
- Share project information and programmes as such information becomes available.

Do you have any comments on the proposed assessment methodology?

4.11.10 Presentation of Results

The presentation of findings will be standardised for the MORL and BOWL projects in order to facilitate assessment of cumulative effects. Cumulative effects will be considered using standardised impact assessment criteria, which will be agreed by the MORL and BOWL project teams, and in consultation with Marine Scotland.

4.12 Underwater Noise

4.12.1 Specialist Advisor

Both MORL and BOWL have commissioned the services of Subacoustech Environmental Ltd to complete the EIA exercise and provide advisory services.

4.12.2 Guidance Documents

The understanding of the impacts of underwater noise on marine species is still developing and until recently guidance has been limited. However, in recent years a number of documents have been issued that will be used during the cumulative impact assessment. The documents that will be considered are set out below:

- Joint Nature Conservation Committee (JNCC), Natural England and Countryside Council for Wales. (2010). The protection of marine European Protected Species from injury and disturbance: Guidance for England and Wales and the UK offshore marine area. June 2010;
- Nedwell, J. R., Turnpenny, A. W. H., Lovell, J., Parvin, S. J., Workman, R., Spinks, J. A. L., Howell, D. (2007). A validation of the dB_{ht} as a measure of the behavioural and auditory effects of underwater noise. Subacoustech Report Reference: 534R1231, Published by Department for Business, Enterprise and Regulatory Reform (commissioned by COWRIE); and
- King, S., Maclean, I.M.D., Norman, T., and Prior, A. (2009) Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers. COWRIE.

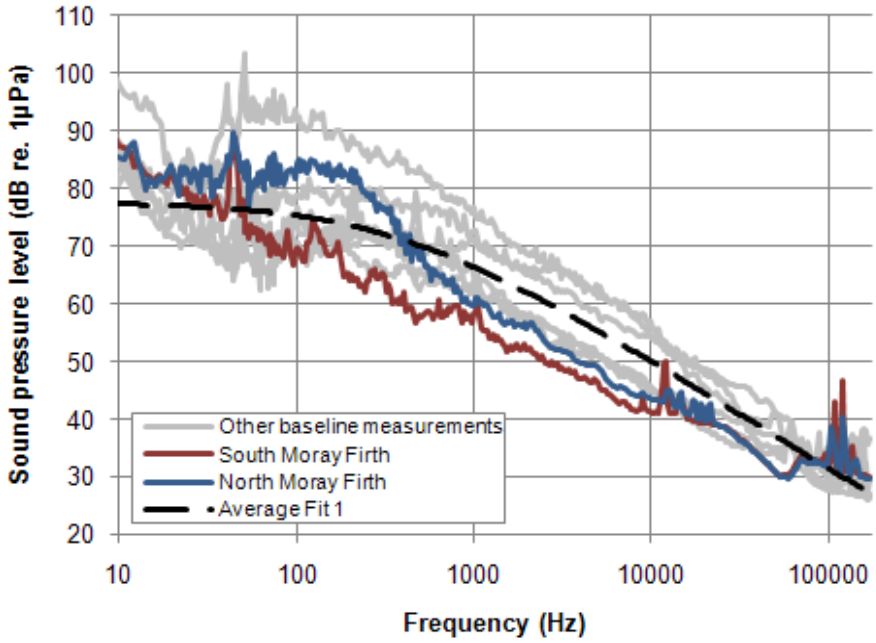
As has been noted in the fish and marine mammals sections, the King *et al*., (2009) study will be used to inform the assessment process.

4.12.3 Baseline

The underwater noise aspects of the EIA will consider the impact on marine mammals and relevant fish species and birds.

Subacoustech hold a database of baseline underwater noise measurements from many locations around the UK coast, including the Moray Firth. As part of the data review these data have been compared and this indicates that background noise in the Moray Firth are generally slightly below average at frequencies above 500Hz but may occasionally be slightly higher than average. The data does not indicate a baseline noise level for the Moray Firth region significantly out of the ordinary and this is illustrated in Box 4.12.1. As such, a baseline noise survey is not considered necessary however this will be confirmed with regulators.

Box 4.12.1 Background noise in the Moray Firth compared with other locations around the UK Coast



The levels of underwater noise that are sufficient to cause physical or behavioural effects to marine species are considerably higher than baseline noise levels and the cessation of behavioural impact will occur when the noise has fallen to an acceptable level rather than to background. Therefore baseline noise is not critical in assessing an impact for high levels sources such as impact piling. Baseline noise will therefore be considered on a more generalised basis using measured underwater noise data from other areas around the UK coast. Subacoustech Environmental holds a large database of baseline noise recordings that will be used for this purpose and further public domain literature will also be used, where available.

Potential noise from military sonar and other development activities within the Moray Firth region (e.g. offshore hub and proposed oil and gas infrastructure) will also be considered where details are available.

Both developers are currently considering the use of impact piling operations during the construction of the wind farm and it is likely that these will be the principal consideration in terms of cumulative impact due to the large areas that could potentially be affected by underwater noise. The impacts of other noisy activities such as vessel movements will also be considered.

Noise levels from turbine operation are considered to be negligible, both in terms of their absolute levels, and in terms of their potential to cause cumulative effects by superposition with other noise. It is proposed that noise from turbine operation is scoped out of the cumulative impact assessment.

4.12.4 Proposed Consultees

It is proposed that the following organisations will be consulted during the EIA process:

- Marine Scotland;
- SNH;
- JNCC; and
- Ministry of Defence.

4.12.5 Potential Effects

Potential effects resulting from the cumulative effects of underwater noise are considered under the relevant receptor headings; see Section 4.4, fish ecology, Section 4.5, marine mammals and Section 4.6 ornithology.

4.12.6 Study Area

The study area will be determined based on the area of impact for the most sensitive marine species to be assessed and the developments to be included in the cumulative impact assessment. See Section 4.4, fish ecology, Section 4.5, marine mammals and Section 4.6 Ornithology.

Do you have any comments on the proposed study area?

4.12.7 Data Gathering

As part of the wider EIA process, Subacoustech Environmental is carrying out a desk-based review of all publically available information and also data held on its own internal database. This work is ongoing, however, data on the baseline noise levels as described above, are available.

Source level, frequency range and transmission loss data are also available on a wide range of wind farm related underwater noise sources so it is proposed that all data required for the assessment can be gathered by desk based studies.

Of principal importance to the underwater noise study will be the source level of the impact piling operations as this will be the principal source of disturbance. This information will also be gathered from a desk-based exercise and will predominantly be based on the information contained on the Subacoustech Environmental internal database of recordings. This is probably the largest database of broadband underwater noise recordings in the world and it is therefore considered to be the best available resource for this project.

Are you aware of any additional data sources that should be considered in the assessment?

4.12.8 Assessment Methodology

The assessment methodology for the cumulative impact assessment will be based on the modelling and analysis procedures that will be used in the broader EIA process. The proposed underwater noise modelling methodology is presented in Annex D. This will be based on a number of key processes, as follows:

- A broad-brush Source Level-Transmission Loss model will be used in order to identify the key noise sources that are likely to have an adverse impact on marine species. This will allow noise sources to be rank-ordered and eliminated from further consideration;
- Subsea noise propagation modelling will then be carried out using the proprietary noise propagation model, INSPIRE, to estimate the ranges of impact for various simultaneous piling operations;
- The extent of cumulative impacts will be assessed based on the overlap of impact zones (auditory injury and behavioural impact);
- In order to conform to the assessment requirements for the EU Habitats Directive relating to the deliberate disturbance to marine mammals, the impact zones will be based on both the M-weighted Sound Exposure Level model (1) as per the JNCC guidance and also the dB_{ht} (species) as the two principal metrics currently available for assessing the impact of underwater noise; and
- In order to make the assessment quantitative in nature these data will need to be compared to marine mammal and fish ecology data. This will be carried out by the relevant specialists.

Do you have any comments on the proposed assessment methodology?

4.12.9 Presentation of Results

Underwater noise impact zones for various individual species (for the dB_{ht} (*species*) data) and for species groups (for the M-weighted SEL data) will be presented as contours of equal perceived loudness overlaid on suitable GIS base layers. Initially these will be charts of the region showing bathymetric data and key locations within the wind farm area. These data will be presented in technical reports to both MORL and BOWL.

4.13 Socio-economics, Recreation and Tourism

4.13.1 Specialist Advisor

It is anticipated that BOWL and MORL will appoint socio-economic specialists to further the cumulative impact assessment in the near future. Consideration is being given to the appointment of the same consultant for both projects as this would promote consistency of approach and streamline the cumulative impact assessment process.

(1)Southall, Brandon L.; Bowles, Ann E.; Ellison, William T.; Finneran, James J.; Gentry, Roger L.; Greene, Charles R.; Kastak, David; Ketten, Darlene R.; Miller, James H.; Nachtigall, Paul E.; Richardson, W. John; Thomas, Jeanette A.; Tyack, Peter L, (2007) Marine Mammal Noise Exposure Criteria Aquatic Mammals, Vol 33 (4).

4.13.2 Potential Effects

Both the BOWL and MORL projects are of such a large scale that it is likely to have significant impacts at a national level. Significant impacts from the quantity of electricity to be provided, from helping to meet EU and national political targets for renewables and CO_2 emission reduction, and helping to achieve long term sustainable development of the Scottish economy, and job creation.

4.13.3 Assessment Methodology

Other developments to be included in this study will include the following:

- Other offshore wind farms;
- Shipping;
- Port and harbour developments in the Moray Firth;
- Relevant military activity; and
- Relevant oil and gas activities.

Once an appropriate appointment(s) has been made the approach to the cumulative assessment will be detailed and agreed with relevant consultees.

An assessment of effects will need to be undertaken first on a site-specific basis and thereafter the developers will share information to enable an informed assessment of cumulative effects within their respective EIAs.

Proposed methodologies for the assessment of Socio-economics, Recreation and Tourism impacts are outlined in detail in the BOWL and MORL Scoping documents. The methodologies by which cumulative effects will be assessed will be developed jointly by BOWL and MORL to ensure consistency where required.

4.14 Oil and Gas, Cables and Pipelines

4.14.1 Baseline

Much of the area of the Moray Firth has never been licensed for oil and gas exploration, or was previously licensed but has since been relinquished. The main oil and gas activity in the Moray Firth area at present is the Beatrice oil field (Block 11/30a). This field was discovered in 1976 and began production in 1981. The oil field has produced over 160 million barrels of oil to date. In the 23rd Licensing Round, Ithaca was also awarded, as one licence, several further blocks and part blocks which surround the Beatrice Field. Polly, 2.5 km east of Beatrice oil field is an emerging opportunity and straddles blocks 11/30a and 12/26c. The Polly oil field region has been illustrated with reference to Ithaca Energy website(1). Key structures include the following:

- The Jacky platform;
- Beatrice Alpha, Bravo and Charlie platforms;

(1)http://www.ithacaenergy.com/greater-beatrice-area.asp

- Seabed cables and pipelines linking the platforms;
- Beatrice oil is exported via a 66 km long 16 inch pipeline from the Alpha complex to a shore terminal at Nigg in the Cromarty Firth, where it is stored until tanker shipment; and
- The Beatrice complex is linked to the mainland via a 132/33 kV seabed power cable from Dunbeath. The demonstrator wind turbines provide approximately 30 % of the Alpha platforms daily requirements.

Beatrice oil platforms A, B and C are owned by Talisman Energy and operated by Ithaca Energy. The Jacky platform is owned and operated by Ithaca Energy. Existing oil and gas infrastructure including well heads will be afforded certain wayleaves and buffer zones, restricting certain types of activities and development within their proximity. Caithness Petroleum holds three licences awarded in the 23rd Round and covering five offshore blocks in the northern coastal area of the Inner Moray Firth. PA Resources hold an exploration licence in the Moray Firth and has been awarded a new license in the UK's 26th Licensing Round.

Cumulative impacts on helicopters and vessels servicing oil and gas infrastructure are considered in Section 4.9 Aviation and Section 4.10 Shipping and Navigation.

The Kingfisher Cable Awareness Charts identify the main subsea cable routes around the coast of the UK. The SHEFA telecommunications cable runs north to south to the east of the development sites. There is also the proposed Viking power transmission cable to consider, the current route of which passes through the MORL eastern development area.

Figure 4.14 illustrates oil and gas infrastructure in the Moray Firth, the SHEFA cable and the proposed Viking Cable.

4.14.2 Proposed Approach

Consultations will take place with the existing platform operators and owners and licence holders to fully understand current and future exploration and production operations.

Consultations are ongoing with SHETL to investigate potential issues, constraints and mitigation measures to ensure all required cabling can be accommodated for each project. SHEFA Ltd will also be consulted.

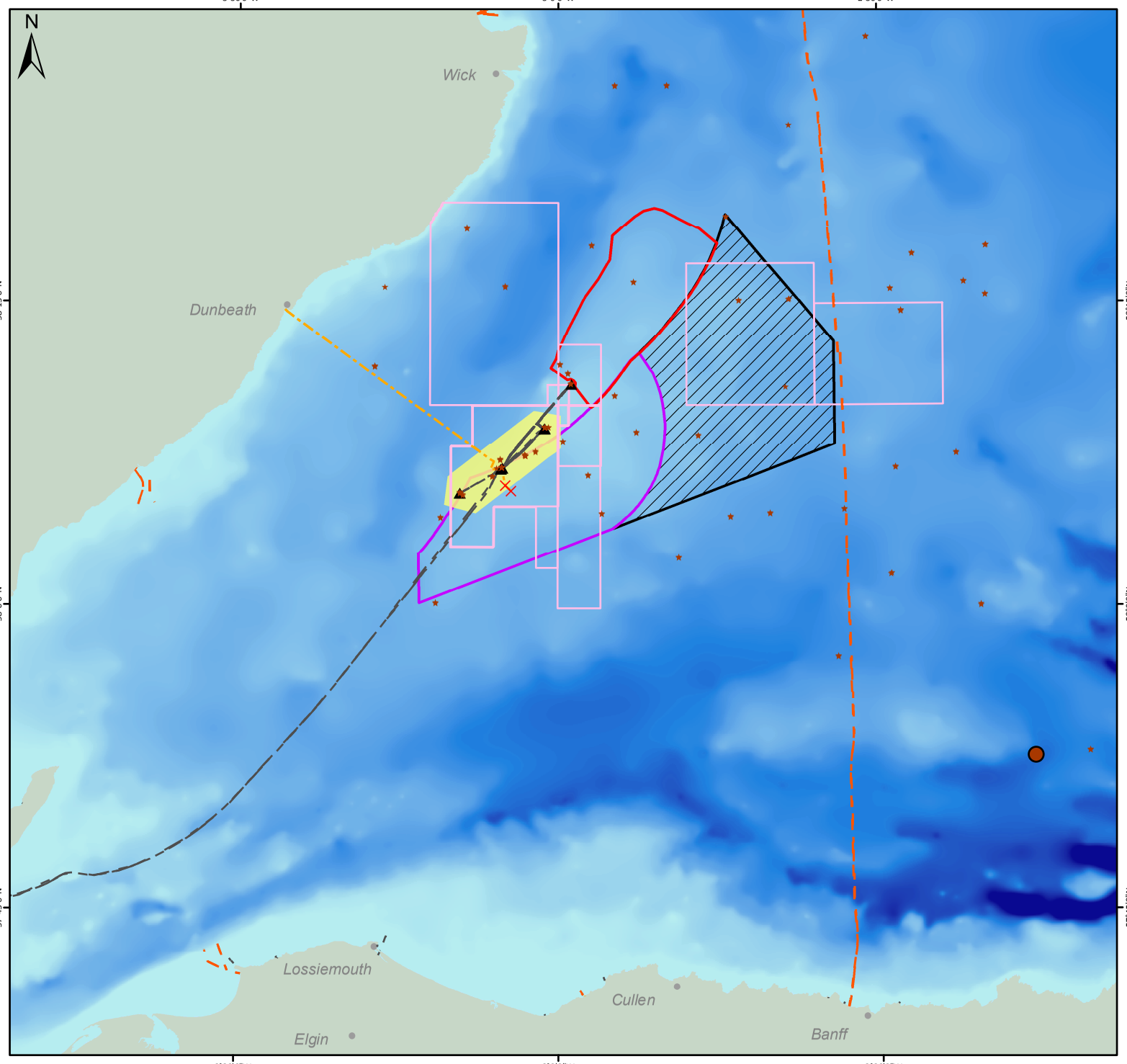
Other developments to be included in this study will include the following:

- BOWL generating station;
- MORL western development area generating stations;
- MORL eastern development area generating stations;
- The SHETL cable;
- The BOWL OFTO cable;
- The MORL OFTO cable; and
- The SHETL hub.

Do you have any comments on the proposed study area?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the assessment methodology?



Legend

- Beatrice Offshore Wind Farm Site Boundary
- MORL Western Development Area
- MORL Eastern Development Area
- Offshore Production Area
- Oil and Gas Licence Regions
- Cable, submarine
- Power Cable, submarine
- Pipeline, submarine
- Existing Demonstrator Turbine
- Wellhead
- Offshore Installation
- Fixed platform/structure

Bathymetry

(Metres Below Sea Level)

0m

-220m

0 2.5 5 10 Km 0 2.5 5 10 Nm

UK Offshore Developments

Figure 4.14

Oil and Gas Activities in the Moray Firth
Cumulative Impact Assessment Discussion Document

Drawn:	KB	Checked:	KG	Approved:	SS
Date:	05/04/2011	Size:	A4	Scale:	1:500,000
Drawing Number:	BEA_MAP_CIA_SSER_016			Revision:	02
Datum:	WGS84	Projection:	UTM Zone 30N		

Beatrice Offshore Windfarm Ltd

moray offshore renewables ltd

4.15 Onshore Traffic and Transport

4.15.1 Specialist Advisor

Specialist consultants will be appointed by both MORL and BOWL to undertake an assessment of traffic and transport impacts.

