European Union

European Regional Development Fund
Investing in your future

Department of Enterprise, Trade and Investment
www.detini.gov.uk

Strategic Environmental Assessment (SEA) of Offshore Wind and Marine Renewable Energy in Northern Ireland
Environmental Report Volume 1: Main Report

Department of Enterprise, Trade and Investment (DETI)
December 2009

Prepared by: SE..
Sarah Edwards
Associate Director

Checked by: SE ....
Sarah Edwards
Associate Director

Approved by: IAB..
Iain Bell
Regional Director

Northern Ireland

Rev No	Comments	Checked by	Approved by	Date
1	Draft for Client Comment	SE	IAB	July 2009
2	Final Draft for Client Comment	SE	IAB	Sep 2009
3	Final Report	SE	IAB	Dec 2009

Lynnfield House, Church Street, Altrincham, Cheshire, WA14 4DZ
Telephone: 0161 927 8200 Fax: 0161 927 8499 Website: http://www.aecom.com

Job No Reference Date Created December 2009

Table of Contents

Section 1: Introduction

1 Introduction

1.1 Introduction

This Environmental Report presents the results of the Strategic Environmental Assessment (SEA) of Offshore Wind and Marine Renewable Energy (wave and tidal) in Northern Ireland.

The Department of Enterprise, Trade and Investment (DETI) has appointed AECOM and Metoc to undertake an SEA of the potential effects that the development of offshore wind and marine renewable energy (wave and tidal devices) would have on the coastline of Northern Ireland and territorial (12nm limit) marine environment. The results of the SEA, presented in this report, have been used by DETI to inform the development of its offshore wind and marine renewable energy Strategic Action Plan (SAP), which has been developed in parallel to this SEA.

The overall objective of the draft Plan is to optimise the contribution of offshore wind and marine renewable to Northern Ireland's proposed 40% renewable electricity target by 2020, enhance diversity and security of supply and reduce carbon emissions.

1.2 Focus of the Environmental Report

This Environmental Report documents the main results and key findings from the SEA. The main purpose of this document is to assess the potential effects of offshore wind and marine renewable energy developments on the marine and coastal environment and identify potential zones within Northern Ireland waters where development could occur, subject to certain criteria and consenting procedures. This information has then been used to inform and assist DETI with the development of the SAP.

1.3 Offshore Wind and Marine Renewable Energy SEA Key Facts

Name of Responsible Authority	Department of Enterprise, Trade and Investment (DETI)
Title of Strategy	Northern Ireland Offshore Wind and Marine Renewables Strategic Action Plan
What Prompted the Strategy	The Strategic Action Plan (SAP) will provide a framework upon which DETI and The Crown Estates can launch a competitive licensing round for the development of offshore wind and marine renewable energy in Northern Ireland territorial waters. This is in response to a number of factors including: ➢ Increased need for renewables in Northern Ireland to ensure diversity and security of energy supply ➢ Reliance on onshore wind energy to date and need to realise other renewables ➢ A number of commercial interests in developing offshore wind and marine renewable energy in Northern Ireland waters ➢ The requirements of the EU Renewable Energy Directive and mandatory renewable energy targets for 2020
Strategy Subject	Offshore Wind, Marine Renewable Energy and Marine Environment
Period Covered	From 2009 -2020
Strategy Area	Northern Ireland territorial waters from mean high water mark seaward to 12nm
Contact Point	Barbara Swann (DETI) 02890 529427 barbara.swann@detini.gov.uk

1.4 How the SEA will Inform the Development of the Strategic Action Plan (SAP)

One of the key questions when carrying out an SEA is 'how will the findings of the SEA actually inform the SAP?' This is important to understand as it confirms the need for the SEA to be carried out in the first place and helps to establish the main objectives of the SEA.

Ultimately the focus of this SEA is to identify how offshore wind and marine renewable energy developments could affect the marine and coastal environment of Northern Ireland. The results of the SEA will then be used to help DETI to identify locations within Northern Ireland territorial waters which could be appropriate for inclusion within a future Crown Estate competitive call for offshore wind and marine renewable development licences.

The SAP is being developed in parallel to this SEA. In addition to identifying possible locations for future development, the SAP will include actions to provide guidance for developers and regulators relating to actual offshore wind or marine renewable energy developments. It is expected that the guidance will include specific requirements for individual developments. In terms of environmental requirements, it is likely that the SAP will establish certain criteria against which individual developments would be assessed in determining a development application. The criteria could include for example certain surveying and monitoring requirements that developers would be required to undertake as part of a development. The key requirements and associated criteria will be informed by the key results and outcomes from the SEA.

1.5 The Crown Estate Licences

The information within this SEA has been used by DETI to assist with the development of the SAP and will inform the establishment of a future licensing round for the development of offshore wind and marine renewable energy which will be initiated by The Crown Estate. However, it must be noted that the identification of any areas or zones for development from the SEA work does not imply any pre-licensing agreement or consent of any future applications to deploy offshore wind or marine devices. Such applications would still be subject to individual assessments on merits as part of the planned work with The Crown Estate.

1.6 Subject of the SEA (Screening Statement)

Under the SEA Directive, transposed into domestic legislation in Northern Ireland through the Environmental Assessment of Plans and Programmes Regulations (Northern Ireland) 2004 (S.R. 280/2004), an SEA is required for plans and programmes which:

- Are likely to have **significant environmental effects.**
- Are prepared for agriculture, forestry, fisheries, **energy**, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use, and which sets the framework for future development consent of projects requiring an EIA or an 'appropriate assessment' in accordance to the Habitats Directive.
- Are subject to **preparation and/or adoption by an authority at national**, regional or local **level** or which are prepared by an authority for adoption, through a legislative procedure by Parliament or Government, and which are required by legislative, regulatory or administrative provisions.

Based on the following it has been determined that an SEA is required for the SAP:

- The SAP will be prepared for energy related development.
- The SAP will contain policies and proposals that will include area specific allocations and could potentially give rise to significant environmental effects.
- The SAP is being prepared by the Northern Ireland Government (i.e. DETI) for adoption at a national level.

1.6.1 Screening For Habitat Regulations Assessment (HRA)

HRAs (including Appropriate Assessment) are required under the European Habitats Directive (92/43/EEC) to assess whether the plan (in this case the SAP) is likely to have a significant adverse effect on a Natura 2000 site (Special Protection Area (SPA) and Special Area of Conservation (SAC) including candidate and proposed sites).

As with SEAs, Appropriate Assessments are a key material consideration in the preparation and finalisation of plans. The HRA process is similar to the SEA process in terms of carrying out strategic level assessments. However HRA (including Appropriate Assessment) focuses specifically on the protection of European sites. Given that the HRA process is specific to European sites it is necessary to have a greater level of detail or information within the plan with regard to the type and scale of development that is likely to occur within a particular location.

Given that the SEA and HRA processes are recognised as being complementary to each other it is becoming increasing recognised as good practice to combine the processes. However, in the context of this plan (the SAP), information on areas for development (resource zones), types of development (offshore wind, wave or tidal) and scale/level of development (e.g. MW) likely to occur within the identified zones will only be determined as an outcome of the complete SEA process, rather than predefined as part of the emerging plan. Given that this information is necessary to carry out the first stage of the HRA process (screening) it has not been possible to carry out both assessments in parallel.

However, once this information is available (e.g. findings from the SEA have been approved and integrated in the SAP) a formal screening exercise will be undertaken to determine whether the SAP would be subject to a full Appropriate Assessment under The Conservation (Natural Habitats) Regulations 1995 which transposes the requirements of the Habitats Directive. This screening exercise will be undertaken in consultation with the Northern Ireland Environment Agency (NIEA). Should the outcome of the HRA screening exercise determine than an Appropriate Assessment be required this will be undertaken prior to adoption of the final SAP.

1.7 Strategic Environmental Assessment (SEA)

1.7.1 Scope of the SEA

The main purpose of this SEA is to assess the potential effects of the offshore wind and marine renewable energy SAP for Northern Ireland on the marine and coastal environment.

1.7.1.1 <u>Differences Between SEA and EIA Process</u>

The SEA process focuses purely on the assessment of plans or programmes, where as the EIA (Environmental Impact Assessment) process focuses on individual development projects. The plans and programmes subject to an SEA can range from national to local level plans and are generally prepared by public bodies (e.g. central or local Government or regulatory authorities) or utilities companies. These plans and programmes set the framework for future development projects, some of which will then be subject to an EIA as part of an application for development consent.

In regard to offshore wind and marine renewable energy developments there are a number of significant differences between the SEA and EIA processes. These are discussed in Table 1.1 below:

Table 1.1: Differences between SEA and EIA Processes:

SEA Process	EIA Process
Subject of the SEA is the DETI Strategic Action Plan	Subject of an EIA would be individual developments (projects) e.g. offshore wind farms, wave/tidal demonstration projects or arrays
SEA is area wide (e.g. covers geographical areas UK, Northern Ireland, regions, districts, boroughs, towns, part of towns). This SEA covers the full extent of the Northern Ireland territorial waters from Mean High Water mark.	EIA is generally site specific (e.g. applies to the sites of a specific development (project) and immediate surrounding area (potential receptors).
SEAs are desk based assessment based on existing available information. Additional studies (e.g. additional data collection exercises) may be undertaken to support the SEA if it is determined that particular data gaps could invalidate the findings of the SEA and affect the decision making process.	EIA involves a range of assessment methods including: ▪ Desk based assessments ▪ Site visits ▪ Surveys and monitoring ▪ Modelling ▪ Sampling and laboratory testing ▪ Research studies
At the plan level the assessment of environmental effects is generally based on: ▪ Plan objectives and strategies ▪ Development/planning policies Occasionally information may be available on: ▪ Potential sites or areas for development ▪ Broad scheme/ project descriptions However, this is not a statutory requirement for all plans.	For EIAs, project descriptions have to include information on: ▪ Site parameters/application boundaries ▪ Development type and scale of development ▪ Design (materials and layouts) ▪ Heights and footprints ▪ Timescales for development ▪ Construction methods ▪ Hours of operation/construction ▪ Shift patterns etc ▪ Levels of construction and operation traffic
The focus for SEA is to look at a range of projects or schemes that could emerge from a plan or programme and assess whether individually or in combination (cumulative) these could potentially have significant adverse effect on the environment.	The focus for EIA is to accurately determine whether an individual development project would definitely have a significant adverse effect on the environment.
At the plan level, mitigation associated with the SEA process generally involves changing the plan or removing/changing certain policies or proposals presented within the plan to reduce, avoid or offset any significant adverse effects. In some cases where there is uncertainty over the nature of a potential effect, mitigation may include the identification of more detailed surveys or monitoring that would have to be undertaken as part of the consenting of individual projects that are taken forward (e.g. as part of an EIA).	At the project level, mitigation is much more specific and generally includes changes to the detailed design of a project, detailed surveying and monitoring, control of construction activities (e.g. timescales) and operational controls e.g. limiting noise emissions. Mitigation measures are usually implemented as conditions of planning permission/development consent or through an Environmental Management Plan (EMP).

1.7.2 *SEA Study Area*

This SEA covers the full extent of Northern Ireland territorial waters from the Mean High Water Mark seaward to the 12nm limit. This therefore includes the transitional zone between the landward limits of the marine environment (mean high water) and the recognised terrestrial planning boundary (mean low water). The SEA initially focuses on all NI territorial waters from Lough Foyle in the north to Carlingford Lough in the south. The study area has then been refined to focus part of the assessment on the recognised areas of interest for the development of offshore wind and marine renewable energy (resource zones). These zones of interest are illustrated in Figure 11.1 and discussed in more detail in Chapters 8, 11 and 12.

However, it should be noted that although a large part of the assessment covered in Chapters 11 and 12 focuses on the specific resource zones it is recognised that other, smaller areas of resource, may be identified that lie outside these zones. Although there may be other areas of interest for development located outside the main resource zones **this SEA does not preclude development in these areas.** The effects of any offshore wind, wave and tidal developments that occur within areas not included in the main resource zones are covered, albeit at a lower level of detail, in the Generic Assessment (Chapter 10) which applies to the entire study area.

It is also important to note that all developments (offshore wind and marine renewable energy) that occur within the study area (within or outwith the resource zones) will still have to be considered on a case by case basis and project level consenting requirements will still apply. This is applicable to demonstration projects as well as commercial developments. The purpose of the SEA it to increase the confidence with which potential areas of resource can be included within any future licensing rounds run by The Crown Estate and developers can select potential sites based on increased knowledge of awareness of the likely constraints that will have to be taken into account/addressed in a particular location.

1.7.3 Transboundary Considerations

Given the location of Northern Ireland and its surrounding territorial waters, the SEA has taken into consideration potential transboundary effects on the following areas:

- Republic of Ireland (RoI) territorial waters
- Scotland territorial waters (mainly waters within the North Channel (Western Scotland including Dumfries and Galloway (off the Rhinns) and Argyll and Bute (Peninsula of Kintyre and Isle of Islay)). In particular there is a need to consider the Scottish Government's strategy for the development of marine renewable energy and proposals presented within the Scottish Marine Bill Consultation Document.
- Isle of Man territorial waters

Further details on potential transboundary issues are included in Chapter 13: Cumulative Effects associated with other plans, programmes and developments.

1.7.4 Objectives of the SEA Directive

The objectives of the SEA Directive, as set out in Article 1, are "*to provide a high level of protection to the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development*". These objectives have been integrated into the relevant national SEA Regulations.

1.7.5 Requirements of the SEA Directive

There are five main requirements of the SEA Directive. These have been transposed into the relevant SEA Regulations and are reflected in the UK guidance note on SEA 'A Practical Guide to the Strategic Environmental Assessment Directive' (September 2005), which was prepared jointly by the former Office of the Deputy Prime Minister (now Department of Communities and Local Government), the former Scottish Executive (now Scottish Government), the Welsh Assembly Government and the Department of the Environment (DOE) in Northern Ireland.