4.15.2 Potential Effects

The proposals relate solely to the marine elements of the wind farm projects (OFTO will be subject to separate licensing and permissions). However, at this stage it is anticipated that turbine components would be delivered to a suitable port facility by sea before being transferred to the wind farm sites to be erected. If both projects were to use the same port facility, there may be the potential for significant land based traffic and transport cumulative impacts. Furthermore, if other port users were loading or unloading abnormal loads or large volumes of material, further cumulative impacts could result.

4.15.3 Assessment Methodology

Where there are residential properties or other sensitive receptors near roads, guidance provided by the former Institute of Environmental Assessment (1) (now the Institute of Environmental Management and Assessment) suggests that significant traffic-related environmental impacts (i.e. noise) may occur if:

- traffic generated by the development increases baseline traffic flows by more than 30 percent; or
- site-related HGV traffic increases HGV flows by more than 10 percent.

Whether significant cumulative impacts result will depend on the port facilities selected. Once port facilities have been selected, local councils and Transport Scotland will be consulted in order to discuss any requirement for an assessment of cumulative traffic and transport impacts during construction and operation of the developments. This may involve the collection of a baseline e.g. classified average annual daily flows and the prediction of generated traffic associated with the project. The percentage traffic increase above the baseline traffic flows would be calculated and an assessment made.

Other developments to be included in this study will include the following:

- BOWL generating station;
- MORL western development area generating stations;
- MORL eastern development area generating stations;
- The SHETL cable;
- The BOWL OFTO cable;
- The MORL OFTO cable;
- Other offshore wind farms; and

(1) Institute of Environmental Assessment (1993) Guidelines for Environmental Assessment of Road Traffic, Guidance Notes No 1, IEA.

- Relevant oil and gas activities.

Do you have any comments on the proposed study area? Are you aware of any additional data sources that should be considered in the assessment? Do you have any comments on the assessment methodology?

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5. CONSULTEE RESPONSE TEMPLATE

One of the objectives of this document is to invite comment from statutory and other key consultees and seek agreement of the approaches proposed by the MFOWDG. We are particularly interested in your responses to the specific questions below and would also welcome any other comments you may have.

Please submit your response by 2 May 2011 to Moray Firth Offshore Wind Developers Group care of:

Stuart Szylak
Environmental Resources Management
Norloch House
36 King's Stables Road
Edinburgh
EH1 2EU

By Email to:
stuart.szylak@erm.com

5.1 Definitions, Receptors and Developments

Do you agree with the definitions of cumulative impacts proposed?

Do you have any comments on Table 2.6.1?

Are the effects identified in Table 3.1.1 appropriate and are you aware of any other effects that should be considered?

Do you agree with the receptors that have been scoped out of the cumulative impact assessment?

Do you agree with the developments to be considered during the cumulative impact assessment? Are there additional developments that should be considered?

5.2 Nature Conservation Designated Areas

Are there other designated areas you would suggest are considered as part of the assessment, in addition to those provided in Table 4.1.4?

5.3 Physical Processes and Geomorphology

Do you have any comments on the proposed study area?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the proposed assessment methodology?

5.4 Marine Mammals

Do you agree that long term avoidance is not likely to be a potential cumulative impact?

Do you have any comments on the proposed study area?

Do you have any comments on the proposed assessment methodology?

5.5 Ornithology

Do you have any comments on the proposed study area?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the proposed assessment methodology?

5.6 Benthic Ecology

Do you agree that the potential release of contaminants and accidental spillages can be scoped out of the cumulative impact assessment?

Do you have any comments on the proposed study area?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the proposed assessment methodology?

5.7 Fish Ecology

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the proposed assessment methodology?

5.8 Landscape, Seascape and Visual Impacts

Do you have any comments on the proposed study area?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the proposed approach to the assessment methodology?

5.9 Archaeology and Cultural Heritage

Do you consider that the initial 30 km study area is appropriate?

Do you consider that the initial 1 km buffer is sufficient?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the proposed assessment methodology?

5.10 Commercial Fisheries

Do you have any comments on the proposed study area?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the proposed assessment methodology?

5.11 Shipping and Navigation

Do you have any comments on the proposed study area?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the proposed assessment methodology?

5.12 Aviation/MOD

Do you have any comments on the proposed study area?

Do you have any comments on the proposed assessment methodology?

5.13 Underwater Noise

Do you have any comments on the proposed study area?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the proposed assessment methodology?

5.14 Traffic and Transport

Do you have any comments on the proposed study area?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the assessment methodology?

5.15 Oil and Gas, Including Cables and Pipelines

Do you have any comments on the proposed study area?

Are you aware of any additional data sources that should be considered in the assessment?

Do you have any comments on the assessment methodology?

5.16 Any Further Comments

Please provide any further comments on the proposed approach to cumulative impact assessment.

Annex A

Methodology for Coastal Processes EIA

moray offshore renewables limited

Beatrice Offshore Windfarm Ltd and
Moray Offshore Renewables Ltd

Proposed Methodology for Coastal Processes EIA for the Beatrice and Moray Firth Offshore Wind Farm Developments

Date: November 2010
Project No: R/3888/7
Report No: R.1698

Proposed Methodology for Coastal Processes EIA for the Beatrice and Moray Firth Offshore Wind Farm Developments

Contents

Appendix

Tables

Figures

Abbreviations

2D	2-Dimensional
3D	3-Dimensional
ABPmer	ABP Marine Environmental Research Ltd
BOWL	Beatrice Offshore Windfarm Ltd
Cefas	Centre for Environment, Fisheries & Aquaculture Science
CPA	Coastal Protection Act
Defra	Department for Environment, Food and Rural Affairs
DHI	Danish Hydraulic Institute
DNV	Det Norske Veritas
EDPR	EDP Renováveis
EIA	Environmental Impact Assessment
ES	Environmental Statement
FEPA	Food and Environment Protection Act
GW	Giga Watts
HRA	Habitat Regulations Assessment
JNCC	Joint Nature Conservation Committee
MCA	Maritime and Coastguard Agency
MGN	Maritime Guidance Note
MORL	Moray Offshore Renewables Ltd
MS	Marine Scotland
MW	Mega Watts
OFTO	Offshore Transmission Operator
OREI	Offshore Renewable Energy Installation
PDS	Project Design Statement
RSPB	Royal Society for the Protection of Birds
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SERL	SeaEnergy Renewables Limited
SNH	Scottish Natural Heritage
SPA	Special Protection Areas
SSC	Suspended Sediment Concentration
UK	United Kingdom

1. Introduction

Beatrice Offshore Windfarm Ltd (BOWL) and Moray Offshore Renewables Ltd (MORL) propose to construct Offshore Wind Farms adjacent to each other in the Moray Firth, Scotland (Figure 1). An overview of these developments is provided in the following sections.

Environmental Impact Assessment (EIA) scoping documents were provided by BOWL and MORL to Marine Scotland (MS) in early to mid 2010. The reports contained sections for each of the anticipated EIA topics, including 'Coastal Processes', a topic that broadly encompasses the potential effects of the developments on the physical (marine) environment. In relation to coastal processes, the report provided information relevant to the proposed Beatrice and Moray Firth Offshore Wind Farms including the following.

- A baseline summary description of the naturally occurring:
  - wind and wave climate;
  - tidal regime (water levels and currents);
  - predicted effects of climate change;
  - geology and seabed sedimentary deposits;
  - seabed sediment mobility; and
  - suspended sediment concentrations.
- Consideration of the potential for in-combination and cumulative effects.
- A summary of potential impacts of the development identified for assessment.
- A summary of the proposed methods by which these potential impacts might be assessed.

This information was disseminated by MS to a further list of statutory and non-statutory consultees, some or all of whom have returned an opinion regarding their more specific requirements for a suitable depth and breadth of EIA.

This document summarises for both developments, the coastal process issues identified by the original scoping documents and, in the instance of the BOWL project, by the subsequently received scoping responses. More detail is then provided with regard to the proposed methodologies by which to make the required assessments, however, these may be necessarily subject to slight variation where possible (following the anticipated publication of best practice guidelines) as the project and the data/evidence base evolves.

This document also will form the basis for further consultation with MS in order to agree a definitive list of issues that will be addressed by the EIA process for both developers.

At the time of writing this version of this document, comments have not yet been received in response to the MORL scoping document, although it is not expected that any significantly different issues will be identified at this stage. Following receipt of comments, this document will be updated accordingly and resubmitted to MS, highlighting any additions or modifications to the list of identified issues or the methodologies proposed.

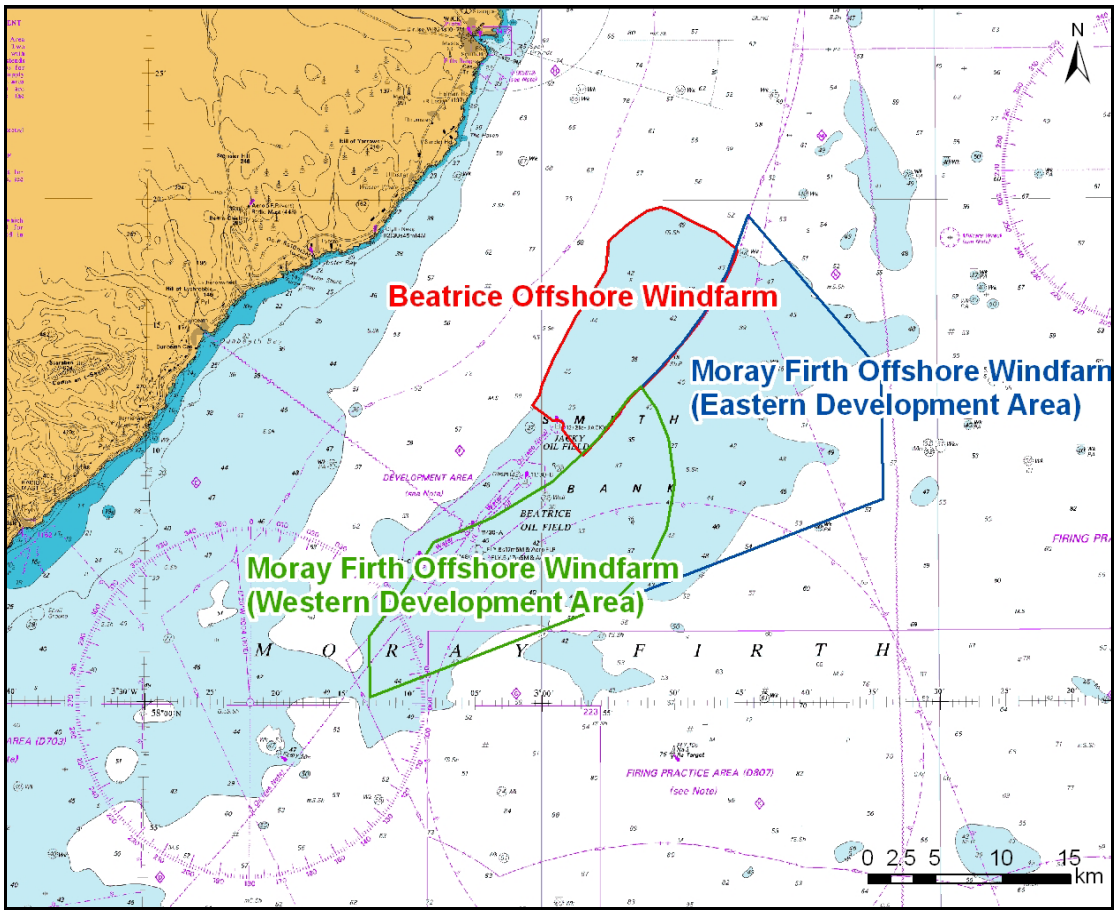

Figure 1. Location of the BOWL and MORL Wind Farm Developments

1.1 Overview of the BOWL Offshore Wind Farm Development

In February 2009, SSE Renewables and SeaEnergy Renewables were granted permission by The Crown Estate to investigate the feasibility and development of the proposed 'Beatrice' offshore wind farm site in Scottish Territorial Waters. SSE Renewables and SeaEnergy Renewables have together formed BOWL to undertake this investigation.

The Beatrice Offshore Wind Farm site is located on the Smith Bank, approximately 15km off the Caithness coastline in the Moray Firth, Scotland (see Figure 1). The south-eastern site boundary (corresponding also to the common boundary between the BOWL and MORL developments) is determined by the Scottish territorial waters limit. The site lies in water depths between 35-50m with a tidal range of 2.8-3.2m and with a maximum tidal current speed of approximately 0.5 knots.

The Beatrice site could accommodate up to 200 wind turbines each with a capacity of approximately 5MW and a maximum rotor tip height of approximately 150m above sea level. However, the final design and layout of the wind farm will ultimately be informed by a number of technical, physical and environmental considerations.

1.2 Overview of the MORL Offshore Wind Farm Development

In January 2010, The Crown Estate awarded EDP Renováveis (EDPR) and SeaEnergy Renewables Limited (SERL) the exclusive rights to develop wind farm sites within Zone 1 of the UK Round 3. EDPR and SERL have formed MORL to develop the zone in the Moray Firth, Scotland

The Moray Firth zone is located 22.2km from the coast on the Smith Bank in the Moray Firth and covers an area of 522.15km^2. The water depths vary between approximately 30-60m. Peak spring tidal speeds can be up to 1.2 knots.

MORL intends to develop 1.5GW of offshore wind by 2020 within the zone. The development will be split into two phases (see Figure 1): a 1.14GW phase (Eastern Development Area) and a 360MW phase (Western Development Area). The table below shows the intended deployment scenarios for the Eastern and Western Development areas from 2016 to 2020.

Table 1. Intended deployment scenarios for the MORL Eastern and Western Development areas from 2016 to 2020

Year	Annual No of Turbines Installed	Turbine Rating (MW)	Annual Installed Capacity (MW)	Cumulative Capacity (MW)	Phase
2016	24	5	120	120	Eastern
2017	60	5	300	420	Eastern
2018	60	6	360	780	Eastern
2019	60	6	360	1140	Eastern
2020	60	6	360	1500	Western

Although the above estimate is based on 5-6MW it is intended that the project will be consented using the envelope of a 5-8MW turbine. As such the turbine number may reduce if the larger rating (and height) turbines are used.

It is intended to progress the consenting of the Eastern Development Area and Western Development Area separately, with the consent applications for Eastern Development Area to be submitted in early Q2 2012 and consent application for Western Development Area to be submitted in 2015.

2. Summary of EIA Scoping and Responses

2.1 Summary of the EIA Scoping Reports: Updated Baseline Conditions

Both EIA scoping reports presented a baseline environmental description, informed by the available literature, from which the scoped EIA issues were proposed. Since that time, the conceptual understanding of the sites has become further supported by the outcomes of the metocean and geophysical surveys that have been undertaken (to date). These data will be reported during the course of the EIA exercise in the form of the baseline assessment in the ES and as separate survey type specific reports.

In particular, the metocean and geophysical surveys have provided further evidence in support of the previous assessment of sediment mobility and transport patterns on the Smith Bank.

It was previously understood (e.g. from Holmes *et al*. 2004) that the internal structure of the Smith Bank comprises erosion resistant glacial till deposits (poorly sorted gravels and sands) and other relatively stable geological sequences. This means that the bank as a morphological feature is relic and inherently stable. A relatively thin sand veneer is observed across parts of the bank (order tens of centimetres to a few meters thick). The geophysical data collected from the BOWL site to date (presently in draft form) supports this description; similar data will become available for the Eastern Development Area of the MORL site shortly.

It has become increasingly evident from the historical and measured tidal and wave climate data that the tidal regime is insufficient to induce frequent mobility of these sands but that intermittent storm wave action may cause energetic sediment resuspension (but not necessarily directional transport). Measurements of suspended sediment concentrations have been observed to significantly increase during storm events, but not in response to the spring-neap tidal cycle.

The draft findings of the BOWL geophysical survey (OSIRIS, pers. comm.) also did not indicate the presence of any tidal current related sedimentary bedforms. Instead, the indicators of long-term sediment transport direction (buried slope angles in the sub-surface geophysical data) suggest that, once resuspended by waves, sediment tends to move down slope under gravity and off the crest of the bank, rather than in the direction of the tidal axis or the dominant wave directions. It is likely that the same observations will result from the similar MORL surveys, to be reported in the near future.

2.2 Summary of the Original EIA Scoping Report: Previously Identified EIA Issues

In the original scoping reports, the following potential impacts were identified for consideration by MS and other consultees.

Potential impacts during the construction and decommissioning phases were identified as the following:

- Increase in suspended sediment concentration during installation/removal of foundations or cables, or the initial phases of seabed scouring around foundations, resulting in short-term locally elevated levels of suspended sediment concentrations and subsequent deposition of sediment on sensitive receptors.
- Seabed compaction or smothering in the footprint of foundations and of jack-up vessels used, leading to mortality of sensitive marine life in these areas.