The UK SEA guidance presents the requirements of the SEA Directive as a series of stages. These stages are described in Table 1.2 below and include:

- Stage A – Setting the context, establishing the baseline and defining the scope
- Stage B – Developing and refining strategic alternatives and assessing effects
- Stage C – Preparing the Environmental Report
- Stage D – Consulting on the Environmental Report
- Stage E – Monitoring implementation of the Strategic Action Plan (SAP)

Table 1.2: Requirements of the SEA Directive

SEA Stages	Description
Stage A **Setting the Context, Establishing the Baseline and Deciding the Scope**	▪ Proposal of SEA objectives. (This SEA proposes to focus the assessment on the individual SEA topics defined by the SEA Directive and key subject areas relating to those topics e.g. European protected species and designated sites (SACs and SPAs), rather than developing specific SEA objectives. ▪ Identify/collect of baseline data ▪ Identify key environmental issues ▪ Identify relevant plans, programmes and environmental protection objectives ▪ Develop method for assessing potential environmental effects ▪ Consult authorities with environmental responsibilities on scope of SEA (i.e. Department of Environment (DOE) in Northern Ireland)
Stage B **Developing Strategic Alternatives and Assessing Effects**	▪ Identify and refine strategic alternatives ▪ Test objectives of the SAP ▪ Predict the effects of the SAP on the environment ▪ Use significance criteria to evaluate the effects of the SAP on the environment ▪ Outline potential measures to mitigate against any adverse effects ▪ Propose measures to monitor the environmental effects of the SAP
Stage C **Preparing the Environmental Report**	▪ Present the findings of the SEA in an Environmental Report ▪ Ensure the Environmental Report is accessible to all interested parties
Stage D **Consulting and Decision Making**	▪ Consult with the public, community groups, authorities with environmental responsibilities (e.g. DOE, Northern Ireland Environment Agency (NIEA), Department of Culture, Arts and Leisure (DCAL), Department for Regional Development (DRD), Department of Agriculture and Rural Development (DARD), Agri-Food and Biosciences Institute (AFBI) and the Maritime and Coast Guard Agency), other key stakeholders, industry and academics ▪ Transboundary consultation ▪ Incorporate comments received from consultation and findings of the Environmental Report into development of the SAP ▪ Assess significant changes to the SAP ▪ Issue a 'statement' (SEA Statement) of how the findings of the SEA and responses from consultation were incorporated into the SAP
Stage E **Monitoring Implementation of the Plan**	▪ Develop aims and methods for monitoring ▪ Respond to adverse effects

1.8 Objectives of this SEA

The main objectives of this SEA include:

- To review earlier studies and confirm the potential capacities in GigaWatts for offshore wind and marine renewables
- To assess and quantify, at a strategic level, the potential effects on the NI coastal and marine environment of developing the offshore wind and marine renewable energy capacity identified in the earlier studies
- To assess and quantify the potential of offshore wind and marine renewable energy to contribute to the proposed UK EU renewable energy targets for 2020 – 15% of all energy from renewable sources and 20% Greenhouse Gas savings
- To advise DETI in the development and implementation of a SAP for offshore wind and renewable energy projects
- To inform future licence determinations under Part II of the Food and Environment Protection Act (or the new regime introduced by the UK Marine and Coastal Access Act) and provide guidance for future developers
- To inform the project level decision-making process for all stakeholders (including regulators and developers)
- To facilitate focused investment in offshore wind and marine renewable energy developments in Northern Ireland

1.9 Deliverables of the SEA

Based on the above objectives and SEA guidance, the main deliverables of this SEA include:

a) Establishment of the baseline situation based on available information. The SEA topics that will be covered by this SEA are listed in section 1.10 below.
b) Identification of gaps and inconsistencies in the baseline data and the need for further work or study (presented in the Scoping Report);
c) Consultation (undertaken continuously, at varying levels, throughout the project as required by the SEA process);
d) Assessment of the nature and extent of opportunities and constraints with regard to offshore wind and marine renewable energy developments in the construction, operation, maintenance and decommissioning phases of development;
e) Assessment of the different effects of the range of marine renewable devices on the marine environment and potential site selection issues;
f) Recommendations of mitigation measures to avoid, reduce or offset and significant adverse effects on the environment;
g) Documentation of the findings from the SEA (screening, scoping and environmental reports which meet the SEA Directive requirements; public consultation; and internal discussions);
h) Advice and support in the preparation of the SAP, guidance for offshore wind and marine development; and
i) Advice on the scope of potential monitoring requirements in terms of the SAP and SEA.

1.10 SEA Topics

Table 1.3 lists the main topics (and associated important factors for assessment) that are covered by this SEA. This list is derived from the SEA Directive and refined to make it relevant to the marine and coastal environment of Northern Ireland. The topics have been identified through the authors' knowledge of the SEA process, the requirements of the SEA Directive, requirements of DETI and an understanding of the potential environmental effects that offshore wind and marine renewable energy developments could have on the environment.

Table 1.3: SEA Topics

SEA Directive Topics	DETI SEA Topics	Important Factors
Water, Soil (Sediment)	Geology, geomorphological and sediment processes Sediment contamination and water quality	▪ Marine designations ▪ Bedrock, superficial sediments, seabed sediments ▪ Marine and coastal processes including erosion, transport and deposition of coastal and marine rocks and sediments ▪ Munitions dumps ▪ Disposal sites ▪ Marine discharges ▪ Bathing Waters/Shellfish Waters Directive
Biodiversity, Flora and Fauna	Protected sites and species Benthic and intertidal ecology Fish and shellfish Birds Marine mammals Marine reptiles Bats	▪ Natura 2000 Sites (SPAs and SACs) ▪ Ramsar sites ▪ Areas of Special Scientific Interest (ASSIs) ▪ Marine Protection Areas (MPAs) ▪ Benthic ecology ▪ Sea birds ▪ Marine mammals ▪ Fish and shellfish ▪ Non-native species ▪ Marine reptiles ▪ Bats ▪ Noise and vibration impacts on above receptors ▪ EMF impacts on above receptors
Cultural Heritage including Archaeological Heritage	Marine and coastal archaeology and wrecks	▪ Wrecks e.g. ships and aircraft ▪ Submerged prehistoric landscapes ▪ Marine archaeological features/remains ▪ World Heritage Sites ▪ Terrestrial archaeological remains/sites ▪ Listed buildings and conservation areas
Population and Human Health	Commercial fisheries Mariculture Shipping and navigation (including ports and harbours) Recreation and tourism Radar interference Military practice areas Disposal areas	▪ Commercial fishing ▪ Aquaculture ▪ Radar (Military and UK/ROI and IOM Aviation) ▪ Shipping and navigation (including safety (Human Heath) ▪ Bathing Waters (cross referenced to Water Quality) ▪ Shellfish Waters (cross referenced to Water Quality and Aquaculture) ▪ Recreation and tourism e.g. recreational sailing routes, watersports, surfing
Material Assets	Cables and pipelines Mineral resources/aggregate extraction Renewable energy developments	▪ Cables and pipelines ▪ Coastal infrastructure ▪ Telecommunications cables ▪ Oil and gas infrastructure ▪ Electricity cables ▪ Aggregate extraction
Landscape/ Seascape	Landscape, seascape and visual receptors	▪ Seascape Character ▪ Topography ▪ World Heritage Sites ▪ Areas of Outstanding Natural Beauty (AONBs) ▪ MNR National Parks ▪ AEHSA ▪ Scenic Quality
Climatic Factors	Carbon impacts of offshore wind and marine renewables (carbon cost) Carbon storage	▪ CO_2 (greenhouse gas) emissions from construction and operation ▪ Promotion of renewable energy ▪ Carbon storage ▪ Gas storage ▪ Sea level rise (effects on coastal infrastructure and shoreline devices)

1.10.1 Socio-Economic Impacts

This SEA does not cover socio-economic impacts. However, in accordance with the SEA Directive, and the Northern Ireland SEA Regulations 2004, the SEA does address 'population' and 'human health' issues. The main factors that have been considered in the context of population include key activities that occur within, or make use of, the marine environment.

These marine activities are considered to be a key component of the wider marine environment. The assessment will therefore consider whether the proposals for the development of offshore wind, wave or tidal energy would cause any disruption, disturbance or displacement to these activities.

The key marine activities considered in this SEA are listed in Table 1.3. Whilst it is recognised that some of these activities have a commercial focus, the SEA **will not** assess the implications of any disruption, disturbance or displacement of these activities in a wider socio-economic context e.g. changes in revenue, job creation or loss etc.

At this strategic level, any socio-economic assessment would require an examination of how the offshore wind and marine renewable energy developments would support local communities in terms of employment and revenue as well their contribution to the wider economy of Northern Ireland. This is beyond the scope of this SEA and the requirements of the SEA Directive.

1.11 Scoped Out Topics

Based on an initial review of the main topics identified for assessment in the SEA, it has been determined that factors associated with **air quality** will not be included in the main assessment i.e. will be scoped out from the SEA.

The justification for exclusion of Air Quality and associated factors from the main assessment is on the basis that the development of marine renewable technologies and offshore wind does not generate any atmospheric emissions (note: **Air Quality does not relate to CO_2 emissions** which are covered under climate change and greenhouse gas emissions). It is recognised that there could be localised impacts on air quality generated during construction (atmospheric emissions from construction vessels) and the possible re-routing of vessels could lead to an increase in localised emissions from those vessels. However, it is not anticipated that these potential effects will be of major significance at a strategic level and therefore will not be taken forward for more detailed assessment as part of this SEA.

1.12 Consultation on the Environmental Report and Draft SAP

This **SEA Environmental Report** and the draft SAP will be available for consultation from 11th December 2009 for 12 weeks.

All comments received on the Draft SAP and SEA Environmental Report will then be reviewed and addressed where appropriate prior to adoption of the SAP in spring 2010. An SEA Statement will be published once the SAP is adopted. This will set out how the findings from the SEA and comments from consultation have been integrated into the final SAP.

The Environmental Report is available for downloading from www.offshorenergyni.co.uk.

All comments received from consultation on the Environmental Report will also be available to view on the website.

1.13 Onshore Grid Reinforcement Study

NIE, as the owner of the grid, in co-operation with the system operator, SONI, is currently investigating options for the development a programme of grid strengthening and upgrading works across Northern Ireland. A key priority for this work is to examine the extent to which grid reinforcement works are required to handle the increased levels of electricity likely to be generated from renewable energy sources. This programme of grid reinforcement works will be subject to a separate SEA, commissioned by DETI.

It is important to note that, although both the SAP and a programme of grid reinforcement works are intrinsically related, they are separate programmes and are therefore required to be subject to separate SEA's. The grid reinforcement programme, whilst linking to the SAP for offshore wind and marine renewable, has a much wider remit which covers all renewable (onshore and offshore/marine), and fossil fuels. The main focus for the grid reinforcement study is to identify the strengthening and upgrading works that are required to absorb much higher levels of renewable generation and improve security of supply across Northern Ireland. Given the wider remit for this programme it would not be appropriate to cover the potential environmental effects of grid works within an SEA that is focused purely on the development of offshore wind and marine renewables.

However, to ensure consistency and a coordinated approach between the two SEAs, the key findings from this SEA (of the SAP) will be used to inform both the Grid SEA and preparation of the programme of grid reinforcement works.

1.14 Study Limitations

The scope of this SEA was defined by the DETI terms of reference, the tender submission, the requirements of the SEA Directive and good practice. Specific items of general concern or interest to a wider group of stakeholders may not be within the remit of this SEA. Some of these specific items are given in Table 1.4:

Table 1.4: Limitation of the Northern Ireland Offshore Wind and Marine Renewable Energy SEA

	Inside of Study Scope	Outside of Study Scope
1	Potential environmental effects will be identified and assessed at a strategic level.	Effects will not be assessed at a project specific level.
2	The SEA will provide baseline information pertinent to the strategic issues associated with the potential development of offshore wind and marine renewables.	The SEA will not replace the need for developers to collect detailed project specific baseline data.
3	The SEA will inform the development and implementation of the SAP	The SEA will not specifically address issues of grid development policy, socio-economic development, or policy relating to consent procedures but will cross refer to other work where relevant.
4	The SEA will help identify areas where there may be opportunities for, or environmental constraints against, development.	The SEA will not examine the commercial viability of development or provide cost benefit analysis.

2 Strategic Action Plan (SAP)

2.1 Introduction

This chapter sets the context to the SAP for offshore wind and marine renewable energy development in Northern Ireland and provides an overview of its content and structure. A draft version of the SAP has been issued for consultation at the same time as this Environmental Report. Further information on the wider legislative and policy framework within which the SAP sits is provided in Chapter 5.

2.2 Background to Renewable Energy

Both the economic implications of a dependence on imported fossil fuels, and the impact they have on the environment and climate, are currently high on the international political agenda. Awareness of the environmental impact of fossil fuels, in particular their contribution to climate change, was first tackled at the international level through the Kyoto Agreement, which was adopted in 1997.

Since then the European Union and the UK Government have taken significant steps in tackling climate change through the introduction of a number of Directives, Bills and White Papers. These all set out long-term aims and objectives for tackling climate change and have resulted in the legal enforcement of a number of targets for reducing CO_2 emissions and increasing the amount of energy produced from renewable sources of energy including wind, wave and tidal power.

The most recent target set by Europe is for 20% of EU energy to be provided from renewable sources by 2020. The UK's target has been set at 15% and the Department of Energy and Climate Change (DECC) published the UK Renewable Energy Strategy in July 2009 setting out how it proposes to reach the EU target. Its lead scenario suggests that more than 30% renewable electricity, 12% renewable heat and 10% renewable transport would be required.

2.3 Renewable Energy in Northern Ireland

Northern Ireland is highly dependent on imported fossil fuels and while the rate of deployment of renewables has been increasing in recent years, at 8% of electricity, there is considerable scope for development of its natural resources such as onshore and offshore wind, marine resources and bioenergy.

This dependence on imported fossil fuels has significant impacts on Northern Ireland's security of supply and it is essential that renewables should contribute more to the diversity of supply. In addition to the impact on security of supply, the high reliance on imported fossil fuels also impacts on the environment in terms of carbon emissions. There are also adverse impacts on local populations and the economy through high, and as demonstrated last year, volatile fuel costs leading to fuel poverty and high energy costs for businesses and industry.

Energy in Northern Ireland is primarily a devolved matter falling to the NI Assembly and the DETI Minister. DETI is responsible for the development and maintenance of an appropriate legislative and policy framework for energy in Northern Ireland and has recently consulted on a new Strategic Energy Framework (SEF 2009). Four main goals have been identified for the SEF – competitiveness; security of supply; sustainability and infrastructure. An increased role for sustainable and renewable energy has been set out with the proposed adoption of new renewable energy targets to 2020.

Northern Ireland's current target for renewable energy is that 12% of electricity consumption by 2012 will be met from indigenous renewable energy sources, with 15% of that 12% being produced from non-wind resources. This later goal amounts to around 25-30 MW. It is likely that the overall target will be met from onshore wind developments and it is hoped that a number of possible Energy from Waste projects will contribute to the non–wind element. Given the timescales involved and with only the MCT Sea Gen tidal project operating within NI waters offshore renewables are not expected to contribute to the 2012 target.

As noted above, proposed new targets have been set in terms of Northern Ireland's contribution to the UK's 2020 targets. These targets are as follows - 40% electricity from renewable sources and 10% electricity from renewable heat sources (the latter is an interim target pending further research work). While onshore wind will continue to be the main renewable source in meeting these electricity targets, it is hoped that offshore renewables can contribute to the 2020 target and, as the technology continues to develop, to post 2020 targets.

In order to develop the potential for offshore renewables, DETI has prepared an offshore wind and marine renewable energy Strategic Action Plan (SAP). This plan is the subject of this SEA process.

2.4 Background to the Strategic Action Plan (SAP)

2.4.1 Offshore Wind and Marine Renewable Energy

The renewable energy industry has increased significantly during the last decade in response to the increased threat of climate change and the subsequent carbon reduction targets set out at a global, European and domestic level. The most advanced technologies focus on harnessing energy from sunlight (solar), wind and biomass (crops and waste). Commercially, wind power is one of the main sources of renewable energy across Europe and within the UK, reflecting the favourable conditions for the exploitation of this resource. Solar power also makes a significant contribution to the amount of energy produced from renewable sources, particularly in southern Europe where sunlight is stronger and generally more consistent.

Within the UK, one of the main constraints to the development of wind energy at a commercial scale is the availability of suitable sites, many of which tend to be open, upland locations. Having recognised these constraints, and the need to find alternative locations for developing wind energy to further expand its contribution to the overall energy mix and meeting EU and UK targets, the industry has now moved into exploiting wind energy in offshore locations.

The offshore wind industry has grown significantly over the last 5 or 6 years, and continues to grow at a steady rate. This growth has been recognised by The Crown Estate, who is currently undertaking a third round of licensing for offshore wind development sites in GB territorial waters to facilitate government's aim of significantly increasing offshore wind capacity and in response to pressures from offshore wind developers for additional sites following the award and subsequent development of offshore wind sites allocated in Rounds 1 and 2.

In addition to offshore wind, there has also been a significant increase in investigations into the potential of exploiting energy from waves and tidal streams. However, in comparison to the offshore wind industry, which has developed off the back of a well established on-shore wind industry, the technologies/devices that are available to harness the potential energy from tidal streams or waves are still relatively new and untested at a commercial scale.

Nevertheless, considerable progress has been made at a demonstration project level in terms of testing new types of wave and tidal devices. These advances have been facilitated through the establishment of specific test centres e.g. the European Marine Energy Centre (EMEC) in Scotland, public funding and private investment in the development of specific types of devices e.g. Pelamis in Portugal and the MCT SeaGen Tidal device in Strangford Lough.

Through monitoring the effectiveness, efficiency and durability of these devices and the impact of their deployment on the environment, valuable information is being obtained to assist and inform the further growth of this industry and its expansion to a commercial level.

Similarly there is also a need to increase our understanding and knowledge about the actual resource that is available in terms of wave and tidal power and how to identify the best sites to develop in order to maximise the potential energy that can be generated from this resource.

2.4.2 Potential Resource (Offshore Wind, Wave and Tidal) in Northern Ireland

A number of studies undertaken over the last few years have identified that within Northern Ireland both offshore wind and marine renewable energy could make a significant contribution towards the Northern Ireland's renewable targets.

2.4.2.1 Offshore Wind

There have been a number of potential proposals to develop offshore wind in Northern Ireland waters. However, these proposals are still at the feasibility stage.

2.4.2.2 Marine Renewables (Wave and Tidal)

Northern Ireland currently accommodates the world's first commercial tidal stream turbine. The device, which is located in Strangford Narrows, was installed by Marine Current Turbines (MCT) in early 2008. Following a period of commissioning and testing, it delivered its first electricity to the grid in July 2008[1]. By December 2008 it had generated at its maximum capacity of 1.2mw, which is enough power to meet the average electricity needs of around 1000 homes[1].

In addition to the tidal resource of the Strangford Narrows, DETI and Northern Ireland Electricity (NIE) have identified a number of other locations in Northern Ireland waters with potential for further development of marine current (tidal stream) energy in Northern Ireland[2]. The potential locations were identified as part of a study undertaken in 2003[2], which used computer-based mathematical models of tidal streams combined with the likely cost and energy capture from the deployment of pile-mounted tidal turbines, to identify locations with greatest potential for tidal stream development. Other than Strangford Narrows, potential locations identified in the study include[2]:

- Copeland Islands
- The North East Coast of Northern Ireland (from Fair Head, past Torr Head to Runabay Head)

Combined with the Strangford Narrows, this study estimated that the development of the tidal stream resource off the Copeland Islands and the North East coast of Northern Ireland could generate up to 100mw of power by 2010[2]. In the longer term it was estimated that, given the development of suitable second generation technology which allows the exploitation of deeper water, several hundred MW could eventually be harnessed from the tidal streams in Northern Ireland waters[2].

More recent investigations have identified a number of other possible locations for tidal stream development. These include Lough Foyle and the waters off Rathlin Island. The North Coast of Northern Ireland has been identified as having potential for the generation of wave power. This section of the coastline is well recognised as a hotspot for surfing due to the large swells and waves that come in from the North Sea.

[1] http://www.marineturbines.com/3/news/article/17/seagen_tidal_energy_system_reaches_full_power___1_2mw/

[2] The Potential for the Use of Marine Current Energy in Northern Ireland (Department of Trade and Industry; Department of Enterprise, Trade and Investment; and Northern Ireland Electricity), June 2003

2.4.2.3 Grid Connections

In addition to available resource and site suitability e.g. water depths, to realise the full potential of the offshore wind and marine energy resource in Northern Ireland waters there is also a need to consider how any power generated in the locations discussed will be connected into the grid for wider distribution.

Access to suitable grid connections and the available capacity within the grid network can significantly affect the commercial viability of any offshore wind and marine renewable energy development and, as noted in section 1.13, DETI is undertaking an SEA of a grid strengthening programme being prepared by the grid owner NIE, in cooperation with SONI, the system operator, to upgrade existing grid infrastructure and handle increasing levels of renewable electricity from onshore and offshore sources.

This grid development work will also take account of the 10km sub-sea cable which runs from Rathlin Island to Ballycastle. The cable, which was officially turned on in 2008, was installed to increase security of supply of electricity to the local community of Rathlin Island. However, it also has capacity to export electricity from Rathlin Island back into the main grid in Northern Ireland for wider distribution. This additional surplus capacity could potentially be used to connect existing and future renewable energy schemes in this area into the main NI Grid. These schemes could include future tidal stream or offshore wind developments.

2.5 Offshore Wind and Marine Renewable Energy Strategic Action Plan (SAP)

2.5.1 Development of the SAP

DETI developed the draft SAP to set the overarching framework for a competitive call, to be undertaken by The Crown Estate (TCE) for commercial projects. It includes a range of short, medium and longer term actions to facilitate the development of offshore wind and marine renewable energy in Northern Ireland.

2.5.2 Objective of the SAP

The overall objective of the draft plan is to optimise the amount of renewable electricity generated from offshore wind and marine renewable resources in Northern Ireland's waters in order to enhance diversity and security of supply and reduce carbon emissions and to take into account the protection of the environment and the needs and interests of other users.

2.5.3 Offshore Wind and Marine Renewable Electricity Targets

The draft SAP includes, for public consultation, targets that reflect the extent to which offshore wind and marine renewable energy could contribute towards achieving the proposed target for Northern Ireland of meeting 40% of Northern Ireland's energy consumption from renewable sources by 2020. These proposed targets have been informed by the results from this SEA. See Chapters 3, 12 and 13.

2.5.4 Associated Actions

The draft SAP recognises that there are a number of key actions that will need to be taken forward to support the overall objective for offshore wind and marine renewable energy. These actions, which will be developed separately to, but in conjunction with, the SAP, aim to address a number of operational and legislative issues including:

- The development in conjunction with The Crown Estate of a competitive call for commercial offshore renewable energy projects 2010-2011, on completion of the SEA

- Develop an appropriate reinforcement programme of the NI Grid, to be completed in time to handle efficiently the increasing renewable electricity generated offshore.
- Complete work by 2010 with Scotland and the Republic of Ireland on the joint Isles project to assess the potential for an offshore regional marine electricity grid linking Ireland and Scotland and consider its findings and recommendations,
- Continue to work with Invest NI, The Crown Estate and others in promoting the opportunities for local manufacturing and service sectors to secures offshore energy supply chain business in relation to projects considering investment in NI waters and also in the wider international and international markets,
- Develop a practical way forward with the Republic of Ireland for handling offshore renewable energy projects in waters in, around or adjacent to state boundaries near Loughs Foyle and Carlingford and agree appropriate operational arrangements,
- Continue to ensure that DETI's offshore energy interests are effectively represented within the development of policy and legislation for the forthcoming NI Marine Bill and other marine related work e.g. the Marine Strategy Framework Directive,
- With The Crown Estate and the Northern Ireland Environment Agency, develop streamlined administrative guidance for developers and officials on the licensing and consenting regimes for offshore renewable energy projects,
- Work with DECC to put in place the necessary offshore energy production and decommissioning regime , similar to that in force in GB waters, for offshore energy projects in Northern Ireland waters,
- Continue to develop the Northern Ireland Renewables Obligation to encourage the generation of electricity from offshore renewables and to agree with DECC the transfer of the vires from DECC to DETI to issue offshore Renewable Obligation Certificates,
- Ensure that Northern Ireland benefits from the range of UK wide regimes supporting research, development and deployment of offshore renewable energy projects.

Some of these associated actions may be the subject of their own plan or programme, and consequently may be subject to their own specific SEA (e.g. plan/programme for strengthening of the NI Grid is subject to a separate grid specific SEA) and as such these initiatives will therefore not be assessed as part of this SEA

3 Alternatives

3.1 Introduction

The following chapter discusses the 'alternatives' that have been considered to the Strategic Action Plan (SAP) and as part of the ongoing preparation of the SAP. This chapter also gives an overview of the potential environmental implications associated with each of the alternatives proposed.

However, it should be noted that most of the alternatives identified have been subject to rigorous assessment as an integral part of the wider SEA process and are therefore discussed in much greater detail in the later chapters of this report (e.g. Chapters 11, 12, 13 and 14).

In terms of this SEA and the SAP, three main alternatives have been identified:

- Evolution of the environment without implementation of the plan
- Alternatives to the preparation of the SAP – including different targets for offshore wind, wave and tidal energy developments
- Alternative scenarios for the development of offshore wind and marine renewable energy within the Northern Ireland study area (territorial waters) – including an analysis of different spatial distributions of offshore wind, wave and tidal developments

3.1.1 Relationship Between the SEA and SAP

In undertaking an assessment of the alternatives it is necessary to firstly understand how the plan (SAP) has evolved in relation to the SEA. In some instances where plans are subject to an SEA, the plan being assessed may already exist in a preferred format with agreed objectives and policies based on the previous selection of the preferred option. In this situation there is limited opportunity for the SEA to influence the overall direction of the plan which is likely to be predetermined. Consequently the assessment focuses more on the policies and proposals that have already been developed, and relies on the modification or removal of policies or proposals as the mechanism for mitigating any potential significant adverse effects on the environment.

However, in this case, the SEA was commenced at the start of the SAP process and has been carried out in parallel to its ongoing preparation. Consequently the SEA has been able to have a significant influence both the direction for the development of the SAP and content of the SAP. This includes the integral and ongoing assessment of the alternatives listed above.

3.2 Evolution of the Environment Without the Plan

As part of the SEA process it is necessary to evaluate the actual need for the SAP in the first place and to appraise how the environment would evolve in the absence of the plan (e.g. the do nothing scenario or continue with current practice scenario). In the case of this SEA, there are currently no plans, programme or strategies for offshore wind and marine renewable energy development within Northern Ireland waters. The focus for the SEA is therefore to appraise how the environment would evolve without the plan (e.g. continue with current practice).

3.2.1 *Drivers for the SAP*

Northern Ireland has recently proposed a target for 40% of its electricity to be generated from renewable energy sources. This proposed target was set out in the recently published Strategic Energy Framework (2009) which identified a number of key drivers behind the target. These include:

- Need to reduce Northern Ireland's dependence on fossil fuels and risks associated with security of supply and volatile and high costs of imported fuels.
- Need to reduce CO_2 emissions associated with the production of electricity from fossil fuels in line with UK, European and International targets and protocols.
- Need to exploit large resource of indigenous fuel sources to increase overall sustainability of energy consumption within Northern Ireland.

In meeting the proposed 2020 target, the Northern Ireland Government recognises that this will involve the development of a mix of renewable energy sources including offshore wind, wave and tidal, as well as onshore wind and waste. As noted in Chapter 2, Northern Ireland's current renewable electricity targets are likely to be met from onshore wind. While it is critical to reduce over reliance on fossil fuels, Northern Ireland also needs to broaden its current range of renewable technologies. Earlier studies have confirmed the potential for offshore renewable development, however, given that, as an industry, offshore wind, and in particular marine renewable energy (wave and tidal), is not as well established as onshore wind or waste (bioenergy) it has been identified that there needs to be a clear strategy or framework in place to give clear direction on how offshore renewable energy in Northern Ireland waters will be integrated into a wider energy mix and what will be its likely contribution.

3.2.2 *Establishing Northern Ireland Renewable Electricity Targets*

In preparation for the draft Strategic Energy Framework consultation, DETI commissioned work to project the likely electricity consumption in Northern Ireland by 2020 and test a number of scenarios to consider how this could be met with a mix of renewable, non-renewable and other energy sources (e.g. interconnectors). A range of possible scenarios for renewable electricity across all the technologies were developed. The aim of this work was to see what targets could realistically be set for renewable electricity by 2020 based on the predicted levels of consumption. It should be noted that this study was undertaken before this SEA work.

Based on the measures of practical resource, the study tested a number of scenarios relating to the potential composition of a renewable energy mix. These scenarios included:

- Low wind
- Medium wind
- High tidal
- High wind
- High biomass

These potential scenarios included estimates for offshore wind and tidal resource ranging from 150MW to 400MW. Wave energy was deemed to be unlikely to contribute significantly to targets due to the limited resource compared to offshore wind and tidal energy.

The key findings from this study have been taken into account in this SEA, although greater emphasis has been placed on the assessment of the potential available resource for offshore wind, wave and tidal and likely contributions to achieving the proposed 40% renewable energy target in respect to potential environmental constraints as opposed to technical or economic constraints. However, technical constraints were taken into consideration in the identification of the main areas of resource (resource zones). Further detail on the identification of the resource zones is presented in Chapter 8.

3.2.3 Risks Associated with Not Implementing the Plan (SAP)

While the SEA has identified that the inclusion of offshore wind and tidal energy within a wider renewable energy mix for Northern Ireland could potentially have adverse effects on the marine environment and other marine users in some parts of the Northern Ireland waters (see chapters 11, 12 and 13, there is potential for these effects to be minimised through appropriate mitigation (see chapters 11 and 14). However, there are also a number of potential risks with excluding these offshore renewable energy sources from the wider energy mix (i.e. not pursue with the SAP). These risks include:

- Waste of untapped natural resource which can address energy security and diversity, climate change mitigation and economic benefits within a sustainable development framework; a resource that is being developed in the UK, Europe and internationally.
- Risk of non achievement of the proposed 40% renewable energy target for 2020, and therefore greater need for higher onshore renewables to make up the difference; such an increase could have greater sustainability issues;
- Need for even greater number of onshore wind turbines to make up for no offshore renewables – potentially greater negative effect on the environment, landscape, visual amenity and greater risk of public opposition. The Grid /onshore wind development proposals are the subject of a separate SEA.
- Security of supply – not developing offshore renewable energy would not resolve security/diversity of supply issues as Northern Ireland would still be heavily reliant on one source of renewables, onshore wind, which has its own limitations (e.g. intermittency of supply). In comparison tidal energy is much more predictable and constant and offshore wind is generally less intermittent.
- Security of supply - continued heavy reliance of fossil fuels would have a number of significant implications due to the volatility of prices and the implications of these on business/enterprise in Northern Ireland as well as the effects on domestic customers in terms of fuel poverty etc.
- Economic development – renewable energy (including offshore wind and tidal) could potentially stimulate significant economic investment at all stages in the supply chain from technology developments, through to manufacturing, installation and maintenance with the potential for employment opportunities i.e. "green jobs". This opportunity would potentially be lost in absence of the development of these offshore renewables. There would also be less opportunity to develop associated clusters of SMEs and build on the engineering tradition in Northern Ireland and current research/academic developments at Queens University Belfast and University of Ulster.

3.2.3.1 <u>Baseline Environment – Key Issues and Future Trends</u>

The baseline data review (Chapter 9) includes information of key issues and future trends. This information looks at current environmental conditions and provides information on how these may change in the future in absence of the implementation of the SAP. These key issues and future trends have been taken into consideration in the main Resource Assessment (Chapter 11) and the assessment of cumulative effects associated with varying levels of development (Chapter 12). The key issues and trends identified have also been considered in respect the potential cumulative environmental effects associated with known environmental issues and problems (Chapter 13) and summarised below.

3.3 Assessment of Alternative Targets and Spatial Distributions of Development

The main focus of the SAP (as discussed in Chapter 2) is to optimise the offshore renewable resource and to identify targets that will reflect the extent to which this resource could be sustainably developed to contribute towards the wider Northern Ireland proposed target of 40% electricity to come from renewable energy sources by 2020. The SAP also identifies number of actions that will need to be undertaken to enable the proposed targets to be achieved.

One of the main aspects of the SEA is therefore to assess the potential effects that different levels of development associated with different targets for offshore wind and marine renewable energy would have on the marine and coastal environment of Northern Ireland. In determining potential targets for offshore wind and marine renewable energy development it has also been necessary to examine where offshore renewable energy developments are likely to be located (spatial distribution). This has been determined by assessing the levels of development that could be accommodated within each of the main areas of resource for offshore wind, wave and tidal (resource zones). These zones are discussed in more detail in Chapters 8 and 12.

Consequently, the assessment of the alternative levels of development (targets) and alternative spatial distributions of the different types of development has been an integral element of the overall SEA process. Detailed results from the assessment of these alternatives are presented as part of the cumulative assessment chapter (Chapter 12), and as part of the recommended mitigation measures for inclusion in the preparation of the SAP presented in Chapter 14.

Overall, the conclusions from the assessment of cumulative effects identified that offshore wind and tidal energy could make a significant contribution (more than 50%) towards achieving the proposed 40% renewable energy target for Northern Ireland without have significant adverse effects on the environment. Achieving this percentage of contribution would require a mix of both tidal and offshore wind energy to be developed within Northern Ireland waters. It would also be necessary in some locations to undertake additional studies or surveys (this may be as part of a strategic initiative or as part of individual projects) to confirm that no significant adverse effects will occur as a result of the development. However, the assessment of the potential level of contribution of offshore wind and tidal energy to the wider Northern Ireland renewable energy target has excluded areas where significant adverse effects are likely to occur.