Potential impacts during the operational phase were identified as the following:

- Changes to patterns of tidal currents and wave activity leading to changes in sediment transport pathways (suspended or bedload) and the form and function of the Smith Bank, impacting on sensitive receptors.
- Scour around foundations leading to local changes in seabed morphology, potentially impacting upon the stability of the turbine foundation itself as a sensitive receptor.
- Impacts on swell waves (period, height and direction) leading to impacts on recreational surfing wave resource in the lee of the development.
- Changes to erosional/depositional processes along the adjacent coastline impacting on morphology and consequently on sensitive receptors.

Potential cumulative and in-combination effects were identified as the following:

- The interaction between plumes of sediment created by the coincident installation of foundations or burial of cables as part of the Beatrice and Moray Firth Offshore Wind Farm site developments during the construction phase, leading to enhanced levels of suspended sediment concentration or rates or thicknesses of sediment deposition, impacting on sensitive receptors.
- The cumulative changes to patterns of tidal currents and wave activity as a result of the presence of both the Beatrice and Moray Firth Offshore Wind Farm site foundations in the operational phase, leading to changes in sediment transport pathways (suspended or bedload) and the form and function of the Smith Bank, impacting on sensitive receptors.
- The cumulative attenuation of waves as a result of the presence of both the Beatrice and Moray Firth Offshore Wind Farm site developments in the operational phase, leading to greater changes or likelihood of changes in erosional/depositional processes along the adjacent coastline impacting on morphology and consequently on sensitive receptors.

2.3 Summary of Scoping Responses

The comments considered relevant to the coastal processes topic of the EIA for the present study are summarised in Table 2, extracted from the various scoping response documents. Comments were provided by the following consultees but not all consultees provided comments relevant to coastal processes.

- Statutory Consultee:
  - Scottish Natural Heritage
- Non-Statutory Consultees:
  - JNCC;
  - RSPB;
  - Historic Scotland;
  - Civil Aviation Authority;
  - Maritime and Coastguard Agency;
  - BT Networks;
  - Northern Lighthouse Board;
  - RYA; and
  - Ports and Harbours.

2.3.1 Scoping Responses Received by BOWL

The comments received in response to the BOWL scoping document from stakeholders of relevance to the coastal processes study are summarised in the following separate documents.

- Marine Scotland (September 2010). Beatrice Offshore Wind Farm - Moray Firth: Scoping Opinion. pp28.
- Scottish Natural Heritage (May 2010). Beatrice - Proposed Offshore Wind Farm: SNH and JNCC Scoping Advice. pp34. Letter, ref CNS REN OSWF BEA.
- Historic Scotland (2010). Beatrice Offshore Wind Farm, Scottish Territorial Waters, Moray Firth Scoping Opinion. Letter, 15/4/2010, ref AMN/16/H.
- Moray Firth Inshore Fisheries Group (2010). Beatrice Offshore Wind Farm Ltd, Beatrice Offshore Wind Farm: Environmental Impact Assessment (EIA) - Scoping Exercise Consultation. Letter, 0/4/2010.
- Northern Lighthouse Board (2010). Beatrice Offshore Wind Farm - EIA Scoping Exercise Consultation. Letter, 9/4/2010, ref AJ/OPS/CPA/OREI/10/W.
- RYA (2009). The RYA's Position on Offshore Energy Developments. General guidance note, December 2009.

2.3.2 Scoping Responses Received by MORL

At the time of writing this version of this document, comments have not yet been received in response to the MORL scoping document, although it is not expected that any significantly different issues will be identified at this stage. Following receipt of comments, this document will be updated accordingly and resubmitted to MS, highlighting any additions or modifications to the list of identified issues or the methodologies proposed.

2.3.3 MCA Guidance MGN371

The MCA and the Ports and Harbours consultees have requested that the assessment should comply with MCA non-mandatory guidance note MGN371. Of relevance to the coastal

processes topic, Annex 2 (Part 1 - The Effect of Tides and Tidal Streams) of the guidance recommends that it should be determined whether:

- Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed installation is situated at various states of the tide i.e. whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa;
- The set and rate of the tidal stream, at any state of the tide, has a significant affect on vessels in the area of the site;
- The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect;
- The set is across the major axis of the site layout at any time, and, if so, at what rate;
- In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream;
- The structures themselves could cause changes in the set and rate of the tidal stream; and
- The structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water depths in the wind farm area or adjacent to the area.

2.3.4 Recreational Surfing Interests

Groups representing surfing interests were also contacted for a further scoping response but none have yet been received. However, the potential for impact has been recognised in the scoping exercise and Surfers against Sewage, one of the most active and long-established of such groups in the UK, provides detailed guidance for the assessment of surfing wave resource in relation to offshore renewable energy developments (Surfers Against Sewage, 2009).

Table 2. Consultee responses of relevance to coastal process issues

Coastal Process Issue	Body			
	Marine Scotland	SNH/JNCC/RSPB	Historic Scotland	MCA/RYA/Ports and Harbours
Hydrodynamics (waves and currents)		Impacts upon the extent, distribution, function or structure of marine and coastal habitats (SACs and SPAs). RSPB - especially the East Caithness Cliffs SPA.		Changes in the set and rate of the tidal stream. Ref MCA guidance MGN371.
Sediment dynamics (changes to sediment transport pathways, suspended sediment concentrations and resulting sediment deposition)		Impacts upon the extent, distribution, function or structure of marine and coastal habitats (SACs and SPAs).	Impacts upon sites of potential archaeological interest	Potential for changes in sediment mobility that might affect navigable water depth. Ref MCA guidance MGN371.
Footprint of seabed lost (Footprint of foundations, of scour around foundations and of installation vessels)		Impacts upon the extent, distribution, function or structure of marine and coastal habitats (SACs and SPAs).		
Cable burial	Concern regarding impacts on local (inc. intertidal mudflat) habitats. However, temporary and localised nature of any effect is acknowledged.			MCA - Concerns regarding depth of cable burial.
Importance of considering cumulative/in-combination effects	Noted	Noted		Noted

3. Proposed General Methodologies for EIA

3.1 Evidence Based Approach

The EIA process will incorporate an "*evidence based approach*" in so far as that remains possible, which is consistent with current best practice and in accord with the regulatory process. Here the relevant works to consider are the two recent COWRIE publications led by ABPmer (COWRIE 2009, 2010). ABPmer continues to add to the published evidence base and aims to maintain an awareness of all relevant studies to support further investigations such as that presently being undertaken.

The evidence based approach relies partially on the previous development of analogous schemes, from which an evidence base has been developed, providing an alternative means to confidently assess the likely impacts of certain aspects of the development without such detailed site specific study. Hence, this approach is appropriate for scheme proposals which have similarities with existing developments and for coastal settings of a similar type. If the development profile were markedly different to existing projects and their known effects (i.e. outside the present envelope of the established evidence base) then the requirement for additional investigations is likely to increase. It can be noted that, despite the scale of this development and the relatively deep water location, the distance from shore is not as great as some other Round 1 and Round 2 developments and hence an evidence based approach might remain relevant to certain aspects of the EIA.

3.2 Collaboration between the Adjacent Developers

It was highlighted in the scoping response to BOWL from MS and also independently by several of the consultees that a coordinated approach to the assessment of EIA issues between BOWL and MORL would be preferable to ensure a holistic approach and consistency of methodology, particularly in relation to cumulative and in-combination effects.

The advantages of such an approach were identified early in the pre-EIA-scoping stages of project development. In relation to Coastal Processes, BOWL and MORL have both retained the services of one specialist advisor, ABPmer, to undertake a joint study on behalf of both developers; an agreement is also in place to share information and data collected to inform the EIA process, wherever possible.

3.3 Scheme/Project Definition

'Realistic worst case' scenarios for the design of the Beatrice and Moray Firth (Eastern Development Area) Offshore Wind Farms will be assessed, both alone and in-combination with each other and other selected identified activities (including the proposed MORL Western Development Area). The resulting EIA will enable the regulator to simultaneously license a range of potential scheme designs, provided that the scheme design(s) eventually chosen is accepted to have a potential for impact equal to or lesser than the schemes tested in the EIA (a

Rochdale Envelope approach). This approach has been taken (by ABPmer) for the majority of offshore wind farm EIAs in UK.

From the Project Design Statement (PDS) two primary scheme definitions for each development will be identified for testing as part of EIA; this decision will be made initially between ABPmer and the client, and subsequently agreed with MS prior to proceeding further with the EIA studies. The chosen schemes will represent the 'realistic worst case' scenarios for development and typically include:

- The foundation option (type and size) presenting the greatest blockage to waves and tides, at the most dense corresponding layout spacing; and
- The largest foundation option (type and size) corresponding to the most dense foundation layout.

In addition to the size and layout of turbine foundations, the PDS will also inform the characterisation of:

- The nature of any ground preparation works (i.e. the rate of sediment resuspension);
- The likely schedule for ground preparation and/or foundation installation (i.e. the scheduling of sediment resuspension events);
- The nature of scour protection being considered;
- The type of installation vessel that may be used (i.e. the extent and frequency of bed disturbance);
- The overall construction timeline (i.e. the overall scheduling of construction events);
- The likely methods for inter-array cable burial (i.e. the potential for and the rate of sediment resuspension); and
- The expected method for decommissioning (i.e. methods for the removal of the foundation, the scour protection and cabling).

The details of the schemes tested in the EIA may not correspond exactly to the eventual scheme design chosen for development, but will be realistic in their nature and have an equal or greater potential for impact. The nominal lifetime of the development from construction to decommissioning will be assumed to be consistent with the typical lease period (50 years).

In addition to the wind farm infrastructure described in the MORL and BOWL Scoping Reports, additional infrastructure will be required to connect the wind farms to the onshore network. This infrastructure is likely to consist on transmission cables and offshore substation platforms.

Due to changes in the regulatory regime relating to transmission infrastructure both the MORL and BOWL transmission assets will likely be owned and operated by a third party, the Offshore Transmission Operator (OFTO). At the moment this regime is subject to consultation with the Regulator Ofgem and the Industry. As a result there is a certain amount of uncertainty regarding how EIA and Consenting Regulations can be applied to these assets.

As a result it should be noted that OFTO Infrastructure may or may not be included in the EIA from either developer. If the OFTO Infrastructure is *not* included within the respective MORL

and BOWL Wind Farm EIA's it will be considered within the EIA as a cumulative impact. The full EIA for the OFTO Infrastructure will then be subject to a standalone EIA.

The approach for consideration of cumulative impact and the OFTO Infrastructure will be agreed in consultation with Marine Scotland and its consultees.

3.4 Gap Analysis of Historical Data

A gap analysis of historical (existing) metocean data (wind, wave, tidal water levels and tidal currents) was undertaken by ABPmer for BOWL and MORL in December 2010 and is being updated as the project progresses. A gap analysis and review of (existing) non-metocean data (e.g. bathymetry, suspended sediment concentrations, sedimentary and geological characterisation) was also undertaken.

A range of suitable data sources were found to support a robust description of the regional context for both developments (i.e. the Outer Moray Firth) but the conclusions of the analysis were generally that insufficient site specific data were available.

In response to this study, a metocean survey programme was designed and executed (see the following section for more details) to fill the site specific metocean data gaps.

Input was also provided from the coastal processes EIA topic leaders to the required outputs of the geophysical survey (collecting bathymetry, broad sedimentary classification maps and sub-surface geological information) and to the design of the benthic survey (collecting sediment grab samples for sediment characterisation), so that the results will be suitable to inform the coastal processes topic.

The requirements for data input to the coastal processes topic (and the design of the surveys) have been identified following the best practice guidance for the use of numerical modelling tools in coastal process EIA for offshore wind farms (COWRIE 2009) and based on the experience of ABPmer in undertaking coastal processes assessments for the majority of offshore wind farm developments in the UK to date.

3.5 New Surveys to Address the Identified Data Gaps

In support of coastal processes assessments (as well as other EIA and Engineering topics), a number of surveys with consistent and complimentary specifications have been commissioned by both developers to address the identified data gaps, namely:

- Metocean survey;
- Geophysical survey;
- Benthic survey; and
- Geotechnical survey.

A metocean survey was undertaken by BOWL to collect direct measurements within the Beatrice site of:

- Tidal water levels (4 months);
- Tidal current profiles (4 months);
- Wave climate (February 2010 to present, approx 8 months to date); and
- Nearbed suspended sediment concentration (February 2010 to present, approx 8 months to date).

A metocean survey was undertaken by MORL to collect direct measurements within the MORL Zone of:

- Tidal water levels (4 months to date);
- Tidal current profiles (4 months to date);
- Wave climate (June 2010 to present, approx 5 months to date); and
- Nearbed suspended sediment concentration (June 2010 to present, approx 4 months to date).

The locations of the equipment deployed, in addition to other public and privately available sources of metocean data are shown in relation to the BOWL development (red) and the MORL development (blue) in Figure 2.

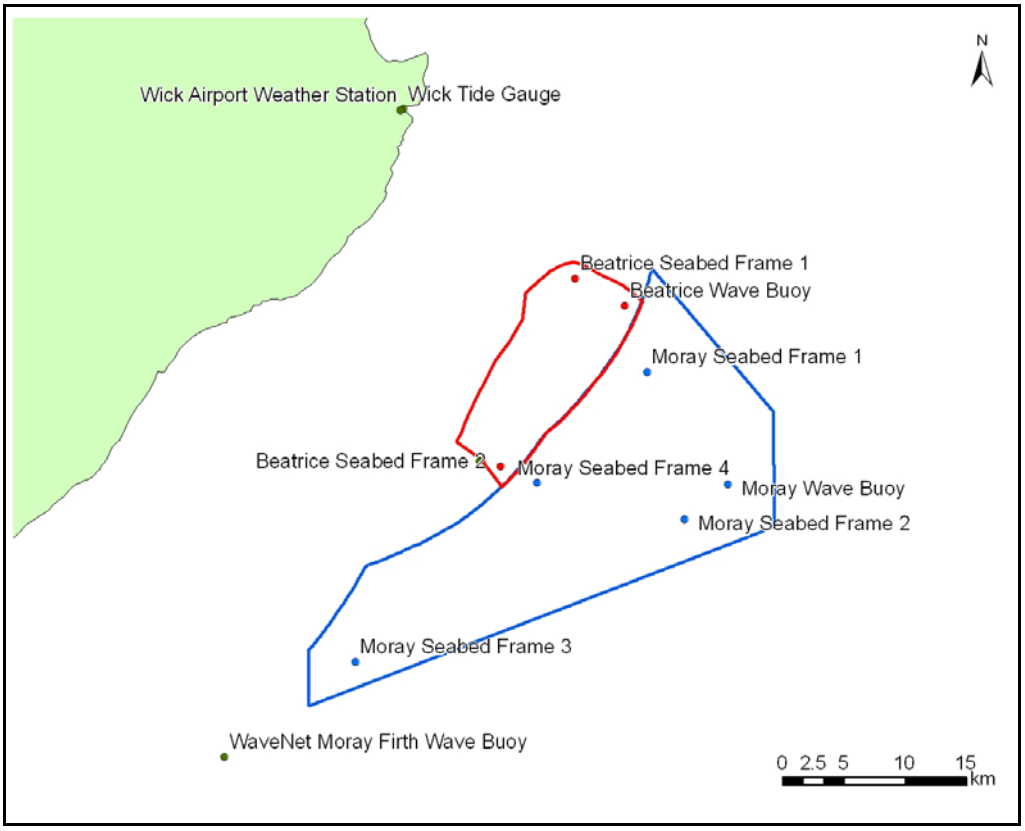

Figure 2. Locations of Newly Collected and Historical Sources of Metocean Data

The main period of data collection at the BOWL site was between February and June 2010; although some equipment presently remains in the water. The main period of data collection at the MORL site began in June-July 2010 and is presently ongoing. The surveys were designed in accordance with the recommendations of COWRIE (2009), draft guidance from MS for wave and tidal renewables EIA (EMEC & Xodus, 2010), interpreted for likely requirements for offshore wind EIA, and previous guidance regarding wind farm coastal process EIA (Cefas, 2004). Measurement locations and the survey duration have been specifically designed in order to collect appropriate data in support of numerical modelling and the EIA process.

Geophysical surveys were commissioned by both developers to confirm the detailed geological structure of the part of the Smith Bank within the extent of the site of the Beatrice and Moray Firth (Phase 1) Offshore Wind Farms, for the purposes of informing the engineering design of the development and the various EIA topics (including coastal processes, benthic ecology, archaeology, etc). The final results of the surveys will become available during the course of the EIA. In relation to coastal processes, the survey collected detailed measurements within the site of:

- Detailed bathymetry;
- Seabed roughness (inferring sediment type); and
- Subsurface geology.

Benthic (ecology) surveys were commissioned by both developers and undertaken in Autumn 2010. In relation to coastal processes, the benthic surveys collected sediment grab samples from the seabed and returned the detailed grain size distribution, providing more detailed information on the regional sediment properties.

Geotechnical surveys are currently underway on the MORL site with approximately 20 borehole samples to be collected in the Eastern Development Area. Geotech surveys will also be commissioned by BOWL (scheduled for autumn/winter 2010). Both campaigns will collect borehole samples at a selected number of locations across the site with the objective of ground-truthing the inferred character of sediments in the subsurface geophysical data already collected. The primary purpose of this survey is to inform the engineering design of the foundation structures. However, should the data become available during the EIA process, they will also be used to further inform the coastal processes topic in relation to the nature of any potential drill arisings.

The complementary metocean (wave, tide and suspended sediment) data sets being collected by the two developers will be incorporated into either the site specific or joint studies being proposed and together provide greater confidence in the potential accuracy of any modelling tools used and therefore any predictions of the potential impacts of the developments.

3.6 Interaction with other EIA Topics

It is anticipated that the coastal processes topic of the EIA (the work described here) will inform, in part, the impact assessments made by other topics, e.g. benthic ecology, archaeology.

To support this process, lines of communication have been established between the topic leaders to share relevant information regarding potential impacts of the development on the physical environment, with implications for other sensitive receptors.

3.7 General Approach to the Physical Processes Assessment

The physical processes assessment will take into account the guidance provided in this respect from the Scottish Regulators (EMEC & Xodus 2010 for wave and tide, to be updated for wind) and will also aim to be consistent with the guideline previously published for EIA of Round 1 and Round 2 of wind farm development to date (Cefas 2004, to be updated shortly for the Round 3 process).

Initially, a baseline understanding of the processes controlling the physical environment in the Moray Firth will be developed to form a conceptual model of the region. The baseline understanding will also include the foreseeable lifetime of the projects (nominally 50 year leases). The natural ranges and statistical behaviour of metocean parameters will be characterised using:

- A review of the available historical metocean data (Section 3.4);
- A review of the available newly collected metocean data (Section 3.5); and
- Where the available measured data are limited in spatial or temporal extent, these may be supplemented using hydrodynamic models, validated using the field data.

The historic natural seabed variability will also be evaluated through the comparison of historical charts and surveys thus allowing the assessment of the likelihood of naturally occurring seabed level change. This will be combined with a further conceptual understanding of baseline sediment transport processes and pathways (without the wind farm structures in place) which will be developed through:

- A review of the geophysical survey data for bedform features (scale, orientation and asymmetry);
- A review of the grab sample and geophysical survey data to characterise the distribution of surficial sediment type;
- A review of any relevant previous studies; and
- Numerical modelling of sediment transport pathways, incorporating use of a hydrodynamic model validated using existing and newly collected field data.

Once a robust baseline understanding of the site specific and regional physical processes has been established, the project specific EIA issues identified in Section 2.2 and 2.3 will be addressed using the methodologies shown.

3.8 General Approach to the Use of Numerical Modelling Tools

In 2009, ABPmer led the production of Best Practice Guidance on behalf of COWRIE regarding the appropriate use of numerical modelling tools for Offshore Wind Farm EIA (COWRIE 2009).

The lead author was David Lambkin (the Project Manager of the present study) and the report was steered and co-authored by Bill Cooper (the Project Director of the present study). Modelling tools and studies in the present study will be developed in accordance with this guidance. The choice of when to use or apply the results from modelling tools is related mainly to the ability of the study to identify and characterise sensitive receptors (examples of which are given in the following section), as summarised in the following extracts from the guidance.

"The sensitivity of some receptors can be clearly defined in measurable terms, while for others there is presently insufficient understanding of the receptor to make anything more than a qualitative statement. For example, loss of 2m depth in a navigation channel may mean that vessels of a certain draught can not access a harbour, or may require regular dredging to allow continued use. Similarly, cable trenching close to a known shellfishery may cause suspended sediment concentrations or sediment deposition rates to rise above a specified threshold value over a defined time period, causing significant mortality rates and loss of fishery income. In these cases numerical modelling may be very useful in defining the intensity and extent of the physical change for comparison with the quantified threshold value."

"In the cases where there is only an indeterminate possibility that changes to the physical situation may affect a receptor, but with no understanding of significant threshold levels or natural variation, then undertaking numerical modelling may well be of no more value than an expert opinion delivered for a fraction of the cost and time. For example, deposition of remobilised fine sediment on a nursery ground may be noted as a possible problem for survival rates, but with no information on the natural tolerance to deposition there is little point in defining the footprint of deposition rates to the nearest millimetre as would be possible with standard plume dispersion modelling - stating significance would be no more than conjecture."

At this point, the need for modelling tools has been identified and will be delivered primarily by the DHI MIKE 21 software suite. For most modules, a flexible mesh (a network of interlocking triangles of variable size) will be utilised. This will be beneficial to the study as higher resolution can be smoothly and selectively applied to sites of interest and enables more accurate definition of bathymetric features (such as deep water channels and complex coastlines).

MIKE modules proposed for use are:

- Tidal regime - MIKE 21 FM HD (Hydrodynamics);
- Wave climate - MIKE 21 SW (Spectral Waves);
- Sediment transport - MIKE 21 FM ST (Sediment Transport); and
- Plume dispersal - MIKE 21 PA (Particle Analysis, rectilinear mesh).

A 2D (vertically integrated) flexible mesh approach is considered to be most suitable in addressing this problem. A 3D modelling approach was considered but found to be unnecessary due to the absence of reported or measured vertical stratification in the water column strong enough to affect hydrodynamic processes.

4. Proposed Detailed Methodologies for EIA

The guidance contained in COWRIE (2009) states that the most appropriate and efficient method to assess each potential impact should be individually considered during the EIA process, in the following order.

i. What are the potential sensitive receptors by category or species? Are the sensitivity thresholds of the defined receptors understood and quantified?
ii. What information about the physical environment is required to categorise the potential impacts on the identified receptors?
iii. Can sufficient information be practicably and effectively provided by existing knowledge and available field data without the need for numerical modelling?
iv. If the answer to Point iii is 'no', can numerical models represent the processes involved sufficiently to provide the required information? If not, then a conceptual solution must be developed.
v. If the answer to Point iv is 'yes', sufficient field data must be obtained to adequately calibrate and validate the model to provide confidence in the results.
vi. Does the regulating authority agree with the proposed approach to the study?

Points i-v of the above list have already been considered at a high level and have been incorporated into the proposed study methodology below.

Also as described in COWRIE (2009), sensitive receptors may be environmental or socio-economic and may include, for example:

- Particular flora or fauna, including commercial species, that might be disturbed, displaced, weakened or even killed by changes to the physical environment (waves, currents, sea bed mobility, coastal erosion, suspended sediment load or increased levels of contaminated sediment or other pollutants);
- Navigation where safety or accessibility may be compromised by changes to water depths, wave conditions or currents;
- Coastal communities, property, infrastructure, habitats, protected geological exposure or valued geomorphological features that may be disturbed or lost due to changing risks of coastal erosion, accretion or flooding;
- Marine structures, infrastructure, wrecks, dumped ordnance, etc that may be compromised by changes to the physical environment; and,
- Coastal or marine recreation that may be influenced by changes to waves, currents, coastal processes, suspended sediment or landscape (due to structures intended to protect cables at the landfall).

In the following sections, EIA issues under the following headings are offered as the complete list which will be considered during the EIA scoping process.

- Sediment Resuspension;
- Footprint of Turbines and Installation Vessels;
- Effect on Tidal Currents and Waves;
- Scour Around Turbine Foundations; and,
- Cumulative and In-Combination Effects.

Where relevant, the further impact of climate change on the baseline metocean conditions or scheme impact will also be assessed. The effects of climate change will be characterised on the basis of UKCP'09 (http://ukclimateprojections.defra.gov.uk/) and a nominal 50 year project lifetime following construction.

More detailed methodologies are proposed with which to address each potential impact in relation to the baseline understanding.

4.1 Sediment Resuspension

Table 3. Sediment resuspension

Sediment Resuspension	
Phase	Construction, Repowering and Decommissioning
Issue	Increase in suspended sediment concentration during installation/modification/removal of foundations or cables, or the initial phases of seabed scouring around newly installed foundations resulting in short-term locally elevated levels of suspended sediment concentrations.
Potential Impact	Methodology
Elevated levels of suspended sediment concentration on sensitive receptors.	The location of receptors sensitive to elevated levels of suspended sediment will be determined. The modelling tools will be used to simulate the release of sediments into the baseline environment at prescribed locations, rates and intervals as described in the PDS for foundation installation, ground preparation and inter-array cable burial. The locations for release will be the likely sites of turbines or cable installation in the vicinity of the identified sensitive receptors; the rate of sediment release will be calculated as the [volume of sediment disturbed]/[time required] and the interval between consecutive releases will be based on the activity Selected time steps of the resulting time-series maps of cumulative suspended sediment concentration in relation to the location of the identified receptors will be presented. These will show the predicted spatial distribution of cumulative or persistently elevated levels of SSC which might be expected as a result of these activities.
Subsequent deposition of sediment on sensitive receptors	The location of receptors sensitive to smothering by sediment deposition will be determined. Using the same approach described above, the predicted spatial distribution of the cumulative thickness of sediment deposited out of suspension will be estimated presented as a map in relation to the identified receptors.

4.2 Footprint of Turbines and Installation Vessels

Table 4. Footprint of turbines and installation vessels

Footprint of Turbines and Installation Vessels	
Phase	Construction, Repowering and Decommissioning
Issue	Seabed compaction or smothering in the footprint of foundations and of any jack-up vessels used.
Potential Impact	Methodology
Mortality of sensitive marine life in directly affected areas.	The most likely sensitive receptors to be affected will be determined. The footprint of the foundations will be calculated from the PDS as [seabed footprint area] x [number of turbines]. The footprint of installation vessels will be determined as [seabed footprint area] x [number of turbines] x [likely number of visits per turbine]. Both values will be presented as a proportion of the total site area and as a proportion of the total habitat area of that type (within the site and within the Moray Firth if possible).

4.3 Effect on Tidal Currents and Waves

Table 5. Effect on tidal currents and waves

Effect on Tidal Currents and Waves	
Phase	Operational
Issue	Changes to patterns of tidal currents and wave activity as a result of the presence of the turbine foundations.
Potential Impact	Methodology
Change in sediment transport pathways (suspended or bedload) affecting the form and function of the Smith Bank or other named SACs or SPAs.	The sensitive receptors to test in this respect are the SACs and SPAs identified in the scoping response. Using the same long time series of baseline and with-scheme data created above, similar cumulative exceedance analyses will be undertaken for locations offshore of the identified sites.
Reduction in recreational surfing wave resource in the lee of the development.	Guidance with respect to assessment of impact on surfing resource is available from Surfers Against Sewage (2009). The sensitive receptors to test in this respect are the surfing beaches located across the south coast of the Moray Firth; the particular wave events of concern are when large waves enter the firth from offshore sectors between North and East. In addition to a set of cumulative exceedance plots (as described above, but without reference to sediments), a subset of key wave conditions will be identified for testing, to be identified using the available guidance. The wave distribution across the firth will be calculated for baseline and with-scheme cases. The effect on the wave climate will be presented as a difference map ([with-scheme] - [baseline]) in the context of natural variability and as a series of tables showing absolute and percentage effect on key surfing wave parameters.
Modification of tidal currents or wave climate affecting navigation in the area	The peak tidal current distribution on flood and ebb tides, for spring and neap periods, will be modelled for baseline and with-scheme cases. The effect on peak current speeds will be presented as a difference map ([with-scheme] - [baseline]) in the context of natural variability. A comment will be made as to any measurable effect on the orientation of the tidal axis.

4.4 Scour around Turbine Foundations

Table 6. Scour around turbine foundations

Scour Around Turbine Foundations	
Phase	Operational
Issue	Scour around foundations leading to local changes in seabed sediment type and morphology.
Potential Impact	Methodology
Impact upon the stability of the turbine foundation.	A high-level estimate of the maximum depth of local scour will be made using empirical relationships from the relevant peer-reviewed literature and following relevant guidance (e.g. DNV, 2007). Such an assessment is not an integral requirement for EIA and no detailed assessment will be made of any resulting effect on actual structural stability. This information will however provide additional confidence in the validity of the PDS and chosen Rochdale envelope.
Localised loss of seabed habitat through seabed modification.	Using the scour depth determined above and information regarding the surficial sediment properties, the likely diameter of the scour hole footprint will be determined. The area of seabed modified by scour will be calculated as ([area of scour footprint] - [area of foundation footprint]) x [number of turbines]. This value will be presented as a proportion of the total site area and as a proportion of the total habitat area. A comment will be made as to the likely difference between the naturally present and scoured sediment surfaces, if no scour-protection were used.

4.5 Cumulative and In-Combination Effects

Other types of activities to be considered, include:

- Other offshore wind developments;
- Marine aggregate extraction activities;
- Marine spoil disposal activities;
- Capital/maintenance dredging operations;
- Port development activities;
- Oil and gas development;
- Sub-sea cables and pipelines; and,
- Wave and tidal developments.

Except for the two proposed offshore wind farms, no other relevant new or planned development activities were identified. The effect of the small number of oil platforms and the two Beatrice Demonstrator turbines on the marine environment is considered to be minimal and is already included in the recently measured baseline data upon which the project will be based (including the recently collected metocean, geophysical and benthic ecology data).

All of the above assessments will be undertaken also for the case of the simultaneous presence of the Beatrice Offshore Wind Farm and the Moray Firth Offshore Wind Farm ([Eastern Development Area alone] and [Eastern + Western Development Areas together]), following the proposed methodologies. The description of the MORL Western Development Area in the cumulative and in-combination testing will be proposed on the same basis as the initial Eastern Development Area. However, this design description will not be informed by the same level of geophysical and geotechnical data and residual uncertainty will be addressed in a separate future EIA to assess the specific impact of the second phase of the MORL development.

Studies of construction related impacts will seek to investigate the operations with the greatest potential for cumulative effect, i.e. simultaneous sediment release along the border of the two development areas.

Studies will consider only one operational in-combination/cumulative scenario, i.e. one of the two site specific schemes being tested for each developer will be taken forward for assessment in the EIA - that which is found to have the greatest potential for or levels of effect.

Assessments of habitat loss due to the footprint of turbines, installation vessels and scour will simply be presented as a combined figure in the same format.

Table 7. Cumulative and in-combination effects

Cumulative And In-Combination Effects	
Phase	Construction, Operational, Repowering and Decommissioning
Issue	For all issues identified above, there is a concern that the combined development activities or presence of the Beatrice Offshore Wind Farm and Moray Firth Offshore Wind Farm may result in local or regional effects greater than would be predicted by considering each separately in isolation.
Potential Impact	Methodology
Impacts as above for each EIA issue.	The same methodologies will be used to assess each potential impact, considering the simultaneous presence of foundations in operational phases

5. Assessment of Significance

A set of criteria will be developed by the respective project lead EIA consultants, against which to assess the significance of any potential impacts of the development(s).

Wherever possible, impacts relating to modifications to scalar quantities (e.g. current speed, wave height, current and wave directions, suspended sediment concentration, rates of sediment deposition, etc) will be assessed in comparison to the natural range of variability at that location, determined either through direct measurements or from the additional data created using the modelling tools.

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Appendix A

List of Relevant SPAs and SACs

Appendix A. List of Relevant SPAs and SACs

In their scoping response, SNH and JNCC provided advice in relation to Habitats Regulation Appraisal. It was recommended that the potential impacts of the Beatrice Offshore Wind Farm on Special Protection Areas (SPAs) and Special Areas of Conservation (SACs) should be considered alone and in-combination with other plans and projects. It is also recommended that the following SPAs are considered in this regard:

- Cromarty Firth SPA.
- Dornoch Firth SPA.
- East Caithness Cliffs SPA.
- Inner Moray Firth SPA.
- Loch of Strathbeg SPA.
- Moray and Nairn Coast SPA.
- Troup, Pennan and Lion's Heads SPA.

It is also recommended that the following SACs designated for marine mammals and for marine and coastal habitats are considered in this regard.

- Culbin Bar SAC - designated for its coastal habitats including sand dunes, vegetated shingle and salt meadows.
- Dornoch Firth & Morrich More SAC - designated for its population of common (harbour) seals
- (*Phoca vitulina*) and for coastal and marine habitats including sand dune habitats, intertidal mudflats and sandflats; subtidal sandbanks and reefs.
- Moray Firth SAC - designated for bottlenose dolphin (*Tursiops truncatus*) and for subtidal sandbank habitat.

It is also recommended that the following SACs designated for fish of conservation concern are considered in this regard:

- Berriedale & Langwell Waters SAC - designated for Atlantic salmon (*Salmo salar*).
- River Borgie SAC - designated for Atlantic salmon, freshwater pearl mussel (*Margaritifera margaritifera*) and otter (*Lutra lutra*).
- River Dee SAC - designated for Atlantic salmon, freshwater pearl mussel and otter.
- River Evelix SAC - designated for freshwater pearl mussel.
- River Moriston SAC - designated for Atlantic salmon and for freshwater pearl mussel.
- River Naver SAC - designated for Atlantic salmon and for freshwater pearl mussel.
- River Oykel SAC - designated for Atlantic salmon and for freshwater pearl mussel.
- River Spey SAC - designated for Atlantic salmon, sea lamprey (*Petromyzon marinus*), freshwater pearl mussel and otter.
- River Thurso SAC - designated for Atlantic salmon.

The identified SPA's and SAC's are shown in relation to the BOWL development (red) and the MORL development (blue) in Figure A1.