3.4 Summary of Assessment of Alternatives

In terms of determining the need for the SAP, there are a number of potential environmental effects associated with developing, and not developing, a strategy for offshore wind and marine renewable energy.

In terms of not developing the SAP, the main environmental implications include the potential adverse effects on landscape, visual amenity and ecology associate with a reliance on onshore wind. There are also likely to be significant adverse effects in terms of delivering the renewable energy targets for Northern Ireland and contributing towards reducing carbon emissions and tackling climate change.

As discussed in Chapters 11 and 12 there is potential for the development of offshore wind and marine renewable energy to have an adverse effect on the marine environment and other sea users. However, through the implementation of appropriate mitigation including the careful siting of developments within particular zones, there is potential for these effects to be minimised or avoided.

Taking into account the potential risks of not implementing the SAP (environmentally and economically) and the results from the assessment of cumulative effects (Chapter 12) which indicate that offshore wind and tidal developments could make a significant contribution to the Northern Ireland target for renewable energy without significant adverse effects on the environment (Chapter 12 and section 3.2 above) it is concluded that it would be appropriate to pursue the implementation of the SAP.

4 Scoping Summary

4.1 Introduction

Consultation on the scope of the SEA was undertaken in May 2009. Scoping involved two key activities:

1. Preparation of a formal Scoping Report for consultation; and
2. A Scoping Seminar.

4.1.1 Scoping Report

A Scoping Report was issued to the Department of the Environment (DOE) in May 2009 as part of the formal consultation on the scope of the SEA. The Scoping Report was also circulated to a wide range of stakeholders and interested organisations and published on the dedicated SEA website (www.offshorenergyni.co.uk) for wider consultation.

The main focus of the Scoping Report was to set the context of the SEA, identify the key topics to be assessed as part of the SEA, present the key sources of baseline data and information to be reviewed as part of the main assessment, and provide detail on the approach and method to be used to strategically assess the effects of offshore wind and marine renewable energy on the marine environment.

4.1.2 Scoping Seminar

A Scoping Seminar was held on 6th May 2009 at the Ramada Hotel in Belfast. The focus of the seminar was to obtain feedback on the scope of the SEA from a range of stakeholders, other interest groups and offshore wind and marine renewable energy developers. The seminar was attended by approximately 65 people. The format included a presentation from DETI on the preparation of the SAP, and a presentation on the SEA process, the preparation of the Scoping Report and the overall approach to the main environmental assessment. Following the presentations there where two group discussion sessions based around some of the questions that were presented in the Scoping Report.

4.2 Scoping Responses

The written responses received on the scope of the SEA generally reiterated the key points that were raised by the different groups at the Scoping Seminar. To avoid duplication, both sets of comments received have been combined in the summary of responses presented below. This is an overview of the main comments received. Not all detailed comments are included in this summary, although they have, where appropriate been addressed within this Environmental Report. A copy of all comments received during the seminar and the written responses are available for download from the website: www.offshorenergyni.co.uk.

Table 4.1: Overview of Comments Received on Scope of the SEA

Topic	Summary of Comments Received	Response
General Scope	▪ Need a clear distinction between the SEA and EIA processes. ▪ Need to be clear on the timescale and spatial coverage of the SAP. ▪ To what extent will the SEA/SAP identify areas where renewable energy proposals would not be acceptable? ▪ The ER could include more detail on the SAP and the licensing/consenting regimes that it is influencing.	▪ Information on the differences between the SEA and EIA processes are included in Chapter 1. ▪ This SAP and the SEA looks at development up to 2020. Renewables developments are generally not being planned for beyond this date. Any development beyond 2020 is likely to be the subject of revised plans and assessments. ▪ This SEA covers the same geographical area as the SAP, which is the mean high water mark out to 12nm. Offshore areas beyond 12nm have not been included in the SAP as these are beyond the NI jurisdiction. However, in assessing cumulative and transboundary effects the SEA does consider the marine environment beyond the 12nm limit. ▪ The basis of the assessment is to identify broad areas where renewable energy developments would not be acceptable environmentally, and where there would be potential opportunities (subject to more detailed assessments) for renewable energy developments to occur. ▪ The SAP, published at the same time as the ER, sets out the current licensing /consenting regime for offshore renewable energy projects and proposals for some streamlining activity.
Forthcoming Marine Bill	▪ In absence of a Marine Bill, the SEA and SAP should help deliver NI's Marine Protected Area network and should provide a basis for a marine plan for the NI waters by putting forward a marine spatial plan for renewable energy that can be linked to future multi-sectoral marine spatial plans. ▪ Key issue for NI is lack of coordinated system for planning and managing development in NI waters.	▪ Whilst it is recognised that the SAP and SEA needs to take into account the future requirements under the Marine Bill e.g. MPA network and Marine Spatial Planning, it is not the role of the SAP or this SEA to deliver Marine Spatial Planning or identify MPAs. ▪ This SEA is required to fulfil the requirements of the SEA Directive. ▪ However, the SEA process does consider how the SAP and results of the SEA may inform or influence future marine spatial plans and MPA designations.

Topic	Summary of Comments Received	Response
Data Gaps	▪ Data gaps are still a concern and could affect the creditability of the assessment, the ability to identify locations and the ability to assess cumulative effects. ▪ Data gaps in relation to fishing activities (fishing grounds, lobster fishing and spawning areas and nursery grounds etc) are the biggest concern. ▪ The SEA should identify which data gaps need to be addressed at the SAP level and which would be more appropriately filled at the project EIA level. ▪ Opportunities for coordinated data collection and management should be examined as part of the SEA (e.g. UK wide databases). ▪ Key deliverable of the SEA should be recommendations and information towards the delivery of an MPA network.	▪ It is recognised that there are data gaps. ▪ Where there are data gaps these are illustrated through the assignment of low levels of confidence in the assessment results and assessing the potential effects as unknown. ▪ Given that this is a <u>strategic</u> study, it is more appropriate to obtain some of the additional data at the project EIA level rather than as part of this SEA. Further information on this is provided in Chapter14: Conclusion and Mitigation Measures. ▪ The SEA recognises, and takes into account where possible the range of ongoing data collection and knowledge sharing initiatives across the UK e.g. COWRIE. ▪ As noted above it is not the role of this SEA to deliver MPAs. However, the future proposals for these have been taken into account in the assessment of cumulative and in-combination effects (Chapter 13)
SEA Topics	▪ The SEA topics should also include: ➢ Vibration effects on cetaceans etc ➢ Bats ➢ Seascape including ASSIs and AONBs ➢ Marine Protected Areas (MPAs) ▪ Most respondees agreed that air quality should be scoped out.	▪ The SEA topics (presented in Chapter 1), have been updated to reflect the comments received on this area of the SEA.
Socio-economic effects	▪ Concern that the SEA is not covering socio-economic effects, in particular in relation to the potential impacts of renewables developments on commercial fisheries. ▪ Essential that socio-economic issues are covered at the strategic level.	▪ The role of the SEA is to assess the potential effects of the SAP against the topics listed in the SEA Directive. Whilst this covers population and human health it does not extend to the local economy. However, it is considered that, through avoiding any significant adverse effects on key activities considered under population e.g. fishing or navigation (e.g. disruption or displacement), any related/resulting socio-economic effects will also be avoided. ▪ Consideration of some broader economic contributions of offshore renewable energy and other users have been considered in the development of the SAP
Baseline Data	▪ A number of additional baseline datasets have been suggested. ▪ Also need to include additional baseline data on: ➢ Existing and future AONB designations (although where there are no defined boundaries for future designations these should be treated with caution as boundaries may change). ➢ Future offshore SPAs and SACs and MCZs. ➢ Fishing grounds (annual, seasonal, lobster, spawning and nursery). ➢ Data on vessels <15m length (fishing). ➢ Port infrastructure. ➢ Belfast port radar.	▪ The additional baseline datasets identified through consultation have, where possible been included in the SEA (see Chapter 9).

Topic	Summary of Comments Received	Response
Alternatives	▪ The SEA needs to consider the following alternatives: ➢ Likely evolution of the environment without implementation of the plan. ➢ Alternative targets (in the SAP). ➢ Alternatives for the spatial distribution of marine renewables. ➢ Alternative environmental criteria in the SAP.	▪ These points are addressed in the assessment of alternatives discussed in Chapter 3.
Assessment Method	▪ The assessment should take into account the following: ➢ Whether buffer zones are required in sensitive areas e.g. offshore wind Round 2. ➢ Solutions for managing competing interests to prevent patchy development and inconsistency in the application of environmental mitigation. ➢ Interrelationships between individual topics. ➢ Effects across the lifetime of a development from construction to decommissioning. ➢ Onshore effects of grid connections and associated infrastructure. ➢ How mitigation will be applied at the SAP level and project level.	▪ The main points raised on the assessment method have been taken into account in this ER (see Chapter 6).
Assessment Criteria	▪ Assessment criteria should also include: ➢ Significant positive effects ➢ Synergistic effects between developments and different topics e.g. fishing and oil and gas. ➢ Confidence levels to deal with uncertainty. ▪ Indirect effects on baseline feature of national importance should be considered as significant adverse effects. ▪ There is concern that if energy developments are considered to be temporary (e.g. can be removed) the criteria referring to temporary developments could affect the ability for a significant adverse effect to be identified for certain topics e.g. landscape. ▪ Weighting of criteria (subjective V quantitative).	▪ Positive and synergistic effects and confidence levels have been considered in the assessment (see Chapters 6 and 11). ▪ For the purpose of this assessment temporary effects will relate to construction, maintenance and decommissioning activities. Effects associated with the operation of developments will be considered long term or permanent effects (mostly long term). ▪ For the purpose of this assessment no distinction (e.g. weighting) is applied to topics assessed either subjectively or quantitatively. The assessment has considered individual topics in their own right rather than their value in relation to other topics. Where the assessment criteria (e.g. subjective V quantitative) used affects the overall conclusions/results this is indicated through the use of confidence levels, rather than weighting.

Topic	Summary of Comments Received	Response
Cumulative Effects	▪ The SEA should adopt a precautionary approach to cumulative effects due to gaps in data and lack of understanding. ▪ Cumulative effects also need to consider: ➢ Transboundary effects. ➢ Effects of other plans and programmes. ➢ Effects across all topics (including displaced fishing activities) and with other marine activities and developments. ➢ Current environmental issues and problems. ➢ Worst case scenario.	▪ Where there is uncertainty in the results of an assessment due to a lack of data or knowledge, these effects are either classed as 'unknown' or a low level of confidence has been attributed to the assessment results. ▪ The cumulative effects listed have been taken into account in the cumulative assessment (Chapter 12).
Plans and Programmes	▪ Need to include more information on the Marine Bill. ▪ The UK Offshore Energy Plan (DECC) should also be considered in terms of the SEA and cumulative effects/influence on the SAP. ▪ Amendments to plans that needed including, changing or removing.	▪ Additional plans and programmes suggested have been included in the report.
Transboundary Effects	▪ Need to assess transboundary effects in particular in relation to migratory species.	▪ Transboundary effects are considered in Chapter 13.
Appropriate Assessment	▪ Due to data gaps may not be enough data to enable full Appropriate Assessment to be carried out. ▪ Appropriate Assessment of the SAP should be undertaken. ▪ Screening for HRA should be integrated into the SEA process.	▪ Further information on the Appropriate Assessment is provided in Chapter 1 section 1.7
Grid	▪ SEA needs to include information on grid connections (effects and locations). ▪ The SEA should be carried out in parallel to and cross cutting with policy development and the SEA on the grid reinforcements.	▪ DETI is currently developing its strategy for the Onshore Grid Reinforcements. ▪ This strategy will be subject to an SEA. ▪ Where possible cross linkages between this SEA and the Grid Strategy SEA have been examined/will be taken into account.

Topic	Summary of Comments Received	Response
Technologies	▪ In terms of technologies the SEA should: ➢ Provide criteria on how device characteristics are identified. ➢ Consider how technologies and devices will change over time. ➢ Identify different configurations and arrangements for commercial developments. ➢ Recognise that some characteristics cannot be averaged e.g. operating water depths as this influences resource areas. ➢ Use of information from existing operational devices/developments ➢ Recognise disparities between level of information available for offshore wind in comparison to wave and tidal. ▪ SEA should identify most environmentally sensitive devices/characteristics and incorporate into new and existing technologies as part of mitigation.	▪ Where possible information from existing operational developments has been used. However, it should be noted that, due to confidentiality clauses and financial constraints (developer ownership of data), a large amount of data that has been collected for specific developments is not directly available for use in this study. ▪ The SEA is responsible for looking at the environmental effects of a wide range of individual device types and characteristics. ▪ Due to the wide range of variables that influence the potential effect of a device or characteristic on the environment it is not possible to identify 'the most environmentally sensitive device or characteristic' as the sensitivity of certain devices and characteristics will increase or decrease according to the environment within which it is placed and the range of receptors present within that environment. This SEA aims to identify potential effects of different device characteristics on a wide range of receptors and marine activities. In some instances a characteristic that may be considered environmentally sensitive for one receptor may actually have a significant adverse effect on another receptor in the same area. ▪ As devices evolve and develop, individual developers will take into account the potential impacts on different receptors in both the technological design of devices and the locations in which they are sited. Opportunities for modifying device designs and the sitng of devices to minimise adverse effects will need to be examined in greater detail at the project consent stage on a case by case basis.
Resource Areas	▪ Resource areas may change as technologies development/evolve and could be affected by grid availability. ▪ Concern that resource areas are defined on economic and technical considerations without any environmental considerations. ▪ Need to look at economic and environmental benefits of selecting lower energy resource areas (higher energy tend to be more environmentally sensitive).	▪ It is recognised that resource areas could be affected by grid and where possible cross links have been made with the ongoing grid strategy and SEA. ▪ The main focus of the SEA is to examine the potential environmental effects of developing offshore wind and marine renewable within areas of known resource. ▪ The resource 'zones' that are assessed in Chapters 11, 12 and 13 have been extended beyond the main area of known resource to pick up the peripheral (e.g. lower energy environments' as well as the main areas of resource that developers have expressed interest in developing.

5 Policy Context

5.1 Introduction

The international drive to develop renewable energy sources has increased significantly in response to the growing awareness of the impacts of fossil fuels on the environment and climate. This issue was first identified at an international level through the Kyoto Agreement, which was adopted in 1997. It has since become a focal point of both international and domestic political agendas, with targets and long term strategies for reducing CO_2 emissions being implemented through a series of Directives, Bills and Acts.

The EU Renewable Energy Directive has set challenging and mandatory targets for increasing the level of renewable energy and DECC has published its UK wide Renewable Energy Strategy, to which Northern Ireland and the other Devolved Administrations will contribute as appropriate .The Climate Change Act 2008 has set out the long term goal to reduce carbon emissions by 60% by 2050.The recent reform of the Renewables Obligation in GB and the Northern Ireland Renewables Obligation to introduce “banding “ to support less well developed/ currently more expensive technologies, such as marine technologies, aims to ensure the deployment of a wider range of renewable technologies.

As mentioned in Chapter 2, the main policy driver for the development of renewable energy in Northern Ireland is the need to increase security of supply. In addition, increasing focus on renewable energy can also deliver environmental and climate change gains, reductions in carbon emissions, and investment and employment opportunities. With a lack of indigenous fossil fuel and no nuclear power stations, Northern Ireland is keen to develop the full range of its available renewable energy resources to optimise the contribution that renewables make to the overall energy mix.

5.2 Marine Environment

The focus of DETI’s SAP is on the future development of offshore wind and marine renewable energy (wave and tidal). In developing the SAP and undertaking the SEA, it will therefore be necessary to understand how it will relate to the existing framework of international, European and domestic obligations and agreements that currently influence the use, and protection of, the coastal and marine environment. It will also be necessary to consider the SAP in the context of the emerging UK and NI framework for the future management of the marine and coastal environment.

5.2.1 Marine Activities

The marine environment is, contrary to its appearance, heavily used for shipping and navigation and commercial fishing activities. It is also used for military testing, aggregate mining, contains a plethora of telecommunication links, sub-sea electricity cables and gas pipelines and is used for the dumping of waste in some controlled locations. The marine and coastal environment is also a major resource in terms of recreation and tourism. Its scenic value and wealth of wildlife, geological and historical features make it a key visitor destination whilst also supporting a range of water based activities such as surfing, diving and recreational sailing.

5.2.2 *Current Marine Protection*

The marine environment and activities that occur within it (or in association with it) is currently subject to a number of controls and protection measures that have been established under a variety of International, European and domestic obligations and agreements. These obligations and agreements are discussed in Appendix A in terms of their implications to this SEA and the SAP.

These obligations and agreements are necessary for ensuring the ongoing protection of the various users of the sea, their permitted activities, and health and quality of the environment in which they operate. These obligations and agreements are implemented through a framework of regulatory instruments which include Directives, Acts, and Regulations and associated licensing procedures. These are also presented in Appendix A. Table 5.1 lists some of the current key obligations, agreements and regulatory instruments that apply to the waters in Northern Ireland.

Table 5.1: Current Marine Protection Obligations/Instruments (note this list is not definitive)

Obligation/Instrument	Main Aim
The MARPOL Convention	Protection of the marine environment with focus on preventing pollution from shipping

The OSPAR Convention 1992	▪ Protection of the marine environment of the North East Atlantic. Relates to pollution prevention e.g. from dumping at sea and protection and conservation of marine ecosystems.
	▪ Set requirements to determine pollution loads to the Marine Environment which are now embodied in the Water Framework Directive (WFD)
	▪ Led to the adoption of several long term strategies for protection of the marine environment of the North East Atlantic relating to:
	  ▪ Hazardous substances
	  ▪ Radioactive substances
	  ▪ Eutrophication
	  ▪ Protection of Ecosystems and biological diversity
	  ▪ Environmental goals and management mechanisms for offshore activities
	▪ In 2000 OSPAR published its first comprehensive Quality Status Report (QSR) on the quality of the marine environment of the North-East Atlantic. Supported by five reports that will be updated in 2010
	▪ In 2002/3 OSPAR set a requirement for the identification of a network of Marine Protected Areas (MPAs) by 2010. This network will complement the Natura 2000 network (required under the Habitats Directive).

UNCLOS (United Nations Convention on the Law of the SEA) 1982	▪ Sets out a legal framework for use of the worlds oceans. Covers navigation, over flight, resource exploration and exploitation, fishing, shipping and conservation and pollution.
World Summit on Sustainable Development (WSSD)	▪ Sets challenging targets and goals for Governments ▪ For oceans these are to promote integrated sustainable management at all levels in order to help maintain the productivity and biodiversity of marine and coastal areas and help to secure a significant reduction in biodiversity decline by 2010. ▪ This will be achieved through the introduction of policies, measures and tools such as the ecosystem approach, marine protected areas and the incorporation of coastal interests in watershed management.

Obligation/Instrument	Main Aim
European Integrated Maritime Policy 2007	▪ Aims to deliver a sustainable development approach for Europe's oceans and seas ▪ Includes: ➢ A comprehensive maritime transport strategy and new ports policy ➢ A European Strategy for Marine Research ➢ A European Marine Observation and Data Network ➢ A Strategy to mitigate the effects of climate change on coastal regions ▪ The Marine Strategy Framework Directive (MSFD) provides the environmental pillar of the sustainable development approach
Water Framework Directive (WFD) 2000	▪ Legal framework for the protection, improvement and sustainable use of surface waters, transitional waters and coastal waters and groundwater across Europe. ▪ Main aims of the WFD include: ➢ Prevent deterioration and enhance status of aquatic ecosystems, including groundwater ➢ Promote sustainable water use ➢ Reduce pollution ➢ Contribute to the mitigation of floods and droughts
The RAMSAR Convention (The Convention of Wetlands of International Importance (1971 and amendments)	▪ Protection and conservation of wetlands, particularly those of importance to waterfowl and waterfowl habitat.
Bern Convention on the Conservation of European Wildlife and Natural Habitats (1979)	▪ Conservation of wild flora and fauna
Bonn Convention on the Conservation of Migratory Species and Wild Animals (1979)	▪ Conservation of species and wildlife on a global scale, in particular migratory species
Habitats Directive 1992 (Directive 92/43/EEC Conservation of Habitats and Wild Flora and Fauna)	▪ Sets out the framework for the establishment of Special Areas of Conservation (SACs) for areas containing habitats of conservation importance (listed under Annex I of the Directive) or species of conservation importance listed under Annex II of the Directive. ▪ Requires the establishment of a network of protected (Natura 2000) sites which include SACs and SPAs (see Birds Directive below) ▪ Network of Natura 2000 sites also now includes the designation of offshore areas for protection
Birds Directive 1979 (Directive 79/409/EEC on the Conservation of Wild Birds)	▪ Sets out the framework for the establishment of Special Protection Areas (SPAs) for areas containing rare or vulnerable birds (listed under Annex I of the Directive) or for regularly occurring migratory species.
Electricity (Northern Ireland) Order 1992 Article 39	▪ Requires the acquisition of a licence for the construction and operation of marine energy installations greater than 1MW (within territorial waters). ▪ Also allows for creation of a safety zone around renewable marine devices where navigation and fishing is prohibited.
Food and Environment Protection Act 1985	▪ Requires the acquisition of a licence for the placement of structures in the sea or on or under the sea bed. ▪ Aim of the licence is to protect the marine environment, human health and minimise interference with other sea users/activities.
The Conservation (Natural Habitats) Regulations (Northern Ireland) 1995 (SR No. 380 of 1995) and amendments.	▪ Implements the Habitats Directive in Northern Ireland

5.3 Future Protection and Management of the Marine Environment

The following section includes a review of the UK Marine and Coastal Access Act 2009 and proposals for the Northern Ireland Marine Bill. It also looks at the Marine Strategy Framework Directive (MSFD) 2008 and the implications of these regulatory instruments on the SEA and the SAP.

5.3.1 UK Marine and Coastal Access Act 2009

The UK Marine and Coastal Access Act 2009 introduces a new framework for the strategic and sustainable management of marine activities and the conservation and protection of marine resources. This framework will be delivered in England and Wales by a dedicated Marine Management Organisation (MMO) and will be underpinned by a new system of marine planning which will facilitate a more holistic and coordinated approach to marine management and protection. Other key elements of the UK Marine and Coastal Access Act 2009 include:

- Marine Licensing
- Marine Nature Conservation
- Fisheries Management and Marine Enforcement
- Migratory and Freshwater Fisheries
- Coastal Access
- Coastal and Estuary Management

In terms of marine planning two of the main deliverables include the introduction of a Marine Policy Statement and the designation of regional marine plans[3]. The Marine Policy Statement will be a UK-wide document which will apply to the whole of the UK's marine waters. It will set out the key strategic priorities for the UK marine area and will be developed in such a way as to be a tangible product against which sustainable licensing decisions will be able to be taken throughout the UK until such times as marine plans are in place. The Marine Policy Statement will provide a clear steer, in accordance with which all decisions in the UK marine environment will need to be made. It is anticipated that the Marine Policy Statement will be in place within two years following the Royal Assent of the Act in November 2009. It is further anticipated that the new marine licensing regime will be commenced during 2011.

5.3.2 UK Marine and Coastal Access Bill Provisions in Northern Ireland

The Marine Policy Statement will be prepared by the Secretary of State, Scottish Ministers, Welsh Ministers and the Department of the Environment (DOE) in Northern Ireland. Northern Ireland is also included in the UK Marine and Coastal Access Bill for marine planning in Northern Ireland’s offshore region (i.e. from the 12 nm limit to the boundary of the Northern Ireland zone) and marine licensing which will repeal and replace the Food and Environment Protection Act (FEPA) 1985 and provisions for marine aggregate extraction[4].

5.3.3 Northern Ireland Marine Bill Proposals

The DOE will be bringing forward a Northern Ireland Marine Bill which will contain provisions for marine planning and marine nature conservation within Northern Ireland’s territorial waters. Subject to the outcome of discussions with other relevant Northern Ireland Departments and stakeholders, the Bill may also include provisions for possible further streamlining of licensing of devolved activities and proposals for better integration of all functions within the Marine Environment.

---

3 http://www.publications.parliament.uk/pa/jt200708/jtselect/jtmarine/159/15907.htm
4 http://www.doeni.gov.uk/index/protect_the_environment/water/marine_bill_.htm

It is the intention to consult on policy proposals in spring 2010 with a view to introducing a Bill to the Northern Ireland Assembly in 2011. DETI is represented on the DOE – led Marine Inter Departmental Group taking forward this legislative work.

5.3.3.1 Marine Spatial Planning

Marine spatial planning is recognised as the mechanism for achieving a more integrated and coordinated approach to the management of marine activities and increased protection of the marine environment.

The marine environment is currently regulated on a sector/activity basis. This approach does not naturally lend itself to facilitating an integrated or coordinated approach to the sustainable management and use of the marine environment. The aim of marine planning is therefore to examine how activities and sectors currently interact, both spatially, and in terms of environmental management and protection, and how these interactions are likely to change, and therefore need to be managed in the future as different sectors expand or decrease.

5.3.3.2 Marine Nature Conservation

In addition to marine spatial planning, DOE will be responsible for increased protection of marine nature conservation within Northern Ireland territorial waters. The focus for Marine Nature Conservation is to promote increased protection of the marine environment of Northern Ireland.

This will be achieved through the designation of Marine Conservation Zones (MCZs). These MCZs will complement the network of marine Natura 2000 sites (SACs and SPAs) by providing increased protection to marine species and habitats that are of national importance. In addition to MCZs it is anticipated that DOE will introduce a series of nature conservation objectives and management measures that will be integrated within the marine spatial planning process. The proposals for marine nature conservation will also reflect Northern Ireland's commitment to implementing requirements of the Marine Strategy Framework Directive (MSFD).

5.3.4 Marine Strategy Framework Directive (MSFD)

Significant progress has been made recently towards increased and improved protection of the marine environment through the introduction of the European Marine Strategy Framework Directive (MSFD). This Directive is the environmental pillar to the EU's Integrated European Maritime Policy 2007, which aims to provide a coherent framework for joined up maritime governance[5].

In the context of the Integrated European Maritime Policy the objective of the MSFD, which was adopted on 17th June 2008, and which must be transposed into domestic legislation by 15th July 2010, is to enable the sustainable use of marine goods and services and to ensure the marine environment is safeguarded for the use of future generations. In achieving this objective the MSFD requires Member States to 'take the necessary measures to achieve or maintain good environmental status (GES) of the marine environment by 2020 at the latest'. It also establishes European Marine Regions and requires Member States to apply an ecosystem based approach to the management of human activities.

The MSFD extends and builds on the requirements of the Water Framework Directive (WFD) into seas beyond the current WFD limit. Under the WFD member states are required to achieve Good Ecological Status (GES) of all controlled waters including estuarine, transitional and coastal waters. Consequently where the MSFD overlaps with the WFD in coastal areas, the latter will continue to take precedence except where the MSFD introduces additional requirements.

---

[5] http://www.doeni.gov.uk/index/protect_the_environment/water/marine_thematic_strategy_.htm

In order to achieve the targets for GES set out in the MSFD all Member States are required to develop a strategy for their marine waters. This strategy must address a number of key actions within specific timescales. These actions include:

- Initial assessment of current environmental status of waters and environmental impact of human activities by 2012
- Determine what constitutes 'good environmental status' (GES)
- Develop environmental targets and indicators by 2012
- Implementation of a monitoring programme by 2014
- Programme of measures (management actions) developed by 2015 and implemented by 2016

The MSFD sets out a number of qualitative descriptors that will be used for determining GES. Table 5.2 presents some of the key GES descriptors from the Directive that have been identified in relation to the proposed offshore wind and marine renewable energy development SAP and the focus of this SEA.

Table 5.2 : Relevant MSFD Qualitative GES Descriptors

GES Descriptor	Description
GES Descriptor 1	**Biological Diversity** is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions
GES Descriptor 2	**Non-indigenous species** introduced by human activities are at levels that do not adversely alter the ecosystems
GES Descriptor 4	All elements of the **marine food webs**, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity
GES Descriptor 6	**Sea-floor integrity** is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected
GES Descriptor 7	Permanent **alteration of hydrographical conditions** does not adversely affect marine ecosystems
GES Descriptor 8	**Concentrations of contaminants** are at levels not giving rise to pollution effects
GES Descriptor 9	**Contaminants in fish and other seafood** for human consumption do not exceed levels established by Community legislation or other relevant standards
GES Descriptor 11	**Introduction of energy**, including underwater noise, is at levels that do not adversely affect the marine environment

5.3.5 *MSFD in Northern Ireland*

It is proposed that the transposition of the MSFD into domestic legislation will be done on a UK wide basis. DOE is leading this work in Northern Ireland and DETI is represented on the Marine Inter Departmental Group as DETI's relevant marine related activities would fall within the coverage of the MSFD.

The MSDF requires co-operation between Member States as well as non-EU countries who share a marine region to develop coordinated strategies[6].

[6] http://www.doeni.gov.uk/index/protect_the_environment/water/marine_thematic_strategy_.htm

The OSPAR Regional Seas Convention is promoted as the mechanism by which Member States will co-operate to achieve GES. With regard to the UK and Northern Ireland, the British/ Irish Council is also likely to be used as a vehicle to achieve regional co-operation between the UK and the Republic of Ireland (RoI).

5.4 Other Offshore Wind and Marine Renewable Energy Plans and Programmes

There are a number of ongoing initiatives and plans and programmes relating to offshore wind and marine renewable energy within the UK, Scottish, Welsh and Irish waters. These include:

- Sustainable Energy Ireland (SEI) Offshore Renewable Energy Development Plan (OREDP).
- Scottish Government Marine Energy Policy Statement 2007.
- Department of Energy and Climate Change (DECC) Energy Plan for Offshore Wind, Oil and Gas 2009.
- The Crown Estate (TCE) Offshore Wind Licensing Rounds 1, 2 and 3 including extensions to Rounds 1 and 2.
- The Crown Estate (TCE) Licensing Round for Wave and Tidal Power (Pentland Firth 2009).
- The Crown Estate (TCE) Scottish Offshore Wind Licensing Round.
- Welsh Assembly Government (WAG) Ministerial Policy Statement on Marine Energy in Wales July 2009.
- Europe’s Onshore and Offshore Wind Energy Potential: An Assessment of Environmental and Economic Constraints (European Environmental Agency EEA).

All of the programmes/strategies listed above, except the TCE Pentland Firth licensing round for wave and tidal developments due to its specific location, could potentially influence or effect the proposals presented within DETI’s Strategic Action Plan (SAP) for offshore wind and marine renewable energy developments. A summary of these main strategies and programmes is provided below. Further detail on the potential interactions between these programmes/ strategies and the SAP and associated environmental implications are discussed in Chapter 13: Cumulative Effects Associated with Other Plans and Programmes.

5.4.1 Sustainable Energy Ireland (SEI) Offshore Renewable Energy Development Plan (OREDP)

The Ocean Energy Development Unit (OEDU) is a collaborative initiative of the Marine Institute, the Department of Communications, Energy and Natural Resources (DCENR) and Sustainable Energy Ireland (SEI) which is Ireland’s National Energy Authority. The OEDU, which sits within SEI, is currently working on the preparation of its Offshore Renewable Energy Development Plan (OREDP).

The focus for the OREDP, which will also be subject to an SEA, is to develop a strategy/plan for the development of Ireland’s offshore wind and marine renewable energy resources. The focus of the plan is to set out how offshore renewable energy can contribute towards achieving the Irish Governments’ 2020 target for 40% electricity to come from renewable sources which was set out in its framework for economic renewal ‘Building Ireland’s Smart Economy’.

In developing the OREDP, the OEDU is examining targets for producing up to 4,500 MW of electricity from offshore wind and up to 1,500 MW from marine renewable from Irish waters and will be conducting an SEA of its plans.