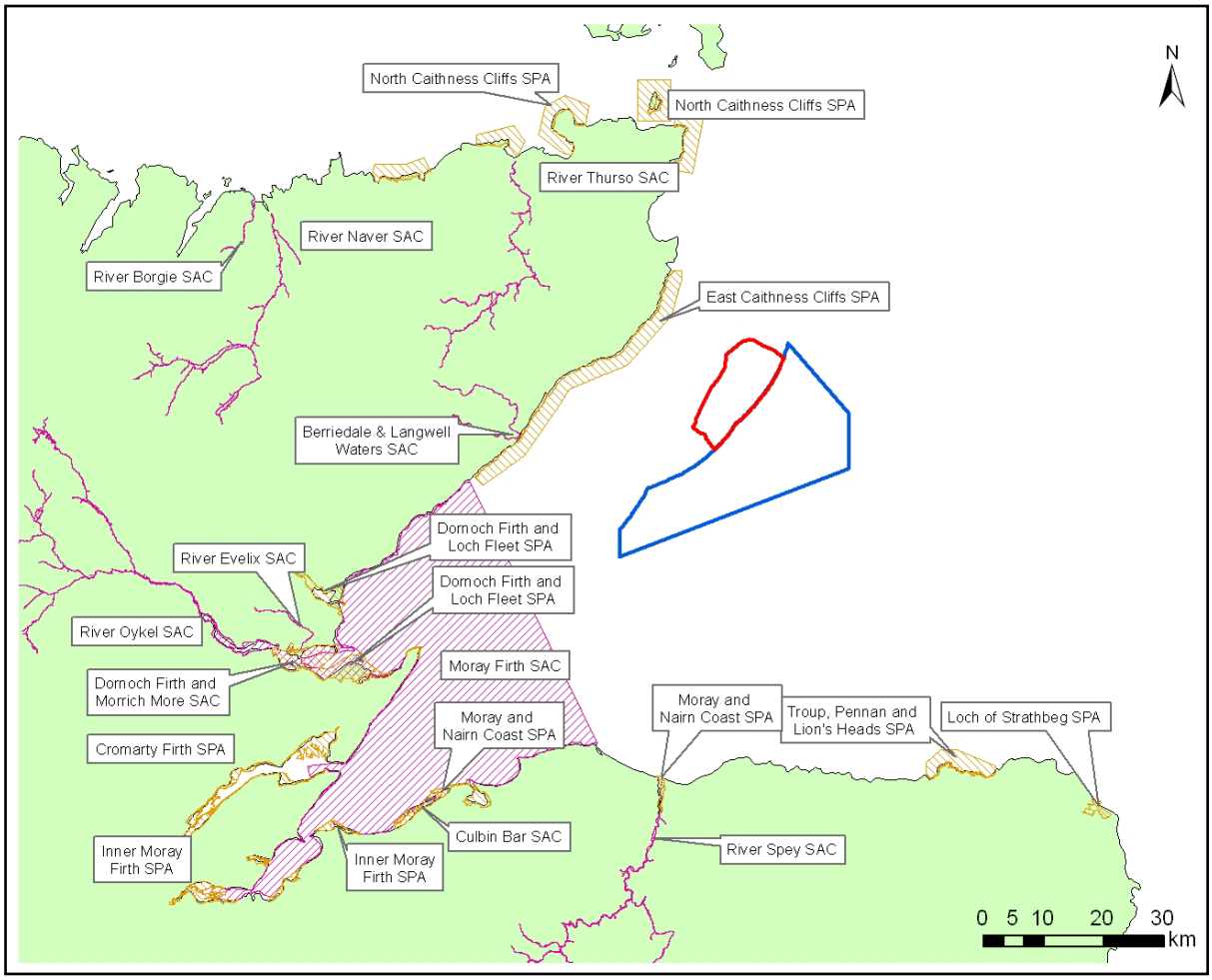

Figure A1. Locations of the SPA's and SAC's identified in the EIA scoping responses

Annex B

Marine Mammal Data Gathering

Pre-consent marine mammal data gathering at the MORL & BOWL wind farm sites

Paul Thompson (University of Aberdeen) & Kate Grellier (SMRU Ltd)

Progress Report - 21st January 2010

The work programme currently being undertaken by the University of Aberdeen and SMRU Ltd for BOWL and MORL has the following three key objectives:

- To use passive acoustic monitoring to characterise the site the cetacean species present, and detail seasonality and year-to-year variability in occurrence

- To use data form aerial surveys conducted in 2010 to assess the density of cetaceans at the proposed sites, and use habitat association models to predict cetacean densities across the Moray Firth

- To assess the likelihood of exchange between the proposed wind farm site and both the Moray Firth bottlenose dolphin SAC and the Dornoch Firth harbour seals SACs.

This progress report provides proposals for the structure and scope of the final project report(s) and a summary of ongoing data collection as required under the programme deliverables.

Report Format

The original scope of work identifies four deliverables:

1. A report will provide an overview of the Passive Acoustic Monitoring (PAM) techniques used, and the data available from the BOWL & MORL sites. The key data presented will show year-to-year and seasonal variability in the occurrence of porpoises and dolphins in and around the BOWL & MORL sites for the period 2005 – 2011. These data will be discussed in relation to other PAM data from NE Scotland. (Objective 1)

2. A report will provide details of the aerial survey techniques used in the DECC funded study, and the habitat modelling used to predict densities in other parts of the Moray Firth. These data will be discussed in relation to previous estimates of cetacean density in waters around the UK, primarily those based upon SCANS and SCANS II surveys. In addition, direct estimates of densities in August/September 2010 will be discussed in relation to PAM data on seasonal and inter-annual variation in occurrence. (Objective 2)

3. A report will outline the acoustic methods used to determine the likelihood that dolphins using the BOWL and MORL sites are likely to be bottlenose dolphins that use the Moray Firth SAC. This will include details of field data collection, and the development and application of the newly developed software used to identify the dolphin species from recordings of their broadband vocalisations. These data will be discussed in relation to other sources of data on the distribution and movements of bottlenose dolphins using the Moray Firth SAC. (Objective 3a)

4. A second report will outline the availability of harbour seal telemetry data, and the strengths and weaknesses of the different datasets in relation to the precision of the techniques used and their temporal coverage. The SSM approach used to account for the different error structures will be described, and the standardised tracking data provided in GIS format. We will outline how mixed GAMMs models are used to provide maps of predicted densities, and provide data in a format that can be incorporated into noise modelling studies. These data will also be used to assess the extent to which harbour seals from the Dornoch Firth SAC are likely to spend time in the BOWL & MORL sites. Data will also be discussed in relation to current knowledge of harbour seal foraging distribution. (Objective 3b)

We now propose to integrate the first two of these reports, and provide a single technical report that describes the University of Aberdeen's work on the distribution and abundance of cetaceans in the outer Moray Firth. This report will also include the results of additional habitat association modelling that uses boat survey data collected in the outer Moray Firth between 2005 and 2010. The proposed structure of this report is given in Annex 1.

Two additional reports will follow the original plan outlined above. These will each report on two separate work packages carried out by SMRU Ltd. The first of these will report on the acoustic analyses undertaken to assess the likelihood that bottlenose dolphins from the Moray Firth SAC use the proposed windfarm sites. These second will describe the habitat association modelling of harbour seal telemetry data to describe the foraging distribution of seals from the Dornoch Firth SAC. The proposed structure of these reports is given in Annex 2 and Annex 3 respectively.

Ongoing data collection.

C-PODS were installed on moorings at 6 locations within the BOWL site and 15 locations within the MORL site during July 2010 (Table 1). These deployments over the summer were carried out as part of the University of Aberdeen's DECC funded project. Following completion of this work in early October, efforts were then made to recover these devices and redeploy replacements at the same locations over the winter. Poor weather delayed this work at most sites, with 3 of the MORL sites serviced on 21st October, the BOWL sites and a further 6 MORL sites serviced on 21st/22nd November, and all but one of the remaining MORL sites finally completed on 19th January 2011. Only 3 devices (15%) were lost during this deployment, a reduced rate of loss compared with 2009, with one remaining mooring to to be checked. Analyses of data from all but the most recent recoveries indicate that all but one of these devices had operated successfully throughout the deployment.

Deployments of EARS for work under Objective 3 were all successfully deployed and recovered between August and November (Table 2). Useful recordings were made during all but one deployment which suffered battery failure. Longer deployments of other EAR units (sampling 60 seconds every 500 seconds) were made during the DECC study to monitor variations in anthropogenic noise. This information is included in case these recordings may be of value for future assessments of variation in ambient noise.

Table 1. Details of the deployment and changeover of C-PODS at locations in the BOWL and MORL sites 2010/11.

Site	Latitude	Longitude	Depth (m)	Deployment date	Changeover Date	Complete record
A15	58.06678	-3.1154	MORL	24/07/2010	31/10/2010	✓
A16	58.07402	-3.01645	MORL	24/07/2010	19/1/2011	Not Found
A17	58.10447	-2.96075	MORL	24/07/2010	31/10/2010	✓
A18	58.16208	-2.93442	MORL	24/07/2010	22/11/2010	✓
A19	58.18403	-2.85993	MORL	25/07/2010	19/1/2011	TBC
A20	58.19663	-2.76345	MORL	25/07/2010	21/11/2010	✓
A21	58.22607	-2.69858	MORL	24/07/2010	19/1/2011	TBC
A22	58.27112	-2.66363	MORL	24/07/2010	21/11/2010	✓
D04	58.08863	-3.09572	MORL	25/07/2010	31/10/2010	×
E14	58.12763	-2.97883	MORL	24/07/2010	19/1/2011	TBC
E15	58.20247	-2.99767	BOWL	24/07/2010	22/11/2010	✓
E16	58.12095	-2.85883	MORL	22/09/2010	21/11/2010	✓
E17	58.22713	-2.93545	BOWL	24/07/2010	22/11/2010	✓
E19	58.23388	-2.86832	BOWL	24/07/2010	22/11/2010	✓
E20	58.26672	-2.88652	BOWL	25/07/2010	22/11/2010	Not found
E21	58.30537	-2.88625	BOWL	24/07/2010	22/11/2010	✓
E23	58.2879	-2.83697	BOWL	24/07/2010	22/11/2010	✓
E24	58.23885	-2.78987	MORL	24/07/2010	21/11/2010	✓
E25	58.12765	-2.75602	MORL	25/07/2010	19/1/2011	Not found
E26	58.15025	-2.61987	MORL	25/07/2010	TBC	TBC
E27	58.17995	-2.67548	MORL	25/07/2010	21/11/2010	✓

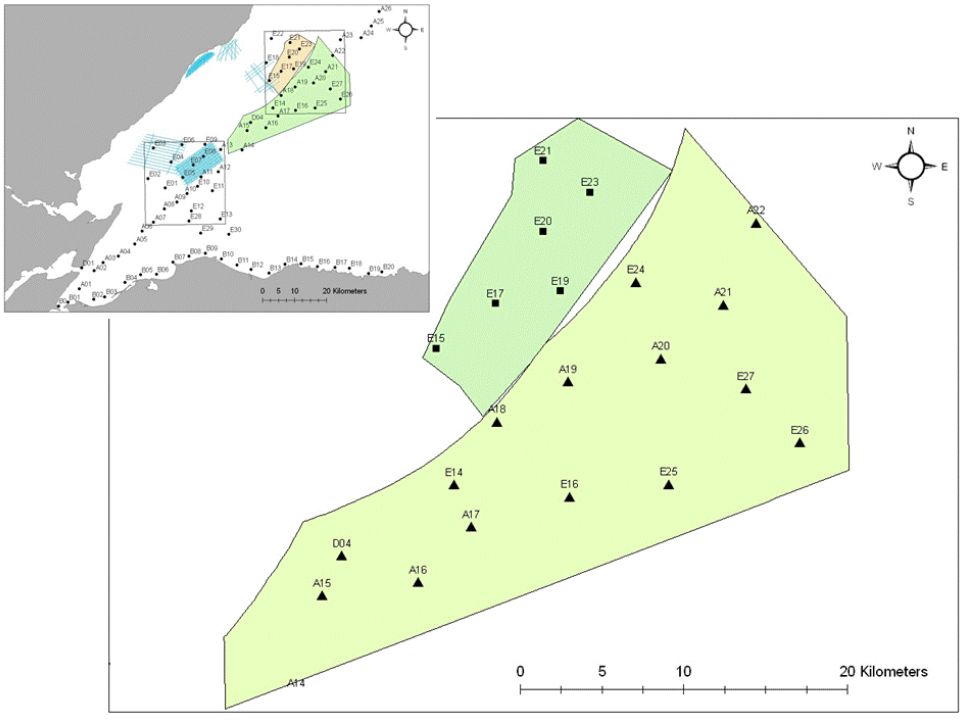

Figure 1. Map showing the sites at which C-PODS have been installed in the BOWL and DECC sites. All sites except E26 now have devices in place that will be collecting data until at least March 2011. Inset map shows site location and the locations of other sites used during the DECC study in the summer of 2010

Table 2. Details of deployment and recovery of EARS for monitoring broad band noise and dolphin vocalisations.

Site	Sampling rate (KHz)	Duty cycle (secs)	Deployment date	Data end / recovery date
A10	50000	60/600	12/07/2010	29/09/2010
A20	64000	1800/3600	25/07/2010	15/08/2010
E17	64000	1800/3600	24/07/2010	11/08/2010
E19	50000	60/600	24/07/2010	22/11/2010
E21	64000	1800/3600	16/08/2010	09/09/2010
E16	64000	1800/3600	22/09/2010	16/10/2010
A22	64000	1800/3600	22/09/2010	23/09/2010
D01	64000	1800/3600	07/10/2010	01/11/2010

Annex 1. Proposed format for report on work carried out under Objectives 1 & 2.

Working title: Distribution and density of cetaceans in the Outer Moray Firth

Lead Authors: University of Aberdeen

Contents:

3.1.2 Figures and tables providing summaries of all visual sightings of different cetacean species

3.1.3 Modelled distributions from visual surveys – presented as a standard set of figures (4x4km grid scale) for key species. The number of species included will depend upon sample sizes, but anticipated to include harbour porpoise, bottlenose dolphins, combined "other dolphin species" and minke whales.

3.1.4 Spatial variation in occurrence based upon PAM data

3.1.4.1 Figures showing probability of detection of a) porpoises and b) dolphins at different sampling across the wider Moray Firth (using data from summer 2009 and 2010).

3.1.4.2 Analysis comparing consistency of spatial patterns in 2009 and 2010

3.1.4.3 Analysis comparing PAM data with predicted distributions from visual survey to evaluate performance of PAM data and likely identify of dolphins using different parts of the Moray Firth.

3.2 Density estimates

3.2.1 Tables presenting results of DISTANCE analysis of line-transect data from aerial surveys, including estimates of the number of individuals using MORL/BOWL sites. Species to be considered will depend upon sample sizes and may be restricted to harbour porpoises.

3.2.2 Analysis comparing PAM data with density estimates to inform understanding of extent to which PAM data can provide insights into variation in density.

3.3 Seasonal & inter-annual patterns of occurrence

3.3.1 Comparison of T-POD and C-POD data to evaluate potential for comparing recent data (2009 & 2010) with earlier data from the Beatrice Demonstrator (2005-2007)

3.3.2 If appropriate, analyses and Figures assessing inter-annual variation in the occurrence of a) porpoises and b) dolphins data at the demonstrator site (2005-2011).

3.3.3 Figures showing seasonal (monthly) patterns of occurrence within the MORL and BOWL sites for a) porpoises and b) dolphins. Limited data for 2005-2007 from the demonstrator site. More comprehensive data from July 2009-March 2011 (BOWL) and July 2011 (MORL).

4. Discussion

5. References

6. Data Appendices

Annex 2. Proposed format for report on work carried out under Objectives 3a.

Deliverable 3a. (Objective 3a).

SMRU Ltd will be responsible for writing a report that outlines the acoustic methods used to determine the likelihood that dolphins using the BOWL and MORL sites are likely to be bottlenose dolphins that use the Moray Firth SAC. This will include details of field data collection (written with support from AU), and the development and application of the newly developed software used to identify the dolphin species from recordings of their broadband vocalisations. These data will be discussed in relation to other sources of data on the distribution and movements of bottlenose dolphins using the Moray Firth SAC.

Annex 3. Proposed format for report on work carried out under Objectives 3b.

Deliverable 3b. (Objective 3b).

SMRU Ltd will be responsible for writing a report that outlines the availability of telemetry data, and the strengths and weaknesses of the different datasets in relation to the precision of the techniques used and their temporal coverage. The SSM approach used to account for the different error structures will be described, and the standardised tracking data provided in GIS format. We will outline how mixed GAMMs models are used to provide maps of predicted densities, and provide data in a format that can be incorporated into noise modelling studies. These data will also be used to assess the extent to which harbour seals from the Dornoch Firth SAC are likely to spend time in the BOWL & MORL sites. Data will also be discussed in relation to current knowledge of harbour seal foraging distribution. Some additional work would be required to update discussion of these data in relation to the latest data on seal abundance trends and ecology in the Dornoch Firth and Morich More SAC and nearby Loch Fleet NNR.

Annex C

Ornithology - Autumn 2010
Migration Survey Report

BOAT-BASED MIGRATION SURVEYS

A dedicated migration observer was present on both the R3Z1 and Beatrice survey vessels whilst undertaking the boat-based ESAS surveys during the autumn migration period. These surveys were carried out for R3Z1 on 22nd and 29th September, and 13th, 16th and 31st October, and for Beatrice OWF on 12th and 13th October. These surveys will be repeated in Spring 2011. The protocol used was:

- systematic 360° scanning (including overhead) for birds in flight;
- target species were geese, swans and any raptors;
- secondary target species were seaduck, waders and passerines; and
- data collected were:
    - time of observation (which was used to identify vessel location with the use of the GPS log);
    - species;
    - flock size;
    - flight height (0-5 m, 5-10 m, 10-20 m, 20-200 m, 200-300 m, or 300+ m);
    - flight direction; and
    - distance from vessel (to the nearest 500 m).