5.4.2 *Scottish Government: Scottish Marine Energy Policy Statement (April 2007) and The Crown Estate Licensing Round for Wave and Tidal Energy in the Pentland Firth*

The Scottish Marine Energy Policy Statement sets out the Scottish Governments support for the development and growth of the wave and tidal energy sector in Scotland. The policy statement highlights the value of the wave and tidal resource in Scotland as being some of the best in the UK and possibly Europe and recognises the opportunities for the development of these resources to assist the Scottish Government in achieving its target of meeting 50% of Scotland's energy demand from renewable sources.

The policy statement focuses specifically on the development of the wave and tidal resource that is located along Scotland's west coast and the Northern and Western Isles. Scotland also has a significant offshore wind resource. However, the future exploitation of this is the subject of a separate, ongoing strategy.

The Scottish Marine Energy Policy Statement also highlights a number of areas where future investment is seen to be essential to enable the marine renewables sector to grow. These areas for investment include:

- Establishment of a dedicated group which would act as a vehicle for coordinating and implementing necessary measures and programme of works to assist the sectors development.
- Identify data gaps and establish research priorities.
- Establishing guidelines for monitoring the effects of wave and tidal devices
- Develop strategic locational guidance.
- Produce guidance on EIA requirements for individual wave and tidal projects.
- Produce guidance on mitigation measures and their implementation.
- Identify grid requirements and provide a vehicle for providing coordinated responses and consultation on grid issues.

Although the policy statement sets out a number initiatives and actions for enabling the growth of the marine renewable energy sector it does not identify any specific locations or sites for development. Consequently, in terms of looking at potential cumulative effects in relation to the implementation of the SAP (Chapter 13), it will only be possible to identify generic effects that could occur as a result of the deployment of wave and tidal developments in Scottish Waters.

One specific area that has been identified for future marine renewable energy development is the Pentland Firth. In 2008, The Crown Estate announced a competitive call for developers to submit tenders for leasing specific areas of the seabed within the Pentland Firth for the purpose of developing wave and tidal technologies. In May 2009, The Crown Estate received 42 tender applications for these leases, demonstrating the potential scale of this sector within Scotland and the overall developer interest in marine renewables.

5.4.3 *DECC Offshore Energy Plan for Offshore Wind, Oil and Gas (June 2009) and The Crown Estate Offshore Wind Round 3 and extension to Round 1 and 2 Lease Areas*

In January 2009, DECC published their draft plan for the development of up to 25GW of energy from further rounds of offshore wind farm leasing in the UK Renewable Energy Zone (REZ) and the territorial waters of England and Wales up to a depth of 60m by 2020. The plan does not include Northern Ireland or Scottish territorial waters. The plan was subject to an SEA.

The plan, which was finalised and published in June 2009 identifies from the SEA a number of potential zones where offshore wind developments, subject to appropriate mitigation measures and the application of site selection criteria, could be taken forward for development. A number of the potential areas are now being taken forward as part of The Crown Estate 3rd Offshore Wind licensing round. The majority of zones that have been identified as having potential for development are located off the east coast of England and Scotland beyond the 12nm limit and are therefore are unlikely to interact with any development in Northern Ireland Waters.

The zones identified on the west coast are located off the north and south Wales coast. There is the potential for cumulative effects to arise from further development of the zone off the north Wales coast (this area is already being developed as part of The Crown Estates offshore wind Rounds 1 and 2). This is discussed in Chapter 13. No zones have been indentified off the west coast of Scotland.

In addition to identifying potential offshore wind energy zones, the SEA also made a number of recommendations regarding the selection of specific sites for development. These included the application of a 12nm buffer zone from the coastline around large (>100 MW) offshore wind farms.

Whilst it is acknowledged that the basis for the 12nm buffer is to safeguard sensitive coastal areas and minimise adverse effects on seascape, the potential wider implications of this recommendation could imply that no offshore wind developments should be taken forward within the 12nm limit. This specific SEA recommendation has, however, been reviewed by DECC and it is now proposed, within the finalised Energy Plan that the application of a 12nm buffer should be examined on a case by case basis depending on the proposed scale of development and the sensitivity of the surrounding seascape.

As noted above, Northern Ireland waters were not included in this DECC SEA, nor have any of the Round 1 and 2 developments taken place within Northern Ireland waters. It should also be noted that Round 1 and 2 projects have been undertaken within the 12nm limit within GB waters and for the purposes of this SEA of Northern Ireland waters, the focus will be on the potential for projects within the NI jurisdictional 12nm limit.

5.4.4 *The Crown Estate Licensing Round for Offshore Wind Developments in Scottish Waters*

On the 16th February 2009 The Crown Estate announced awards for offshore wind farms within Scottish Territorial Waters. In total 10 sites for development have been identified, five of which are located in off the west coast of Scotland. Included within the five sites are two sites in the Solway Firth, one site off the southern end of the Rhinns of Kintyre (north coast), one off the west of Islay and one off south west tip of Tiree. This licensing round is currently the subject of an SEA that is being carried out by the Scottish Government.

5.4.5 *Welsh Assembly Government: Ministerial Policy Statement on Marine Energy in Wales (July 2009)*

The Welsh Assembly Government (WAG) recently issued its Ministerial Policy Statement on Marine Energy in Wales. This policy statement sets out how the Welsh Assembly Government proposes to maximise the exploitation of the marine energy resource around the Welsh coast as soon as possible and with the minimum of local environmental impacts. It also recognises the importance of the Severn Barrage for which a number of feasibility studies have been undertaken and highlights the value of the offshore wind and marine energy industry in terms of opportunities for economic investment and employment across Wales.

In exploiting the marine energy resource, the policy statement outlines a range of actions that the Welsh Assembly Government will undertake in conjunction with other key stakeholders. These actions, which will be underpinned by more coordinated and joined up working with DECC, The Crown Estate, regulatory authorities and other public sector bodies and private sector enterprises include investment in a number of additional research studies (technical and environmental) and further studies into consenting and licensing.

The policy statement also supports continuation of a number of ongoing initiatives and studies including the Wales marine energy report which looks at the technical practicalities of exploiting the marine energy resource and the Marine Renewable Energy Strategy Framework (MRESF) which examines potential environmental and geographical constraints. It is proposed that an SEA will be conducted in 2011-2012.

5.4.6 Europe's Onshore and Offshore Wind Energy Potential: An Assessment of Environmental and Economic Constraints (European Environmental Agency EEA)

In 2009, the EEA issued its report into the onshore and offshore wind potential of Europe. The study, upon which the report was based, focused on examining the 'raw' and 'constrained' wind resource potential in a geographically explicit manner. The 'constrained' wind potential takes into account a range of environmental and social factors including for example impacts on visual amenity and seascape.

The study found that the raw potential wind resource for Europe (onshore and offshore) is massive and could be more than 20 times the total energy demand in 2020. A large proportion of this raw wind resource is located in the northern and western regions including the UK.

However, whilst the study identified a large proportion of the raw potential wind resource in the offshore areas, it also identified that this total raw resource is likely to be reduced by more than 90% when environmental and social factors are taken into account e.g. Natura 2000 sites and other designations, navigation, fishing, oil and gas exploration, seascape impacts and effects on visual amenity. By comparison when the same environmental and social factors are taken into account in calculating the onshore wind potential resource, the total raw wind potential is only reduced by 13.7% illustrating that potential constraints to offshore wind are much greater than those for onshore wind.

5.5 Other Relevant Plan and Programmes

A summary of the key plans and programmes that have been identified as being relevant to the SEA and development of the SAP are presented in Appendix A.

6 Assessment Method

6.1 Approach to the Assessment of Effects

The approach applied to the assessment of the effects of offshore wind and marine renewable energy (wave and tidal) developments on the marine and coastal environment of Northern Ireland comprises three parts:

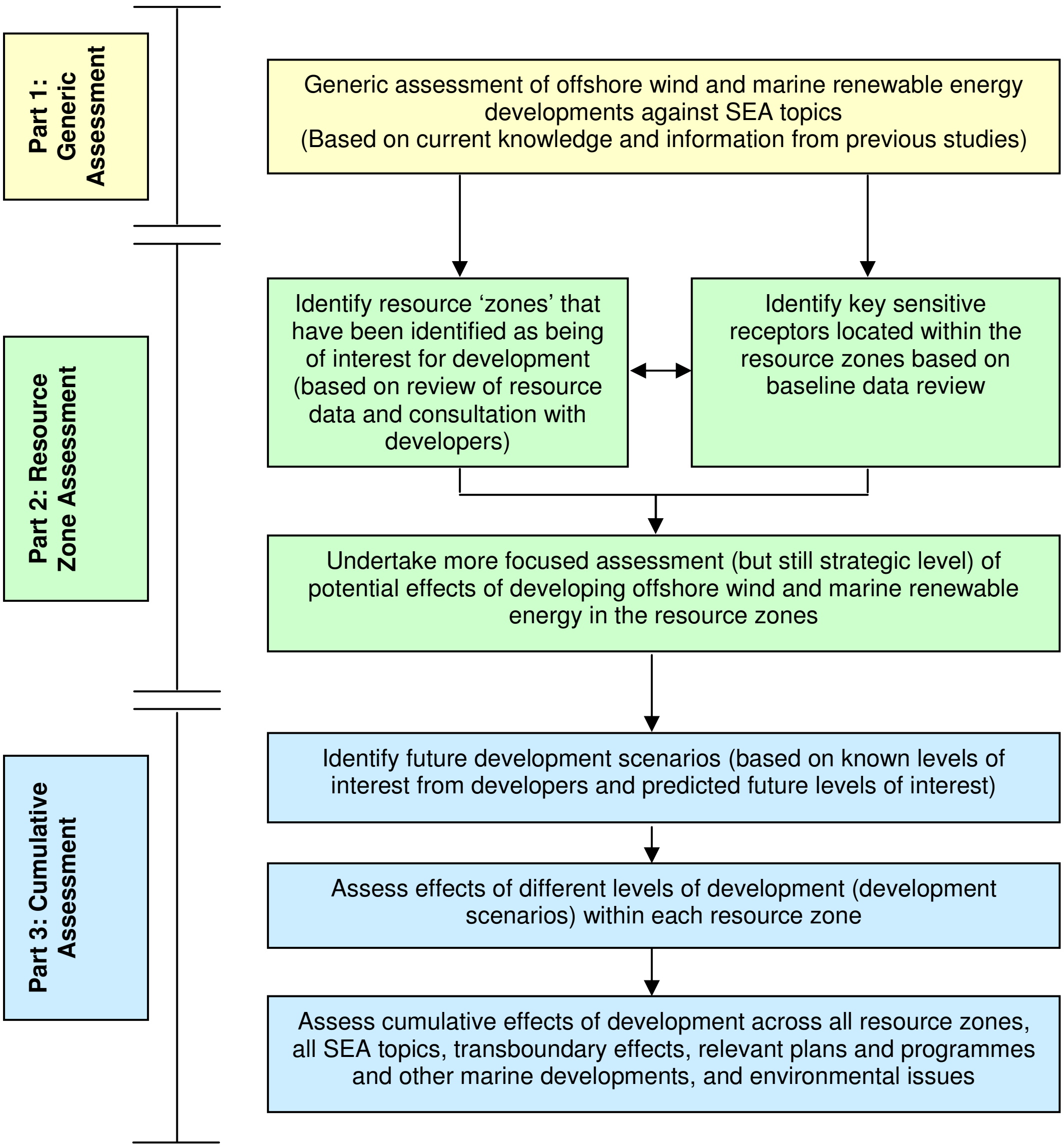
Part 1: Generic environmental effects (Chapter 10).

Part 2: Detailed assessment of specific resource zones (Chapter 11).

Part 3: Cumulative assessment (Chapters 12 and 13).

This approach is illustrated in Diagram 6.1 and discussed in greater detail in Sections 6.4.2 to 6.4.4 below:

Diagram 6.1: Approach to Assessment of Effects



6.2 Assessment Method

In terms of the assessment method applied to the SEA there are two key factors that need to be taken into account:

1. Although the assessment includes an assessment of specific resource zones, this does not preclude any development occurring outside of these zones (see below).
2. A separate assessment method has been developed for the Seascape Assessment.

6.2.1 Study Area V Resource Zones

The generic assessment (Part 1) covers the entire study area (all Northern Ireland waters from the mean high water mark seaward out to 12nm) whereas the resource zone assessment focuses on the key areas of resource (offshore wind, wave and tidal) that is present within the study area.

The aim of this assessment is to identify what levels of commercial development could occur in Northern Ireland waters without significant adverse effects on the environment, and therefore the extent to which offshore wind and marine renewable energy developments could contribute towards achieving the proposed renewable energy target for Northern Ireland of 40% by 2020. In determining how much development could occur in Northern Ireland waters it is necessary to focus the assessment on the main recognised areas of resource as these are the areas that, based on current technologies and operating parameters (Chapter 7) are most likely to be taken forward for development.

However, it is recognised that other, smaller areas of resource, may be identified that lie outside the main resource zones. Although these areas have not been included in the specific resource zone assessment, **this SEA does not preclude development in these other areas**, as the potential effects of offshore wind, wave and tidal developments in these areas are covered, albeit at a lower level of detail, in Part 1: Generic Assessment.

It is also important to note that all developments (offshore wind and marine renewable energy) that occur within the study area (within or out with the resource zones) will still have to be considered on a case by case basis and project level consenting requirements will still apply. This is applicable to demonstration projects as well as commercial developments. The purpose of the SEA it to increase the confidence with which potential areas of resource can be included within any future licensing rounds run by The Crown Estate and developers can select potential sites based on increased knowledge of awareness of the likely constraints that will have to be taken into account/addressed in a particular location.

6.2.2 Objective and Subjective Assessment Methodologies

It is recognised that, although the majority of SEA topics included in this SEA will be assessed objectively (e.g. assessment will be based on specific quantifiable facts and figures), seascape assessments tend to be more subjective. However, it is important to note that judgements on the significance of an effect in the seascape assessment, including those on the valency of effect, are impartial and based on professional experience and opinion informed by best practice guidance.

In reflecting these differences between the objective and subjective types of assessment, two assessment methodologies have been developed for the purpose of this SEA:

- General SEA Assessment Method (applied to all SEA topics except seascape)
- Seascape Assessment Method

These methods are discussed in detail below.

6.3 General SEA Assessment Method (applies to Parts 1 and 2)

6.3.1 Part 1: Generic Assessment

Part 1 of the assessment involves a review and examination of information obtained from a range of sources including the Scottish Marine Renewables SEA, the recently completed SEA of the third round of offshore wind development in UK waters prepared by the Department of Energy and Climate Change (DECC) and the report by ABPmer on Wet Renewable Energy and Marine Nature Conservation: Developing Strategies for Management (March 2009), prepared as part of the npower Juice Fund project. This information has been used to assist in the identification of generic potential effects of offshore wind, wave and tidal developments on the SEA topics.

6.3.2 Part 2: Resource Zone Assessment

Part 2 of the assessment focuses specifically on resource zones within the study area that have been identified as having potential for the future development of offshore wind and marine renewables (wave and tidal). The identification of these resource zones was based on:

- Potential areas of resource (offshore wind, wave and tidal) identified from the DTI Marine Atlas and previous studies undertaken by DETI, other organisations and developers (see information presented in Chapter 8 of this report)
- Potential areas of developer interest based on feedback from the developer questionnaires and subsequent discussions with offshore wind and marine renewable energy developers

For each of the resource zones identified, focused, but strategic level, assessments have been undertaken to determine the potential environmental effects that could occur in these zones.

These assessments focus specifically on assessing the potential effects of offshore wind and marine renewable energy developments on the sensitive receptors (identified from the baseline review) that are either present within, or associated with, these resource zones. This has provided a more focused and detailed (however, still strategic) assessment of potential effects in the known areas of developer interest. A key focus for this part of the assessment has been the identification of competing interests within certain locations and examining solutions for resolving those competing interests or identifying appropriate mitigation measures that can be implemented as part of the SAP to prevent, reduce or offset any significant adverse effects that may occur within those areas.