COASTAL MIGRATION SURVEYS

Migration observations from four coastal vantage points were undertaken to collect additional flight route data. Observations were carried out over an 8-week period between mid-September and mid-November, on a total of 16 days per vantage point (i.e. an average of 2 days per week). These surveys will be repeated in Spring 2011.
The locations for the coastal vantage points were:

- Sarclet Head, 7 km south of Wick (ND350433), to record flights heading from Caithness across the Moray Firth; and
- Duncansby Head (ND406733), to record flights around the coast into the Moray Firth;
- Rosehearty, 7 km west of Fraserburgh (NJ931678) to record flights arriving into north-east Aberdeenshire; and
- Whitehills, 4 km west of Banff (NJ658655) to record flights arriving into the eastern part of the Moray coast.

Locations further west on the Moray coast, or further south-west on the Caithness coast, were not felt necessary as flights were unlikely to occur over these parts of the coast which are either heading towards or have headed from the proposed wind farm developments of MORL and BOWL. The protocol used was:

- systematic 180° scanning (including overhead) for birds in flight, for 6 hours per day (an hour break was taken between each 3-hour stint);
- target species were geese, swans and any raptors;

- secondary target species were seaduck, waders and passerines;
- these surveys were not undertaken in weather conditions which were likely to preclude migration; and
- data collected were:
    - vantage point location;
    - time of observation;
    - species;
    - flock size;
    - flight height (0-20 m, 20-200 m, 200-300 m, or 300+ m);
    - flight direction;
    - distance from observer (to the nearest 500 m); and
    - the recording of flight-lines at the site onto maps which could later be digitised.

The observations on the Caithness coast were organised by Natural Power, and the observations on the Moray coast were organised by RPS Group Ltd. Surveys were coordinated between the four locations to ensure that some observations were carried out concurrently, and where this was the case there was communication between observers so that repeat sightings of the same flock could be identified. Days when a survey vessel was carrying out at-sea bird surveys for either site were prioritised for carrying out the coastal observations, as long as weather conditions were not likely to preclude migration.

Annex D

Underwater Noise Modelling Method Statement

Project Title	Proposed methodology for the modelling of subsea noise impact on marine species for the Beatrice Offshore Wind Farm and Moray Firth Round 3 Zone development
Project Number	E287
Authors	J R Nedwell, A G Brooker and R J Barham
Company	Subacoustech Environmental Ltd
Report Number	E287IR0401
Date of Issue	4th March 2011

This summary report briefly reviews the information available regarding the effect of underwater noise on marine species, discusses the criteria that are available for assessing the likelihood of an adverse impact caused by the noise, and hence presents the intended approach for assessing the impact of subsea noise on marine species (fish, marine mammals and birds) for the Beatrice Offshore Wind Farm and the Moray Firth Offshore Wind Farm projects (BOWL and MORL).

Due to the close proximity of the BOWL and MORL development areas, the two developers have appointed Subacoustech Environmental as the sole specialist advisor for underwater noise modelling and advisory services. The approach will therefore be consistent between the two developments, which will be of particular value to the cumulative impact assessment stage.

The report is split into two sections, comprising a summary of the background considerations relating to the method adopted, and a more detailed discussion of some of the principal technical matters.

Background considerations.

While a detailed discussion of the effects of noise is beyond the scope of this document, a brief description is essential in order to understand the background to the methodology.

In order to understand the importance of any noise generated during an offshore construction programme, it is essential to understand the consequences of the noise. In order to understand the consequences, the effects must be divided into various classes, and a means found to understand the likelihood of that effect occurring as a consequence of the noise. In other words, it is essential to not only be able to predict the likely level of noise during an activity, but also to have a criterion by which the significance of the noise level can be judged. Without a criterion, an estimate of noise is completely useless. The criterion will be different for different effects, and may be expressed in a particular scale of measurement of noise, such as peak pressure, RMS level, impulse, or a more sophisticated measure.

The effects of noise on marine animals may be considered to fall into three categories. These comprise in order of descending severity:

1. **Lethality and physical injury.** At the highest levels of noise, such as may be caused by the use of underwater explosives, sound has the capacity to kill or maim. Injuries tend to be associated with the rapid compression of air containing structures, such as the swim

bladders in fish and the airways of marine mammals. The likelihood of injury or death tends to be associated with the peak pressure and impulse of the noise.

2. **Auditory injury.** At levels of noise below those capable of causing physical injury, damage to hearing may occur as a result of two processes. First, permanent and irreversible auditory trauma may result from a single exposure to noise at a high level. The likelihood of auditory trauma in humans is associated with the peak pressure of the sound, and is known to occur during close exposure to gunfire. Second, accumulative auditory damage may occur as a result of prolonged exposure to noise at lower levels. In humans, accumulative damage has been shown to be related to the energy of the noise. The SEL approach proposed by Southall et al (2007)[1] will be used to estimate the likelihood of auditory damage to classes of marine mammals, and the dB_{ht} approach proposed by Nedwell et al (2007)[2] to estimate the likelihood of auditory damage to individual species of marine mammals and fish.

3. **Behavioural effects.** This range of effects is probably the most misunderstood, yet since they may occur at relatively low levels of noise, they are of critical importance since they always effect very much greater areas than the preceding categories of effects. For the purposes of this document, the authors offer a definition of the behavioural effects of noise as "a change in the behaviour of an animal, caused by exposure to noise". The change in behaviour may be cognitive, that is, involving a conscious decision by the animal, or instinctive, where an animal reacts to a pleasant or unpleasant stimulus. Behavioural effects may also encompass attraction or avoidance. For instance, an animal moving towards and investigating a noise may be considered to be an example of cognitive attraction. An animal fleeing a noise having the characteristics of a predator may be considered to be an example of cognitive avoidance. An animal fleeing an acceptably loud noise may be considered to be an example of instinctive avoidance. The importance of this classification is that cognitive effects may occur at any level of sound that the animal may hear, whereas instinctive effects are believed to be associated with a sensation of "unbearable loudness". All of these effects are however associated with the hearing, and therefore for a criterion to be realistic it must incorporate a measure of hearing acuity. The dB_{ht} of Nedwell has been developed to estimate the likelihood of behavioural effects on individual species of marine mammals and fish; Southall tentatively recommends the SEL as a criterion for single impulsive noises whereas for multiple pulse and non-pulses a qualitative model based on received RMS Sound Pressure Levels is proposed.

It may be commented that even in the case of relatively high noise level sources such as piling, there are practical mitigation strategies which may be used to reduce or eliminate the risk of both physical effects and auditory injury. Consequently, the methodology of this document focuses on

[1] Southall, Brandon L.; Bowles, Ann E.; Ellison, William T.; Finneran, James J.; Gentry, Roger L.; Greene, Charles R.; Kastak, David; Ketten, Darlene R.; Miller, James H.; Nachtigall, Paul E.; Richardson, W. John; Thomas, Jeanette A.; Tyack, Peter L, (2007) *Marine Mammal Noise Exposure Criteria Aquatic Mammals*, Vol 33 (4).

[2] Nedwell J R, Turnpenny A W H, Lovell J, Parvin S J, Workman R, Spinks J A L, Howell D (2007b). *A validation of the dB_{ht} as a measure of the behavioural and auditory effects of underwater noise.* Subacoustech Report Reference: 534R1231, Published by Department for Business, Enterprise and Regulatory Reform.

behavioural effects, as being by far the most difficult to mitigate, covering the largest area of sea and therefore having the greatest capacity to cause an adverse effect.

Proposed general methodology

It is proposed that the general approach to estimating the levels of subsea noise from offshore wind farm developments is in two phases. Initially, a broad-brush modelling approach will be used to rank order a wide range of offshore wind farm related sources of underwater noise. In the main, the information used to generate this model will come from the very substantial database of recordings of various noise sources made by Subacoustech Environmental over the last 20 years. The model will use an estimate from this database of the typical frequency content, source levels and transmission losses associated with each noise source type. These data will be used to determine the impact of each noise source on the marine environment, by using the estimate of noise level and a suitable criterion for a level above which it will have an effect to estimate the area which is effected by the noise source for each class or species of marine animal.

The rank ordering will allow most of the activities to be eliminated from further consideration, where they are shown to cause negligible adverse effect, and hence allow further consideration to focus on sources of noise that have the capacity to cause a significant adverse effect. The activities that generate the highest noise levels (e.g. impact piling) will require detailed modelling to provide a detailed assessment of the area affected. The results of this detailed modelling will be combined with population and behavioural data to allow biological assessment of the significance of any effects on fish, marine mammals and birds to be determined.

Information required for modelling

All detailed modelling will be tested at all stages against previously measured data and the outputs of all modelling will be validated against existing measured data. By this means, it will be possible to ensure that the modelling is realistic and representative.

At the time of writing, it is anticipated on the basis of experience that the predominant noise source requiring evaluation in the case of the Beatrice Offshore Wind Farm and the Moray Firth Offshore Wind Farm projects. will be that of impact piling for the wind farm foundations. Subacoustech Environmental has developed the powerful INSPIRE model, which enables the noise from impact piling to be accurately predicted. It is intended that this model will be used predicatively to estimate the noise impact of individual piles and guide the construction programme, thus enabling the construction programme to be optimised from noise impact standpoint and hence ensuring adherence to best practice.

In order to determine the level of noise, reliable estimates of the critical parameters that effect the levels of underwater noise produced will be required. Typically for piling these include:

- Pile diameter
- Expected blow forces
- Expected installation time
- Water depths at the piling location and in surrounding waters

It is expected that these will be supplied by the engineering design team. Water depths to a suitable resolution are available as electronic bathymetry data from Seazone or the UKHO.

In order to assess the importance of other noise sources, a list of the types of activity creating the noise and the type of equipment used (trenching, rock placement, dynamically positioned vessels, work boats, seismic survey, etc) will be required, along with the likely duration of each activity.

Where details of the activity are not yet known, a range of scenarios will need to be considered, typically using a "worst case" estimation for each (the Rochdale Envelope approach). In estimating the impact of each source, both the area of sea affected and the duration of the exclusion (i.e., the loss of habitat in square kilometre-days) will be included, in order that the importance of low-level persistent noise sources can be assessed against high-level intermittent sources.

Interaction with other EIA topics

The output of the modelling will be objective physical quantities, including the predicted levels of underwater noise from wind farm activities and the area of sea effected around each noise source. These quantities represent relatively simple physical outputs that can be interpreted from a biological standpoint to assess their significance for fish, marine mammals and diving birds, thus ensuring that biological and acoustic expertise can be combined to provide the most accurate possible estimate of the biological significance of noise.

Details of the noise modelling methodology

The noise modelling will be undertaken in two phases.

Phase 1: rank ordering of noise sources.

The initial stages of the underwater noise modelling will be carried out using a simple yet realistic broad-brush Source Level-Transmission Loss (SL-TL) model. This model will be based on Subacoustech Environmental's substantial database of noise sources to provide an indication of the typical levels of underwater noise generated by wind farm related activities. This model is being developed as part of this project and will allow the significance of a wide range of sources of underwater noise to be rank-ordered for a wide range of marine animals. This information, along with details from the engineering specialists regarding duration of the activities, will then be used by the other EIA specialists in the marine mammal, fish and ornithology sections to determine the overall potential impact for each.

In detail, as sound propagates through water it reduces in level as a result of losses relating to energy dissipation (absorption) and also due to the sound energy simply spreading over a wider area (geometric spreading). Typically, a source of underwater noise is quantified in terms of a Source Level (SL), which is the level of sound energy released by the source, usually described as the level of underwater noise at a range of 1 m from the source. In order to characterise the rate at which energy is lost a value for the Transmission Loss (TL) is often given. The level at a particular point in the water space to which an animal is subjected, the Received Level (RL), is in logarithmic terms the Source Level minus the Transmission Loss.

$$RL = SL - TL \qquad \text{eqn. 1}$$

Over short distances, absorption effects have little influence on the Transmission Loss and can often be ignored, and in this case and over a defined spread of range it is reasonably accurate to use a linear fit of the form

$$RL = SL - N \log r \qquad \text{eqn. 2}$$

where N is generally characterised as being a term associated with the spreading of sound. The Source Level itself may be quoted in any physical quantity, for instance, a piling source may be expressed as having a "peak to peak Source Level of 200 dB re 1 µPa @ 1m". It may be also specified in terms of a frequency weighted level for a particular animal species or class, allowing the "loudness" or effect of the sound to be evaluated. This approach is inherent in both the Nedwell dB_{ht} formulation and the Southall SEL approach.

It will therefore be appreciated that this simple model has been chosen in the main because it is pan-specific, that is, able to evaluate the significance of the noise for a wide range of marine animals having greatly varying acuity of hearing, and frequency range over which they can hear. This is critical to any realistic investigation, because noise sources with a significant content of high frequency noise will tend to selectively effect high frequency hearers such as the harbour porpoise, while sources with a significant content of low-frequency will tend to affect low-frequency hearers such as fish. The effect of any given noise source may therefore be greatly different for different species, and it is therefore essential to use a modelling process that considers the hearing acuity of the effected species.

Although the formulation is simple, obtaining accurate values to insert into it from actual data from a wide range of experimental measurements processed into a large range of animal types is both complex and onerous. For instance, it is often not realised that, since the value of Source Level quoted for a particular source is obtained by extrapolation; the value will depend on the model that is used to perform the extrapolation. Figure 1 illustrates this point. The diagram illustrates a set of measurements made of the noise from piling. In the simplest case, in order to draw conclusions about the data, it may be fitted to a straight-line model; this is shown in the figure by the green line. Such a model effectively assumes that the noise level attenuates only as a result of geometric spreading. This however will generally over-estimate the level for low and high ranges, since it ignores the effects of absorption of the noise. An improved model, including absorption, is represented by the red line and gives a better fit to the data, and indeed this simple form is usually adequate for modelling sound propagation from a source in deep water of roughly constant depth. However, in the case of relatively shallow coastal waters, where the proposed project is situated, the depth may rapidly fluctuate between shallow water of a few metres and deep water of tens of metres or more. In these circumstances, the Transmission Loss becomes a more complex function of depth that depends heavily on the local bathymetry and hence should ideally be calculated using a more sophisticated model, such as INSPIRE. Where these effects are included, as illustrated by the blue line, yet another value of Source Level may result; typically lower levels of noise may be predicted near to the noise source.

The variation in estimates of Source Level for the same dataset, when analysed in different ways, indicates how Source Level will in general be a function of the model that is used to express the noise levels. For the purposes of the methodology of this assessment, the initial rank ordering of noise sources undertaken in phase 1 will use a simple straight-line formulation. However, for the detailed analysis of phase 2, the INSPIRE model will be used to offer sophisticated and more accurate estimates of the noise.

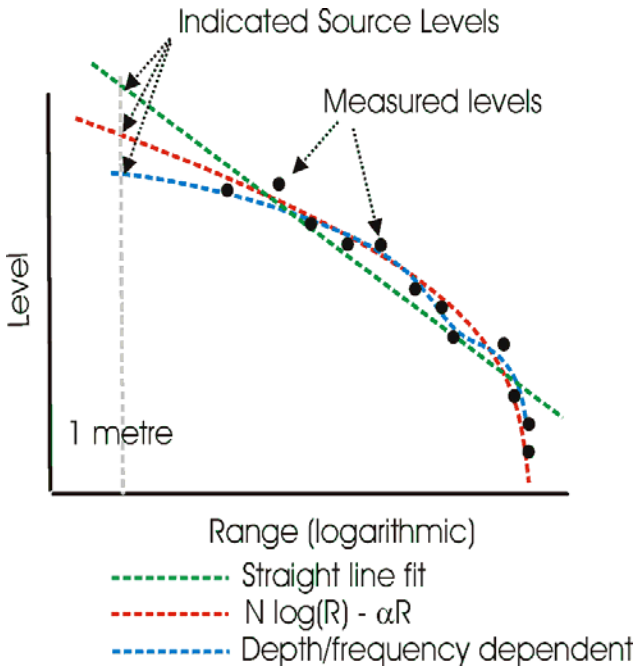

Figure 1 – Differences in Source Level estimation based on various models

The simple model will also take into account variations in the parameters affecting the noise level. For instance, currently available information suggests that the level of underwater noise from impact piling operations is closely related to the pile size, with sound levels increasing with pile size. The blow force applied to the pile also influences the noise levels produced; however, typically, blow forces also increase with pile size so these two factors are actually interdependent. The INSPIRE model also takes this into account via an inbuilt source function, but in the simple model it is intended to add this explicitly.

As an example, Figure 2 shows a summary of Source Levels extrapolated from measured data on a number of impact piling operations using various pile sizes. It can be seen that as the diameter of the pile increases, the source level also increases, although it may be commented that two results that underlie the general curve for small pile diameters are now believed to be anomalous. These Source Level data will be used as an input to the simple model to provide a reasonably accurate estimation of the sound energy generated by striking of different sized piles. This is adequate for the purposes of ranking the significance of the various noise sources required in phase 1. However, the subsequent estimates of phase 2 will use the highly accurate INSPIRE model to provide detailed analysis.

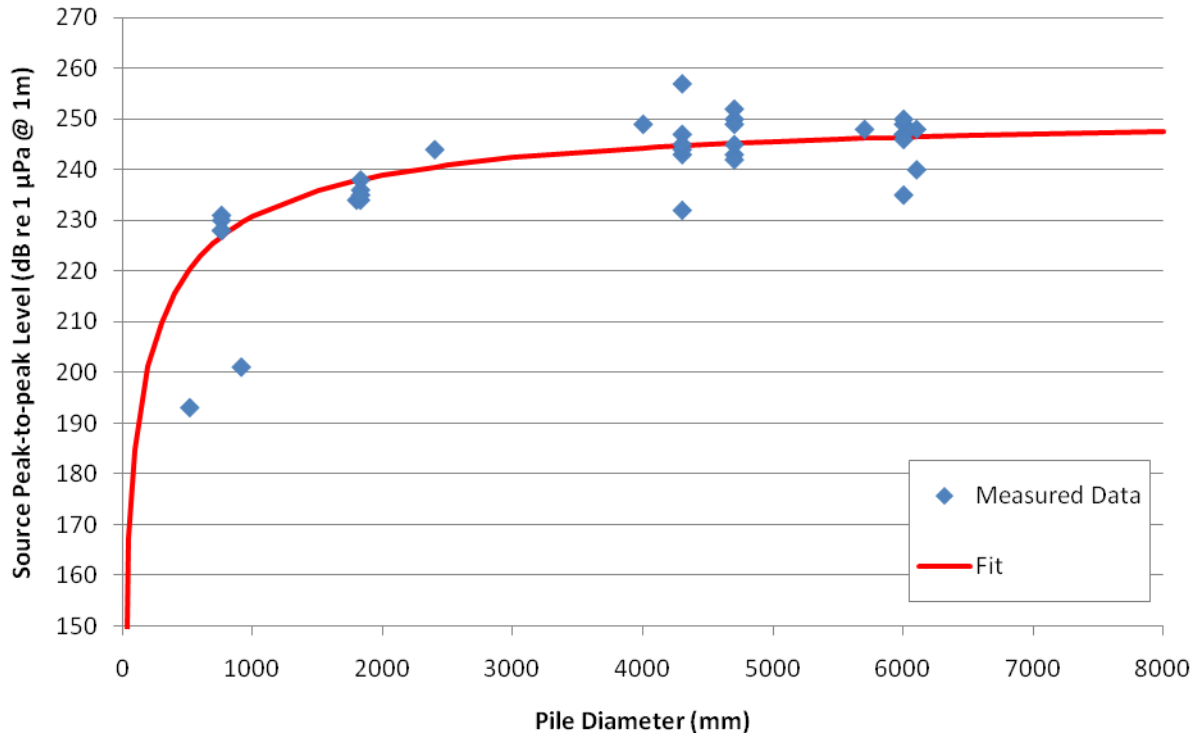

Figure 2 - Plot showing the asymptotic best fit to source level calculated from measured piling noise data for various pile sizes

In summary the initial ranking process will be based on a simple yet representative model which will enable the impact of a wide range of noise sources on a range of marine species to be evaluated in terms of the noise level, area affected and duration of activity. This process will be undertaken in consultation with the other EIA specialist areas.

It is envisaged that the information provided by this model will be capable of eliminating many of the construction activities from further consideration as they will be indicated to have a negligible risk of causing environmental impact. Phase 2 of the modelling programme will then use a more sophisticated model (INSPIRE) to provide detailed information on the noise levels from the highest level noise sources (e.g. impact piling)

Phase 2: Detailed noise modelling and guidance to engineering process.

Both developers are currently considering the use of impact piling to install foundations for the turbines and ancillary structures. Impact piling is known to generate high levels of underwater noise that can be potentially harmful to marine species (see for example Nedwell et al (2007)[3], Parvin et al (2007)[4]). It is therefore anticipated at this stage that the detailed modelling carried out in phase 2

[3] Nedwell J R, Parvin S J, Edwards B, Workman R, Brooker A G and Kynoch J E (2007) *Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK waters.* Subacoustech Report No. 544R0738 to COWRIE Lts. ISBN: 978-09554279-5-4.

[4] Parvin S J, Nedwell J R and Harland E (2007). *Lethal and physical injury of marine mammals, and requirements for Passive Acoustic Monitoring.* Subacoustech Report 565R0212, report prepared for the UK Government Department for Business, Enterprise and Regulatory Reform.

will need to concentrate on the potential impact of underwater noise from impact piling operations. On the basis of initial considerations, it is not thought that any of the other potential noise sources are likely to be of great significance, although this remains to be demonstrated by phase 1.

Where the level of noise is high, it is important to form an accurate estimate of its likely level such that its impact can be accurately assessed. There are a variety of acoustic models for underwater noise propagation in coastal and offshore regions as a result of military interests. However, the authors are not aware of any underwater broadband noise propagation models suitable for the much shallower environments typical of wind farm construction, or for the highly impulsive time histories encountered from impact piling. In these environments and with these source types there is a greater capacity for underwater sound to interact with absorptive processes in the seabed, resulting in propagation losses which typically increase with frequency but decrease with depth.

The Impulse Noise Sound Propagation and Impact Range Estimator (INSPIRE) model has been developed specifically to model the propagation of impulsive broadband underwater noise in shallow waters. It uses a combined geometric and energy flow/hysteresis loss model to conservatively predict propagation in relatively shallow coastal water environments, and has been tested against actual results from a large number of other offshore wind farm piling operations. A statistical package currently in development and due for release later in the year will also allow error bars to be assigned to the estimates. In addition, a "fleeing animal" model is being developed, which will enable the noise dose of an animal as it is moving away from a piling operation to be calculated. The model is able to provide a wide range of physical outputs, including the peak pressure, impulse, SEL, dB_{ht} etc. of the noise. Transmission Losses are calculated by the model on a fully range and depth dependent basis. The INSPIRE model imports electronic bathymetry data as a primary to determine the transmission losses along transects extending from the pile location input in addition to other simple physical data.

In the current version of the model, sound fields are generated on a high-resolution basis which is suitable as an output for detailed biological analysis. However, as a result of discussions during the early stages of the project, a stripped-down version of the INSPIRE model has also been generated, which can provide an output in a matter of a few minutes, and will be used during face-to-face meetings with engineering staff to guide the initial formulation of the construction plan. The authors are not aware of any other project in which environmental considerations relating to underwater noise have been built in to the engineering process at this relatively early stage.

In phase 2 the INSPIRE model will be used to assess in detail the range which fatality and physical injury, auditory injury and behavioural avoidance is likely to occur, for a range of animal species and classes. Each of these effects will be assessed in the EIA using the best available guidance, which for convenience is outlined below.

Physical injury and fatality

The data currently available relating to the levels of underwater noise likely to cause physical injury or fatality are primarily based on studies of blast injury at close range to explosives, with an additional small amount of information on fish kill as a result of impact piling. All the data concentrates on impulsive underwater noise sources as other sources of noise are rarely of a sufficient level to cause these effects.

Parvin *et al* (2007) presents a comprehensive review of information on lethal and physical impacts of underwater noise and proposes the following criteria to assess the likelihood of these effects occurring;

- Lethal effect may occur where peak to peak levels exceed 240dB re 1µPa; and
- Physical injury may occur where peak to peak levels exceed 220dB re 1µPa.

Although some evidence indicates that very small fish (<0.01g) may suffer injury at lower levels than these, the above criteria will be used to assess these effects on fish and marine mammals.

Auditory Damage

Parvin *et al*., (2007) also suggests that for continuous sound, direct injury to gas-containing structures or auditory mechanisms may occur at lower incident sound levels depending on duration and frequency content of the noise. Several studies have been carried out relating to the onset of auditory damage in terms of Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS) (see, for example Nedwell *et al*., (2007)[5] and Southall *et al*., (2007)[6] for a review of these studies). Nedwell *et al*., (2007) suggests the use of species specific weighting metrics (the dB_{ht}) similar to the approach used to assess human response to noise. The study suggests a criterion for instantaneous hearing damage that is similar to that used for humans, where levels of exposure exceeding 130 dB_{ht}(*species*) are likely to cause traumatic injury in a very short exposure time. This approach takes into the account the varying sensitivity and hearing abilities of marine species.

Southall *et al*., (2007) present another set of criteria for the levels of "pulsed" and "non-pulsed" underwater noise that may cause auditory injury to marine mammals based on the M-weighted Sound Exposure Level (SEL) and peak Sound Pressure Level. These criteria are presented in Table 1. In order to obtain the weighted sound exposure levels the data are first filtered using the proposed filter responses presented in Southall *et al*., (2007) for either high, low or mid-frequency cetaceans or pinnipeds in water, then the sound exposure level is calculated. Table 2 presents a summary of the various marine mammal groups, the suggested frequency range of hearing of each and example species.

It should be noted with regard to the below criteria that the Sound Pressure Level values are based on the peak pressure assumed to elicit TTS plus 6 dB and the Sound Exposure Level values are based on the SEL level assumed to elicit TTS plus 15 dB.

[5] Nedwell J R, Turnpenny A W H, Lovell J, Parvin S J, Workman R, Spinks J A L, Howell D (2007). *A validation of the dB_{ht} as a measure of the behavioural and auditory effects of underwater noise.* Subacoustech Report Reference: 534R1231, Published by Department for Business, Enterprise and Regulatory Reform.

[6] Southall, Brandon L.; Bowles, Ann E.; Ellison, William T.; Finneran, James J.; Gentry, Roger L.; Greene, Charles R.; Kastak, David; Ketten, Darlene R.; Miller, James H.; Nachtigall, Paul E.; Richardson, W. John; Thomas, Jeanette A.; Tyack, Peter L, (2007) *Marine Mammal Noise Exposure Criteria Aquatic Mammals*, Vol 33 (4).

	Sound Type		
Marine mammal group	**Single pulses**	**Multiple pulses**	**Nonpulses**
Low frequency cetaceans			
Sound Pressure Level	230 dB re. 1 μPa (peak)	230 dB re. 1 μPa (peak)	230 dB re. 1 μPa (peak)
Sound Exposure Level	198 dB re. 1 μPa^2-s (M_{lf})	198 dB re. 1 μPa^2-s (M_{lf})	215 dB re. 1 μPa^2-s (M_{lf})
Mid frequency cetaceans			
Sound Pressure Level	230 dB re. 1 μPa (peak)	230 dB re. 1 μPa (peak)	230 dB re. 1 μPa (peak)
Sound Exposure Level	198 dB re. 1 μPa^2-s (M_{mf})	198 dB re. 1 μPa^2-s (M_{mf})	215 dB re. 1 μPa^2-s (M_{mf})
High-frequency cetaceans			
Sound Pressure Level	230 dB re. 1 μPa (peak)	230 dB re. 1 μPa (peak)	230 dB re. 1 μPa (peak)
Sound Exposure Level	198 dB re. 1 μPa^2-s (M_{hf})	198 dB re. 1 μPa^2-s (M_{hf})	215 dB re. 1 μPa^2-s (M_{hf})
Pinnipeds (in water)			
Sound Pressure Level	218 dB re. 1 μPa (peak)	218 dB re. 1 μPa (peak)	218 dB re. 1 μPa (peak)
Sound Exposure Level	186 dB re. 1 μPa^2-s (M_{pa})	186 dB re. 1 μPa^2-s (M_{pa})	203 dB re. 1 μPa^2-s (M_{pa})

Table 1 Proposed injury criteria for various marine mammals groups (after Southall et al., 2007)

Functional hearing group	Estimated auditory bandwidth	Genera represented	Example species
Low frequency cetaceans	7 Hz to 22 kHz	Balaena, Caperea, Eschrichtius, Megaptera, Balaenoptera (13 species/subspecies)	Gray whale, Right whale, Humpback whale, Minke whale
Mid frequency cetaceans	150 Hz to 160 kHz	*Steno, Sousa, Sotalia, Tursiops, Stenella, Delphinus, Lagenodelphis, Lagenorhynchus, Lissodelphis, Grampus, Peponocephala, Feresa, Pseudorca, Orcinus, Globicephala, Orcaella, Physeter, Delphinapterus, Monodon, Ziphius, Berardius, Tasmacetus, Hyperoodon, Mesoplodon* (57 species/subspecies)	Bottlenose dolphin, striped dolphin, killer whale, sperm whale
High frequency cetaceans	200 Hz to 180 kHz	*Phocoena, Neophocaena, Phocoenoides, Platanista, Inia, Kogia, Lipotes, Pontoporia, Cephalorhynchus* (20 species/subspecies)	Harbour porpoise, river dolphins, Hector's dolphin
Pinnipeds in water	75 Hz to 75 kHz	*Arctocephalus, Callorhinus, Zalophus, Eumetopias, Neophoca, Phocarctos, Otaria, Erignathus, Phoca, Pusa, Halichoerus, Histriophoca, Pagophilus, Cystophora, Monachus, Mirounga, Leptonychotes, Ommatophoca, Lobodon, Hydrurga,* and *Odobenus* (41 species/subspecies)	Fur seal, harbour (common seal), grey seal

Table 2 Functional marine mammal groups, their assumed auditory bandwidth of hearing and genera presented in each group (reproduced from Southall et al (2007))

Behavioural response

At levels lower than those that cause auditory injury, noise may nevertheless have important behavioural effects on a species, of which the most significant is avoidance of an area around the source. The significance of the effect requires an understanding of its consequences; for instance, avoidance may be significant if it causes a migratory species to be blocked, delayed or diverted. However, in other cases, if the noise merely causes the movement of species from one area to another, it may be of no consequence. Similarly, where the avoidance causes a significant proportion of the foraging area of an animal to be excluded to it, the noise may have a significant impact.

The physical and auditory injury effects of noise occur at relatively short distances from a noise source and effect relatively small areas of sea. While the possibility of an unlucky individual straying

into this area around the piling operation cannot be excluded, the physical effects are relatively easily mitigated by approaches such as soft start, acoustic mitigation devices, and the use of MMOs. By contrast, since behavioural effects can occur at ranges of tens of kilometres, effective mitigation is difficult and accurate assessment of the likelihood of an effect is essential.

Various metrics have been proposed to assess the possibility of auditory damage and behavioural avoidance response occurring to marine species.

Estimates of behavioural effect based on the dB_{ht} criteria.

On the basis of a large body of measurements of fish avoidance of noise (Maes *et al,* 2004), and from re-analysis of marine mammal behavioural response to underwater sound, the dB_{ht} was developed to assess the potential impact of the underwater noise on marine species, and published by the Department of Business, Enterprise and Regulatory Reform (BERR) (Nedwell *et al,* 2007b). The concept of the dB_{ht} is very simple, although it should be commented that the calculation of the values is computationally onerous. In essence, the approach may be considered to be a generalisation of the dB(A) used to estimate the effect of noise on humans. The only significant difference lies in the use of various weighting curves that are related to the hearing abilities of individual species; this is the reason that the specific name must be appended to a value, since a given noise will have a different value for different species with different hearing abilities. A significant advantage of the approach is that where the audiogram of the species is known, or can be estimated, and accurate assessment of the "loudness" of a given noise may be made for any species. The approach is therefore particularly valuable in assessing the likelihood of a behavioural response,

Level in dB_{ht}(species)	**Effect**
0 – 50	Low likelihood of disturbance
75 and above	Mild avoidance reaction by the majority of individuals but habituation or context may limit effect
90 and above	Strong avoidance reaction by virtually all individuals
Above 130	Possibility of traumatic hearing damage from single event

Table 3 Assessment criteria used in this study to assess the potential impact of underwater noise on marine species

Conceptually, the approach is illustrated in Figure 3, in which the same noise spectrum is perceived at a different loudness level depending upon the particular fish or marine mammal receptor. The figure illustrates the spectrum of a source; overlaid over this are representations of the audiograms (threshold of hearing) of three typical marine animals. The portion of the noise that can be heard is therefore represented by the 'hatched' region in each case. It may be noted that the receptors also hear different parts (components) of the noise spectrum. In the case shown, Fish 1 has the poorest hearing (highest threshold) and only hears the noise over a limited low frequency range. Fish 2 has very much better hearing and hears the main dominant components of the noise. Although having the lowest threshold to the sound, the marine mammal only hears the very high components of the noise, and so in this case it may be perceived by that animal as relatively quiet.

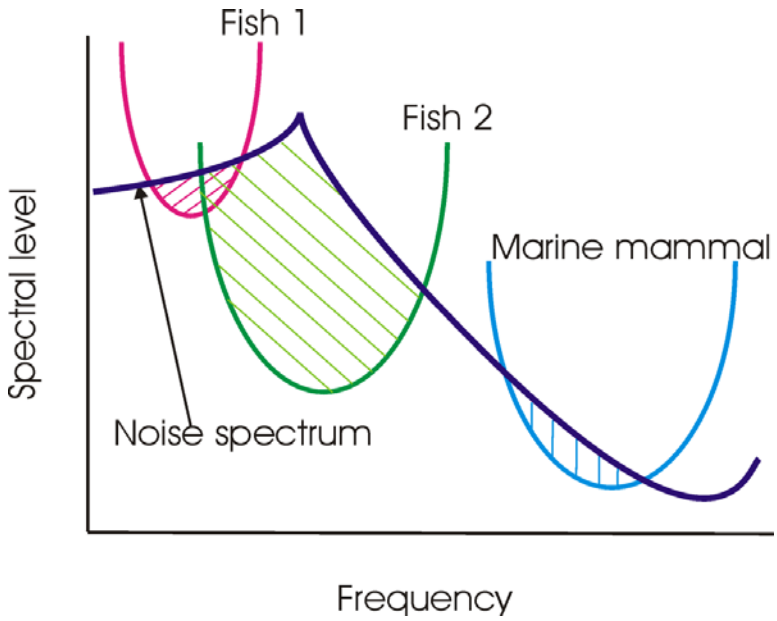

Figure 3. Illustration of perceived sound level (dB_{ht}) for representative fish and marine mammal species.