6.3.2.1 Assessment Method (Resource Zone Specific)

The method used to assess the potential effects within the specific resource zones is outlined in Diagram 6.2 below.

Diagram 6.2: Method for Assessing Potential Effects in Resource Zones

Identification of how offshore wind and marine renewable energy devices/developments interact with the marine environment (based on generic effects identified in Part 1)

↓

Identification of key receptors (in relation to the SEA topics) located within the resource zones that could potentially be affected by offshore wind and marine renewable energy devices/developments

↓

Assessment of **potential effects** of offshore wind, wave and tidal developments **WITHOUT** mitigation

↓

Identification of mitigation measures that could be implemented to reduce, avoid or offset the overall significance of the effect

↓

Assessment of **residual effects** of offshore wind, wave and tidal devices **WITH** mitigation (based on assumption that mitigation would be implemented appropriately)

6.3.2.2 Assessment Criteria

The assessment criteria used as part of the assessment of the potential effects of offshore wind and marine renewable energy developments on the individual resource zones within the study area reflects the strategic nature of this SEA.

The general approach to SEA is to identify potentially significant adverse effects. Significance is a measure of the magnitude of a potential effect compared to/in relation to the sensitivity or importance of the receptor e.g. the SEA topics. An accurate and robust determination of effect magnitude or sensitivity of a receptor requires a certain level of qualification or quantification. This is generally based on the information contained within the plan, programme or strategy being assessed and the information contained within the baseline review.

It is recognised that, as a result of extensive research, data collation and monitoring of existing developments, the potential environmental effects of offshore wind developments are relatively well understood. However, by contrast, the potential environmental effects of marine renewable energy developments are still relatively unknown, although the general levels of understanding and knowledge of potential effects have increased during the last few years (see below).

As identified from the Scottish Marine Renewable SEA, there are two main factors that currently influence this limited understanding of potential environmental effects associated with wave and tidal devices:

- Lack of knowledge as to how wave and tidal devices interact with the marine environment and how key receptors respond to wave and tidal devices. This is due to the industry being relatively new with only a few devices having been deployed to date.
- Gaps in baseline data. This is mainly due to the size of the study area, the relative inaccessibility of the marine environment in comparison to the terrestrial environment, and the fact that there are generally fewer marine developments from which to obtain information from (e.g. surveys).

During the last five years our understanding of how marine renewable energy devices interact with, and effect the environment, has increased considerably. This has been mainly achieved through the ongoing monitoring of the various demonstration projects that have been deployed around the UK, in particular at the EMEC test centre (see Chapter 7 for more information on marine renewable energy devices). There is also an ongoing programme of monitoring as part of the consent for the SeaGen turbine in Strangford Lough. A particular focus of this monitoring is related to marine mammals (mainly seals) and the impacts of the device on the status of the Special Area of Conservation (SAC) within which it is located.

There has also been an increase in the amount of baseline data that is available. This increase mainly relates to the ongoing survey work that has been undertaken to inform the designation of the offshore Natura 2000 sites, as required under the Habitats Directive. However, there has also been an increase in the amount of information obtained from surveys carried out to inform offshore wind and marine renewable energy developments e.g. Strangford Lough and surveys carried out as part of the Offshore Wind Round 3 SEA (DECC 2008).

Whilst there have been increases in the amount baseline data available and reductions in knowledge gaps, it is still important to recognise that some gaps still exist. These knowledge and data gaps need to be reflected in the approach taken to this environment assessment as insufficient information could affect the overall accuracy and robustness of the assessment in terms of being able to determine effect magnitude, receptor sensitivity and effect significance.

Taking this into account it is proposed that the criteria will not attempt to qualify the assessment of 'significance' in any great detail. This includes any differentiation between high, medium or low significance as there may not be sufficient information available to accurately determine any variation between these measures e.g. benthic ecology. The assessment undertaken in Part 2 will therefore be based on the criteria outlined in Table 6.1 below:

Table 6.1: Assessment Criteria

Potential Effect	Assessment Criteria
Significant Adverse	The precise measure for **significant adverse effect** varies across the different SEA topics. This is reflected in the results presented in Chapters 11 and 13. However, in general, the key factors influencing the potential for a significant adverse effect to occur generally include: ▪ Permanent, long term or irreversible change in baseline conditions e.g. reduction in quality of baseline environment or effect on baseline features (receptors). ▪ Direct and indirect effect on baseline features of international or European importance e.g. habitats, species and sites designated under the EU Habitats or Birds Directives, where habitats and species are known to be sensitive to interactions from marine devices/offshore wind developments. ▪ Direct and indirect effects on baseline features of national importance (e.g. habitats or species of national value/importance) where habitats and species are known to be sensitive to interactions from marine devices/offshore wind developments. ▪ Direct, long term or permanent exclusion from, or disruption to, recognised shipping/navigation channels or fishing grounds of international, European or national importance. It should be noted that each SEA topic, and the baseline environment/features (receptors) associated with that topic, have been considered on a case by case basis. The criteria listed above are generic and have been subject to modification during the assessment to reflect specific characteristics of the baseline environment within Northern Ireland waters. However, any modifications will be reflective of the main principles of an assessment of **significant adverse effect** listed above.

Potential Effect	Assessment Criteria
Negative	As above, the measure of **negative effect** varies across the different SEA topics. However, in general, the key factors influencing the potential for a negative effect to occur include: ▪ Temporary, short term or reversible change in baseline conditions e.g. reduction in quality of baseline environment or effect on baseline features (receptors). ▪ Direct effect on baseline features that are not designated under international, European or national legislation but which are known to be sensitive to interaction with marine devices/offshore wind developments. ▪ Indirect, temporary or short term, disruption to, or exclusion from, main (international, European and national) shipping and navigation channels and fishing grounds. ▪ Direct, long term or permanent disruption to, or exclusion from, local shipping and navigation routes and fishing areas.
Negligible (positive or negative)	Negligible effects are identified where there is likely to be change in baseline, or effect on a baseline feature (receptor), but the level of change/effect will be indiscernible/very slight. Negligible effects may be positive or negative.
Neutral	Neutral effects are identified where the potential effect on the baseline features (receptor) are both positive and negative, thus balancing the overall effect on an SEA topic.
No Effect	The development of marine renewable energy/offshore wind developments in Northern Ireland waters will have no effect (e.g. cause no change in baseline conditions).
Positive	The development of marine renewable energy/offshore wind will have a positive effect on the baseline environment/features.
Unknown	Where there is insufficient information available to accurately determine the level and type of potential effect these have be classed as 'unknown' effects. Unknown effects are likely to occur where there is: ▪ A lack of baseline data. ▪ Limited knowledge on how marine renewable energy devices/offshore wind developments interact with particular baseline features/ characteristics. ▪ A lack of knowledge as to whether certain baseline features (receptors) are sensitive to interactions from marine renewable energy devices/offshore wind developments.

6.3.2.3 Presentation of Results

The results from the Resource Zone Assessment are presented in a series of tables which are included in Chapter 11 (Tables 11.4 to 11.11). The information included in these tables reflects the method for assessing potential effects in the resource zones illustrated in Diagram 6.2 above and includes:

- SEA topics where potential strategic environmental effects could occur
- Type of the potential effect
- Phase of the development during which potential effects are likely to occur e.g. installation, operation, maintenance and decommissioning
- Device characteristics that are likely to give rise to potential effects
- Device type (wind, wave or tidal)
- Assessment of potential effect (effect without mitigation)
- Summary of key environmental sensitivities (from baseline data) and description of potential effect
- Description of possible project level mitigation that could be implemented to reduce, avoid or offset potential adverse effects
- Assessment of potential residual effect (effect with mitigation)

6.3.2.4 Confidence Levels

As discussed previously it is recognised that there are a number of known data and knowledge gaps in particular relating to baseline data for certain SEA topics and understanding how wave and tidal devices will interact with the environment.

As part of this SEA it is necessary to identify these data and knowledge gaps as they can affect the overall accuracy and robustness of the assessment results, both from the location specific assessment and cumulative assessment (see below).

To illustrate where the results of the assessment have been affected by a lack of data or a lack of understanding of how certain device characteristics interact with the environment, confidence levels have been assigned to the assessment results (see Table 11.5 in Chapter 11). These confidence levels are summarised below:

Table 6.2: Confidence Levels

Confidence Level	Description
High	High levels of confidence occur where: ▪ There are no gaps or very limited gaps in baseline data ▪ Interactions between the environment and marine devices are well understood (e.g. there is recognised guidance or well documented and peer reviewed evidence of potential effects that could occur (e.g. offshore wind developments)
Medium	Medium levels of confidence are likely to occur where: ▪ There are gaps in baseline data but knowledge and experience from related projects or fields of work leads to a greater level of confidence in the assessment of potential effects that could occur ▪ There are limitations in understanding in how devices interact with the environment but greater certainty in available baseline data and supplementary evidence from related areas of work/similar projects.
Low	Low levels of confidence are likely to occur where: ▪ There are known gaps in baseline data and no available supplementary information to support assessment of effects ▪ There are known gaps in understanding how devices interact with the environment and no available supplementary information to support assessment of effects

6.3.2.5 Weighting of SEA Topics

This SEA does not involve any weighting of SEA topics. Each topic is considered in terms of its own value. This applies to the resource zone assessment and the cumulative assessment.

In terms of the resource zone assessment there is a certain degree of weighting within the individual SEA topics. This is required to determine varying levels of importance or sensitivity of key receptors across the study area and therefore the levels of significance of any potential effects. For example in terms of seascape effects some areas of the Northern Ireland coastline are considered to be of greater seascape value than other areas and therefore more sensitive to potential effects. Consequently potential effects on these more sensitive areas are likely to be of greater significance.

With regard to the cumulative assessment the potential effects are assessed on a topic by topic basis and across individual topics. When assessing across topics the conclusions from the assessment are made on the basis that within a certain resource zone there could, for example, be a significant adverse cumulative effect on both shipping and navigation and marine mammals. However the assessment does not apply any weighting to these topics. The main purpose of the SEA is to provide guidance and advice on where potentially significant adverse effects could occur and how these can be avoided or reduced. It is not the role of the SEA to determine which of the topics assessed are of greater or lesser value to the marine environment than others.

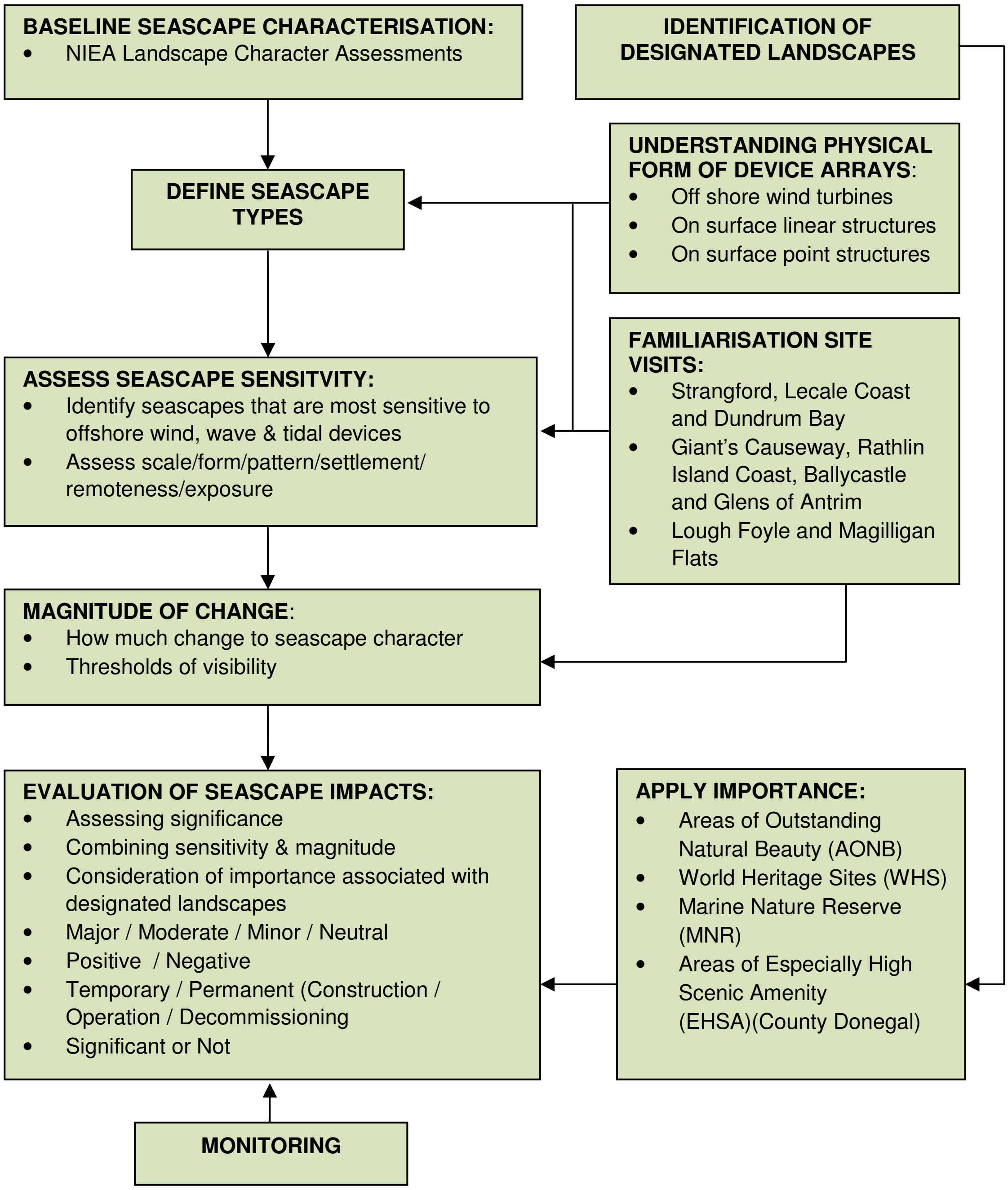
6.3.2.6 Weighting of Assessment Criteria

As noted above each SEA topic is assessed on its own individual basis. It is recognised that for some topics it is possible to undertake quantitative assessments and for others the assessment is more subjective and that this could influence the accuracy and robustness of the final results. However, given that individual topics are not weighted against each other, the differences in the assessment methods do not influence how individual topics are compared against other topics. Where there is uncertainty over the results of an assessment due to the type of information that is available for the assessment, this is measured using confidence levels discussed above.

6.4 Seascape Assessment

The key stages involved in the seascape assessment are illustrated in Diagram 6.3 below.

Diagram 6.3: Key Stages in the Seascape Assessment



6.4.1 Background Research

6.4.1.1 Review of Seascape Guidance and Good Practice

The seascape assessment has been prepared with reference to a number of guidance documents including:

- DTI Guidance on Seascape and Visual Impact Assessment of Offshore Wind Farms[7]
- Scottish Marine Renewables SEA, 2007[8].
- UK Offshore Energy SEA 2009[9].
- Scott *et al* Assessment of the Sensitivity and Capacity of the Scottish Seascape in relation to Offshore Wind Farms[10].
- Guide to Best Practice in Seascape Assessment (Hill *et* al., 2001)[11].
- Guidelines for Landscape and Visual Impact Assessment (GLVIA), published by the Landscape Institute and the Institute of Environmental Management and Assessment in 2002

It should be noted that there is currently no specific seascape assessment guidance available for wave and tidal devices. However, the DTI Guidance does encourage consistency and good practice in seascape assessment across a range of developments, and in combination with the Scottish Marine Renewables SEA 2007 has provided a useful reference for refining the strategic approach taken to carrying out seascape assessments in relation to wave and tidal devices.

6.4.1.2 Determining Device Characteristics

As with the assessment of the other SEA topics, the devices (offshore wind, wave and tidal) are considered in terms of their characteristics rather than individual technologies. This reflects the vast range of different device types that are being developed, tested and deployed to extract energy from wave and tidal stream. To ensure consistency, the assessment also focuses on the offshore wind device characteristics, even though offshore wind development are generally much more evolved and advanced than wave and tidal.