It will be realise that any given sound will inevitably be perceived differently by different species, since they have differing hearing abilities. Consequently, in dB_{ht} analysis, the species name must generally be appended when specifying a level. For instance, the same sound might have a level of 70 dB_{ht} (*Gaddus morhua*) for a cod and 40 dB_{ht} (*Salmo salar*) for a salmon.

It will be noted that the perceived noise levels of sources measured in dB_{ht} (species) are usually much lower than the unweighted (linear) levels, both because the sound will contain frequency components that the species cannot detect, and also because most aquatic and marine species have high thresholds of perception (are relatively insensitive) to sound.

Subacoustech has recently carried out a review of a substantial body of public domain literature relating to the impacts of underwater noise on marine species. This review will be available soon, however, the data indicate a high level of agreement between the dB_{ht} behavioural avoidance criteria and the observed reactions of marine species to underwater noise presented in the studies.

Fish and marine mammal hearing

The hearing sensitivity of an animal is specified by their audiogram, upon which the dB_{ht}(*species*) analysis is based. Table 5 presents a generalised summary of the hearing abilities of fish and marine mammals. As mentioned, there is a considerable variation even within these groups, however, this does provide an indication of the typical frequencies and levels that species are able to perceive.

Species group	Typical frequency range	Lowest threshold level	Frequency of peak sensitivity	Example species
Fish – hearing specialists	30 Hz – 4 kHz	75 dB re. 1 µPa	30 Hz – 1 kHz	herring (*Clupea harengus*), sprat (*Sprattus sprattus*)
Fish – hearing generalists	30 Hz – 400 Hz	95 – 118 dB re. 1µPa	100 – 200 Hz	Dab (*Limanda limanda*), cod (*Gadus morhua*)
Cetaceans	100 Hz – 170 kHz	40 dB re. 1 µPa	20 – 150 kHz	Harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncates*)
Pinnipeds	100 Hz – 128 kHz	60 dB re. 1 µPa	10 – 40 kHz	Common (harbour) seal (*Phoca vitulina*), grey seal (*Halichoerus grypus*)

Table 5 Summary of typical hearing sensitivity data for species of fish and marine mammals

Where good quality audiogram data for a species does not exist or is not available, it is possible that the audiogram data for another surrogate species having a similar hearing morphology may be used to provide an indicative assessment of potential impact. The surrogate audiogram data is usually selected on the basis of having similar auditory morphology, and therefore hearing abilities, as the species of interest. A surrogate may also be used to provide a conservative estimate of potential impact ranges by selecting a suitable representative audiogram for a species having sensitive hearing, that is, the lowest auditory threshold.

Table 6 presents a summary of the species which will be considered in the MORL and BOWL EIAs along with the availability of good quality audiogram data and use of surrogates.

Species common to area	Audiogram available?	Surrogate used	Comments	Reference
Grey seal	Partial – only upper frequencies	Harbour seal	No single audiogram dataset covering full audiometric range available. Data from two studies used	Kastak and Schusterman (1998) Mohl (1968)
Common (harbour) seal	Yes	-	No single audiogram dataset covering full audiometric range available. Data from two studies used	
Harbour porpoise	Yes	-	-	Kastelein (2002)
Minke whale	No	None	No surrogate data available for large mysticetes	-
Killer whale	Yes	-	-	Szymanski *et al*., (1999)
Risso's dolphin	Yes	Striped dolphin	Existing audiogram data indicates higher threshold than other dolphin species but high background noise levels during audiogram tests	Risso's dolphin – Nachtigall *et al*., (1995) Striped dolphin – Kastelein (2003)
White-sided dolphin	No	Bottlenose dolphin	Audiogram data suggest bottlenose dolphin are most sensitive dolphin species to sound so may provide conservative indication of impacts	Johnson (1967)
White beaked dolphin	Partial – only upper frequencies	Striped dolphin	Partial audiogram data for white-beaked dolphin indicates close match to striped dolphin data	White beaked dolphin – Nachtigall *et al*., 2007 Striped dolphin - Kastelein (2003)
Bottlenose dolphin	Yes	-	-	Johnson (1967)
Herring	Yes	-	-	Enger, 1967
Plaice	No	Dab		Chapman and Sand (1974)
Whiting	No	Cod	Of the same taxonomical family as cod so the audiogram data for cod is the best available information on which to base the impact assessment for this species.	
Cod	Yes	-	-	Chapman and Hawkins (1973)
Salmon	Yes	-		Hawkins and Johnstone (1978)
Trout	No	Salmon		Hawkins and Johnstone (1978)
Guillemot			See below section on assessment of underwater noise impact on diving birds	
Razorbill			See below section on assessment of underwater noise impact on diving birds	
Puffic			See below section on assessment of underwater noise impact on diving birds	
Gannet			See below section on assessment of underwater noise impact on diving birds	
Arctic turn			See below section on assessment of underwater noise impact on diving birds	

Table 6 Summary of species considered in this study and availability of audiogram data or suitable surrogates

Ornithology

While in principle there is no reason that the dB_{ht} approach should not be applied to the exposure of diving birds to noise underwater, the approach is particularly challenging as there is currently no audiogram available for submerged birds, and hence no direct indication of their sensitivity to underwater sound.

We would therefore propose to take the following approach to assess the impact of underwater noise on diving birds:

- Figure 4 indicates the average bird audiogram in air (after Dooling, 2002)[7]. This indicates that the bird hearing process is typical of terrestrial animals, with a maximum sensitivity in the low kHz region. It may be seen that the peak sensitivity is slightly higher than human sensitivity; however the basic hearing process is by tympanic conduction and hence similar to human hearing.
- Other average audiograms are available for other groups of birds (Passeriformes and Strigiformes); this particular audiogram is for species of birds that Dooling, (2002) refers to as "not of the order Passeriformes or Strigiformes". This group includes one species of the order Charadriiformes, which includes Guillemots, Razorbills and Puffins. We would welcome further discussion on the suitability of this choice, however, for the purposes of this advisory note the grouped average audiogram is presented.

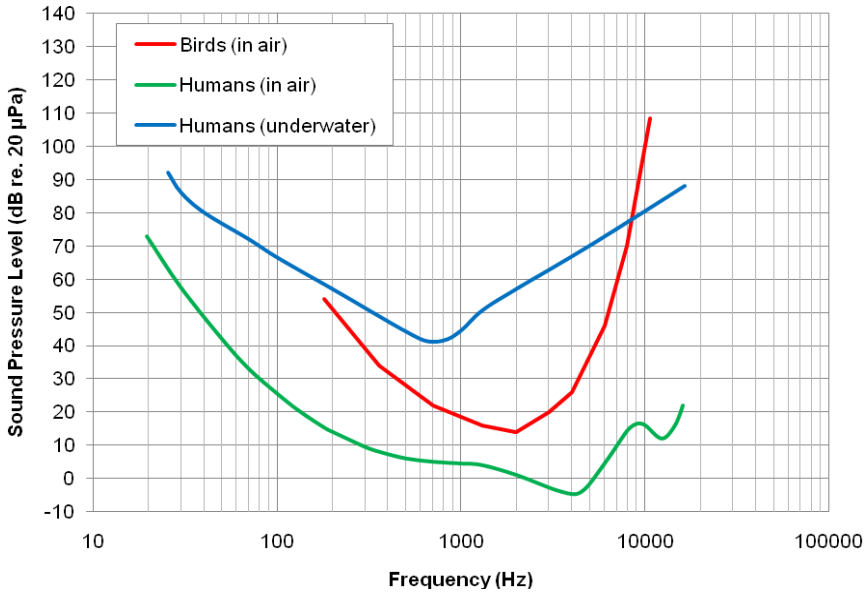

Figure 4 – A comparison between audiograms for humans in air and underwater and for an average bird in air

- The audiogram for human hearing in both air and water is also shown on Figure 4 (Parvin and Nedwell, 1995)[8]. These data indicate that there is a reduction in sensitivity to sound in a

[7] Dooling R. (2002). *Avian Hearing and the Avoidance of Wind Turbines.* National Renewable Energy Laboratory, NREL/TP-500-30844. p4. Available at: http://www.nrel.gov/wind/pdfs/30844.pdf

[8] Parvin S J and Nedwell J R. (1995). *Underwater Sound Perception and the Development of an Underwater Noise Weighting Scale.* Journal of the Society for Underwater Technology 21(1), 1995.

submerged human when compared to human hearing in air. This is because the water mass loads the tympanum, reducing the sensitivity of the tympanic hearing route. At high frequencies, hearing occurs by direct bone conduction.

- The underwater human hearing weighting curve (termed the dB(UW)) has been shown to be closely associated with the degree of impact of underwater sound on human divers, and it is interesting that the criterion that is used for unacceptable noise level is the same as that used by the authors of this report for more general application to the impact of underwater noise on marine animals. At the levels of 90 dB above the human submerged hearing threshold (i.e. dB_{ht}), sound is judged to be "unacceptable" by a majority of human divers.
- To apply these results to the case of diving birds, it is hypothesised that the same degree of sensitivity reduction to the average bird audiogram as is seen in human hearing is also likely to occur in diving birds under water. It is therefore proposed to use this as a "correction factor" to convert the average terrestrial audiogram of birds to an equivalent underwater hearing audiogram. In order to undertake this process, it is intended to non-dimensionalise the frequency based on the peak hearing sensitivity in air.
- This would generate an effective underwater generic bird audiogram, which would then be used in dB_{ht} analysis, subject to a 90 dB_{ht} criterion for unacceptable noise level, as has been done for fish and marine mammals, to provide indicative impact ranges for diving birds for wind farm related activities.

It should be noted that the study undertaken by Parvin and Nedwell is the only comparison of its type. In-air and underwater audiograms are available for various species of seal, however, as seals spend large amounts of time underwater, it is unlikely that this will give a meaningful comparison to species of birds; which, like humans, are primarily only exposed to terrestrial sound. Therefore, it is thought that the human hearing data will provide better guidance on submerged bird hearing.

Estimates of behavioural effect based on the Southall SEL criterion

Southall *et al*., (2007) also discuss the levels of underwater noise that may cause a behavioural avoidance response in marine species. Numeric criteria are provided for behavioural disturbance assessment for single pulse sound sources which are based on the level of underwater noise that the evidence presented in Southall et al (2007) indicate will be likely to cause TTS. The assumption upon which this is based being that a significant behavioural disturbance will occur at levels high enough to cause TTS as communication and/or detection capabilities will be interfered with. It may be commented that whereas the use of an SEL criterion for indicating the possibility of auditory injury in classes of marine mammals may well have utility, it is difficult to understand how it might provide an adequate criterion for behavioural effects. For instance, a human exposed at a sound pressure level of 75 dB(a) for eight hours, or 110 dB(A) for 10 seconds, both receive the same SEL value. It is clear that while the former is comparable with the levels of noise in a noisy office, and unlikely to cause a behavioural effects, the latter would be judged deafeningly loud by most people.

However, the study also concludes that the currently available evidence does not support the development of specific numeric criteria for the levels of underwater noise likely to cause a behavioural avoidance response for multiple pulse (i.e. impact piling) and non-pulsed noise sources. Instead, a severity scale is developed to rank the effects of a source of underwater noise in terms of the observable behavioural response. The findings of this study are used as the basis for the Joint Nature Conservation Committee (JNCC) guidance document on the deliberate

disturbance of marine mammals (JNCC, 2010)[9]. In the document the various severity ratings are summarised as "relatively minor and/or brief, score 0-3; with higher potential to affect feeding, reproduction, or survival, score 4-6; and considered likely to affect these life functions, score 7-9". It is also noted that the timescales over which a noisy activity may occur may be of significance. If an avoidance reaction lasts for less than 24 hours and does not occur again in subsequent days, it may not be considered to have caused a significant avoidance response, whereas an activity causing an avoidance response over a longer period would. Generally the guidance indicates that there is a greater risk of a disturbance offence being committed if the observable effect ranks as 5 or above on the Southall *et al*., (2007) severity scale.

Whereas this is useful in the context of observing behavioural response in marine species during an activity, it is difficult to quantify the potential for a behavioural avoidance response to occur in a predictive exercise such as this study. Table 4 below extracts a summary of the information presented in Southall *et al* (2007) for various levels of underwater noise from continuous noise sources and the behavioural avoidance responses that may result based on the studies reviewed by Southall *et al* (2007). These descriptions have been used to estimate the potential for behavioural avoidance to occur in marine mammals.

Group	RMS Received Level (dB re. 1 µPa)	Quoted description of associated behavioural response
Low frequency cetaceans	120 – 160	Increasing probability of disturbance
Mid frequency cetaceans	90 – 120	Individuals in the field showed behavioural response with high severity scores.
	120 – 150	Individuals in the field failed to show behavioural response
	170	Exposures in captive setting fail to induce a behavioural response
High frequency cetaceans	140	Profound and sustained avoidance responses
Pinnipeds	90 – 140	Generally do not appear to induce a strong behavioural avoidance response in pinnipeds

Table 4 Summary of behavioural avoidance responses and associated levels from Southall et al (2007)

[9] Joint Nature Conservation Committee (JNCC), Natural England and Countryside Council for Wales. (2009). *The protection of marine European Protected Species from injury and disturbance: Guidance for the marine area in English and Wales and the UK offshore marine area.* March 2010.

Modelling output

The output of the modelling will be in terms of contour plots indicating areas of equal loudness, similar to weather surface pressure charts or mapping. An example of the output is shown below. In this example the data are presented in terms of unweighted peak to peak levels but data will also be presented in terms of the other metrics discussed above.

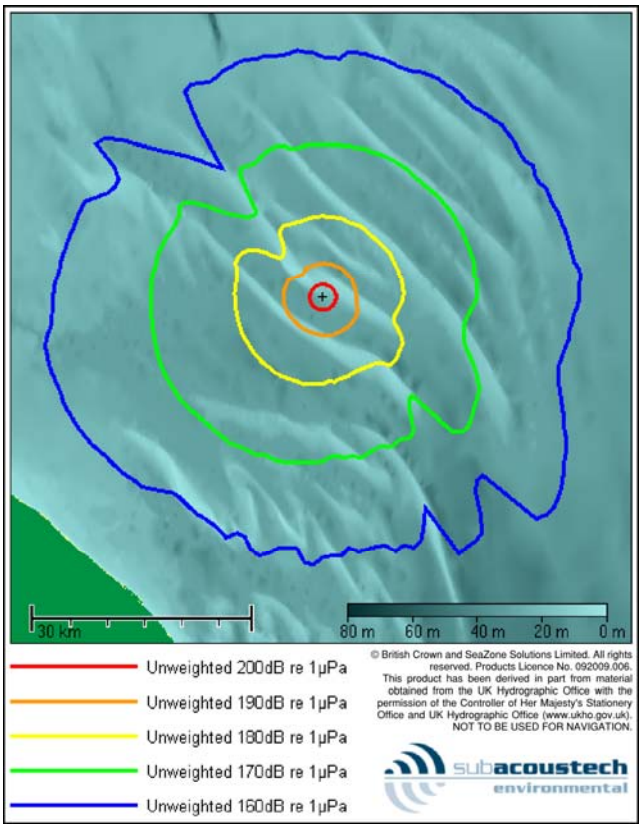

Figure 5 Typical example of the data output from the INSPIRE subsea propagation model

Cumulative impact assessment

The assessment methodology for the cumulative impact assessment will be based on the same modelling and analysis procedures that will be used in the broader EIA process.

- The broad-brush Source Level-Transmission Loss model will be used to provide information on the noise levels associated with a variety of wind farm related sources, and the range at which a behavioural effect may occur estimated. It is expected that the majority of sources will be of sufficiently low level that there will be no intersection of these zones with each other. In this case, the noise sources may be considered to be independent.
- It is envisaged that this process will however identify simultaneous impact piling operations as the key source of cumulative impact to marine species, with a significant probability of the zones of impact of two separate piling operations converging.
- Subsea noise propagation modelling will then be carried out using the proprietary noise propagation model, INSPIRE, to estimate the ranges of impact for typical simultaneous piling operations.

- The extent of cumulative impacts will be assessed based on the overlap of impact zones and the cumulative noise energy within the intersection.
- In order to conform to the assessment requirements for the EU Habitats Directive relating to the deliberate disturbance to marine mammals, the impact zones will be based on both the M-weighted Sound Exposure Level model10 as per the JNCC guidance and also the dB_{ht}(*species*) as the two principal metrics currently available for assessing the impact of underwater noise.
- This assessment will yield as an output objective, quantitative results which may be compared to marine mammal, fish and diving bird population, spawning and migration route data, allowing the overall cumulative impact to be assessed based on the overall effect of the noise on these key areas. It is anticipated that this will be carried out by the relevant biological specialists in each area.

[10] Southall, Brandon L.; Bowles, Ann E.; Ellison, William T.; Finneran, James J.; Gentry, Roger L.; Greene, Charles R.; Kastak, David; Ketten, Darlene R.; Miller, James H.; Nachtigall, Paul E.; Richardson, W. John; Thomas, Jeanette A.; Tyack, Peter L, (2007) *Marine Mammal Noise Exposure Criteria Aquatic Mammals*, Vol 33 (4).