The specific characteristics of offshore wind, wave and tidal devices taken into consideration in the seascape assessment include:

- Offshore wind structures:
  - Wind turbines in open water.
  - Turbines with a generating capacity of 3-5 MW and height to blade tip approximately 80-120 m).
  - Typical arrangements of commercial arrays comprising approximately 300 MW array (60 turbines) of 30km^2.

- On surface linear structures:
  - Wave devices in open water.
  - Devices between 2 and 14 m in height above the water surface.
  - Commercial arrays comprising up to 6.5 km$^{2.}$

- On surface point structures
  - Wave or tidal devices in open water

[7] Guidance on the Assessment of the Impact of Offshore Wind Farms. Seascape and Visual Impact Report. (DTI, November 2005)
[8] Scottish Marine Renewables Strategic Environmental Assessment 2007, Scottish Executive,
9 UK Offshore Energy Strategic Environmental Assessment 2009, DTI
10 Scott, K.E., Anderson, C. and Benson, J.F. (2005). An Assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms. Scottish Natural Heritage Commissioned Report No. 103 (ROAME No. F03AA06)
[11] Hill, M. *et al.* (2001) Guide to Best Practice in Seascape Assessment. Countryside Council for Wales

- Varying levels of protrusion above the sea surface, with the smallest visible element comprising marker buoys and lighting beacons, ranging to vertical structure up to 14 m in height.
- Typical arrangements for wave devices are difficult to predict. For example a point absorber, which usually comprises buoys moored to the seabed, may have moorings that spread out over a significant distance thereby increasing the separation between devices in the array. For the purposes of this assessment the following arrangement has been considered: an array of approximately 50-100 tidal devices, generating 100-200 MW, in coastal water would be expected to occupy 1-2 km^2.

It is important to note that device features could change as technologies develops and should therefore not be considered as being definitive. The exact geometry of commercial arrays will also vary from location to location and will be site and device specific. Also as the technology develops the footprint of individual devices could extend corresponding to the increase in energy output.

6.4.2 Establishing the Baseline

6.4.2.1 Identifying Landscape Regions

The first stage in defining seascape character types (see below) at a national scale involved a review of the landscape character assessments (LCAs) that were undertaken by the Northern Ireland Environment Agency (NIEA) in 2000.

In this assessment 42 separate landscape character assessments are grouped geographically into twelve regions covering the SEA study area. Whilst the majority of these LCAs defined coastal types or areas on the basis of the characteristics of the coastline, rather than the character of the marine element or relationship of land and sea, sufficient information on coastal character was available to form the basis of defining seascape character types across the study area as discussed below.

6.4.2.2 Identifying Seascape Character Types

Based on the information presented in the LCAs, the specific coastal landscape character types were reviewed and then grouped according to shared characteristics. The geographical spread of the dominant characteristics was evaluated in conjunction with Ordnance Survey maps and a review of previously defined seascape types (based on previous seascape assessments e.g. the DTI Guidance on Seascape and Visual Impact Assessment of Offshore Wind Farms and the Scottish Marine Renewables SEA).

Based on the information presented in the LCAs, the detailed coastal landscape character descriptions were then grouped according to shared characteristics. The geographical spread of these dominant characteristics was evaluated in conjunction with Ordinance Survey maps of the study area and a review of previously defined seascape types (based on previous seascape assessments e.g. the DTI Guidance on Seascape and Visual Impact Assessment of Offshore Wind Farms and the Scottish Marine Renewables SEA). These new groupings of amalgamated and slightly simplified coastal types were then reviewed in the context of their relationship with coastline and sea to formulate nine seascape types with shared dominant characteristics. These are discussed in more detail in the baseline data review (Chapter 9).

It should be noted that for the purpose of this SEA, seascape character types are defined by dominant characteristics that represent the strategic nature of this study. However, due to the highly varied nature of the Northern Ireland coastline there are likely to be a number of smaller, local level variations in the specific characteristics within a defined seascape type e.g. certain characteristics may be present within in a seascape character type that is defined by different set of dominant shared characteristics.

These smaller scale, local variations will be identified on a case by case basis as part of any detailed seascape assessments carried out to inform the consenting/development of individual projects.

6.4.2.3 Familiarisation Visits

A number of familiarisation visits were undertaken both within Northern Ireland and elsewhere in the UK to obtain information on how different device types and characteristics interact with different seascapes and to assist with the identification of the different seascape types around the coast of Northern Ireland. Familiarisation visits were made in the following locations:

- The Solway Firth (Scotland) where the Robin Rigg offshore wind farm is currently under construction
- Lough Foyle and Magilligan Flats
- The Causeway Coast and Rathlin Island Coast
- Glens of Antrim
- Belfast Lough
- Strangford Lough (where the SeaGen demonstration tidal device is located)
- Lecale Coast
- Dundrum Bay

The familiarisation visits were also used to inform the understanding of the potential visual effects of offshore wind, wave and tidal devices e.g. to determine at what distance the visibility of offshore wind farms becomes insignificant.

6.4.2.4 Designated Landscapes

For the purpose of the seascape assessment, the importance of certain landscape areas has been addressed by reference to national, regional and local landscape designations. However, the absence of a designation in relation to other landscapes does not infer a lack of quality or importance. For example, some landscapes, whilst they may not be identified as being of national importance or value may be very important a local scale e.g. to local communities. The main landscape designations considered in this SEA include:

- World Heritage Sites (WHS)
- Areas of Outstanding Natural Beauty (AONB)
- Marine Nature Reserves
- Areas of Especially High Scenic Value (AEHSV, County Donegal)

Further detail on these designations is provided in Chapter 9.

6.4.3 Assessment of Effects (Seascape)

6.4.3.1 Valency and Public Attitudes to Wind Energy Developments

Environmental effects can be beneficial (positive) or neutral as well as adverse (negative). This is known as the ‘valency’ of effect which depends on a) the type and nature of impact and b) the perception / opinion of the observer, with the latter being particularly pertinent to the assessment of wind farms. The term ‘valency’ applied to EIA originates in Durham County Council guidance and is used in Inspectors’ decision letters.

Wind farm development generates a variety of responses ranging from strongly adverse to strongly positive. Experience of individual responses to proposed wind turbine development is that opinions can differ not only between close (i.e. adjacent) neighbours but also between members of the same family living in the same house. Surveys of public opinion relating to renewable energy development including wind farms, like the one referred to below, are helpful in understanding the valency issue.

The Department for Business, Enterprise and Regulatory Reform (BERR) document titled "*Renewable Energy Awareness and Attitudes Research: Management Summary*" was published in June 2008 and reports on quantitative research undertaken "*to explore awareness and attitudes to renewable energy amongst the general public in Great Britain, and determine influences on their opinions of this subject."*

The report concludes that "*Awareness and support in Great Britain for renewable energy has remained at similar levels to those found in 2006 and 2007, with the majority still supporting its use (84%)…..80% are in favour of the use of wind power … [and] just under two thirds said that they would be happy to live within 5km of a wind power development (65%), an increase on the previous two years."*

6.4.3.2 Valency of Effect

In order to address the valency question only the degree of significance of effect is recorded in this assessment; judgements as to whether the landscape and visual effects identified are adverse (negative), neutral or beneficial (positive) are deferred to the discretion of the determining authority, which is best placed to judge this question based on feedback from consultees and the local public. However, for the avoidance of doubt, in this Seascape SEA, the default position on impact significance is neutral unless stated otherwise.

It is important to note that judgements on impact significance in this Seascape SEA, including those on the valency of effect, are impartial and based on professional experience and opinion informed by best practice guidance. Whatever the judgement made by either of the polarised camps in the wind farm debate, be it adverse or beneficial, there will be a contrary judgement which, provided it is founded on reliable information and genuinely held, will be legitimate and should therefore be afforded respect.

6.4.3.3 Sensitivity to Change

Sensitivity refers to the sensitivity of the seascape character type to the change induced by the presence of an offshore wind or marine renewable energy development. The assessment of seascape sensitivity is therefore specifically related to the three types of offshore renewable energy developments and their associated characteristics.

Renewable energy technology is a rapidly evolving field, appearance and scale of potential future development is accordingly difficult to predict with accuracy. When considering the potential effects of device characteristics on the existing seascape we have taken a precautionary view, basing assessment of the sensitivity to change, magnitude and on effects prior to mitigation.

Some of the seascape character types identified as part of this seascape assessment (Chapter 9) are more sensitive to offshore wind and marine renewable energy developments than others. The sensitivity of a particular seascape type to the presence of an offshore wind, wave or tidal development is one of the criteria used in the overall assessment of the potential significance of the effect (see section 6.4.3.5 below).

The extent to which the device array would affect the seascape varies depending on the various stages of the development and the capacity of the existing seascape to absorb these components. The construction and decommissioning phases of the development would involve temporary and relatively short periods of change and as a result the impacts on the seascape are not considered to be significant and are consequently not considered below.

The operational phases of the development when the devices are installed in the water would, however, result in more permanent and potentially significant effects and it is these operational effects on the seascape, which are described below. It should be noted that whilst submerged devices are not considered to result in potential significant impacts the buoys and lighting associated with these device arrays have been assessed as there is the potential for them to affect the seascape.

The sensitivity of different seascape character type to offshore renewable energy developments depends on the capacity of the different elements that comprise that character type, to accommodate change. Table 6.3 below provides a summary of criteria used to determine the different levels of sensitivity of specific seascape elements to offshore wind and marine renewable energy developments.

It should be noted that this table has been included to help aid transparency to the approach taken and does not represent a complete account of the various judgements and considerations that were undertaken when determining sensitivity.

Table 6.3: Criteria for Seascape Sensitivity

Criterion	Increase in Sensitivity	Decrease in Sensitivity
Scale (e.g. horizontal or vertical plane, linear or non linear, open or enclosed, large or small)	Small scale, enclosed Views extend out past enclosing land mass across sea to horizon Elevated views from coastal edge Absence of scaling elements	Large scale, open
Coastal topography/form /pattern (e.g. flat and simple, complex and intricate)	Intricate, complex, rugged Important focal points – Mountains, headlands, offshore islands	Flat, horizontal, simple, lack of natural focal points
Settlement/infrastructure (e.g. linear developments, urban forms, presence of large scale infrastructure or small, clustered nucleated villages or scattered settlements)	Traditional coastal and rural, scattered settlements Lack of visually prominent infrastructure.	Larger scale, urban mass and linear settlements Visually prominent infrastructure and busy navigational routes
Scenic quality (e.g. inherent distinctive visual qualities, condition and completeness of inherent natural characteristics, traditional landscape patterns, wilderness, tranquillity)	Seascape of high scenic quality with distinctive visual qualities, and inherent natural characteristics or traditional landscape patterns intact, or in good state of repair, or well looked after.	Degraded set of landscape features contributing to a less intact visual quality within the landscape. Visually prominent industrialisation of the landscape.
Exposure (linked to scale and topography e.g. exposed cliff faces and escarpments or sheltered bays)	Sheltered, calm coastal areas	Exposed, dramatic seascapes
Protected Areas (designated landscapes)	Areas protected by specific designations that include protection of landscape character or scenic quality such as WHS, AONB, MNR, EHSA	No designations relating to the area that include protection of landscape character or scenic quality

The following provides a brief definition of the criteria listed above:

- **Scale:** the scale of the seascape takes into consideration whether the emphasis is horizontal or vertical, linear, open, large or small. Sensitivity to devices will generally increase with small scale enclosed seascapes and decrease with large open scale areas.
- **Coastal topography/form/pattern:** Where seascape form is relatively, flat and simple such as low lying agricultural coastal land, low lying linear devices could relate to this characteristic. Where the seascape form is more complex and intricate, the straight linear lines of the device arrays may conflict with the inherent pattern, forms and focal points. Topography of associated land form, even when distant, will also inform the sensitivity of

seascape to change, especially, when in the case of off shore wind, the landmass is prominent within the setting. Where the accessible coastal edge or immediate hinterland provides elevated views the distance at which effects would be considered low or negligible, would increase proportionally creating a higher level of sensitivity.

- **Settlement/infrastructure:** Device arrays are more likely to relate to linear developments, urban forms and areas where larger scale infrastructure exists than to small clustered, nucleated villages or scattered settlement where scale and character contrasts are greater. It should be noted that settlement and infrastructure is only considered in relation to the seascape and not the importance of visibility and views from them.
- **Scenic quality:** The scenic quality of a landscape relates to its inherent distinctive visual qualities, and to the condition and completeness of inherent natural characteristics or traditional landscape patterns.
- **Exposure:** Exposure to the elements is linked to the scale of the seascape but is also affected by topography. As waves crashing against rocks can seem dramatic and heighten the sense of wildness of the sea, so a distinction has been made on whether an area is calm, sheltered (higher sensitivity) or exposed, wild (lower sensitivity) and what effect the elements could have on each of the device characteristics.
- **Protected Areas:** For the purposes of the seascape assessment, landscape value has been addressed by reference to national, regional and local landscape designations. Absence of such a designation, however, does not infer a lack of quality or importance. Factors such as accessibility and local scarcity can render areas of nationally unremarkable quality, highly valuable as a local resource.

The sensitivities of the nine seascape character types are then evaluated and described using the following 3 point scale as follows:

- High sensitivity - a seascape of unique character and particularly high scenic quality, where the key characteristics are fragile and susceptible to small changes of the type proposed;
- Medium sensitivity – a seascape where the key characteristics are vulnerable but with some capacity to tolerate change of the type proposed; and
- Low sensitivity – a seascape where the key characteristics are potentially tolerant of substantial change of the type proposed.

The sensitivities of the individual seascape character types are described in the baseline review (Chapter 9).

6.4.3.4 Magnitude

The issues which influence magnitude of potential effects (magnitude of change) are complex, and comprise a number of quantifiable and less quantifiable parameters. More quantifiable parameters include, the distance from the development and the number and proportion of devices visible in the array. Less quantifiable parameters include the scale of change with respect to the loss or addition of key components, features and characteristics of the seascape; the nature of the effect e.g. whether significant, moderate or slight; and the effects of aspect, lighting and weather on the changing perception of the seascape character.

However, it is often the distance from the receptor/seascape components, which tends to most strongly influence judgements on the magnitude of potential seascape effects. The DTI guidance[12] suggests that distance is a key parameter and one, which might offer some form of standardisation in the way that magnitude of change is considered. Whilst the guidance ultimately advises that a range of criteria should be considered when determining magnitude of change, the high level nature of this SEA and the lack of information on the location of the devices within the study area, has meant that visual significance thresholds have been used as the determining factor when considering the magnitude of change.

[12] Guidance on the Assessment of the Impact of Offshore Wind Farms. Seascape and Visual Impact Report. (DTI, November 2005)

The magnitude of change arising from the three device types is based on:

- The visibility thresholds for offshore wind documented in the UK Offshore Energy SEA 2009
- Considerations for Wave and Tidal devices documented in the Scottish Marine Renewables SEA, 2007.

These thresholds were tested and verified during the site visits to the Solway Firth, Strangford Lough and the Causeway Coast, Antrim and Lecale Coasts and Dundrum Bay (Appendix E). Based on these thresholds the following potential effects on seascape were identified:

- For On Surface Linear and On Surface Point Devices:
  - Large: 0 - 5km from the coast. Notable change in seascape characteristics over an extensive area ranging to a very intensive change over a more limited area;
  - Medium: 5 - 10km from the coast. Moderate change in localised areas;
  - Small: 10 - 15km from the coast. Small or imperceptible change in seascape components; and
  - Negligible. 15km + from the coast. No discernible change in any seascape component.

- For Offshore Wind 5-7MW
  - Large: 0-15km from the coast. Notable change in seascape characteristics over an extensive area ranging to a very intensive change over a more limited area;
  - Medium: 15-24km from the coast. Moderate change in localised areas.

6.4.3.5 Significance of Effects

The two principal criteria determining the potential significance of an effect are the sensitivity of the seascape and the magnitude of change and it is the evaluation of these factors against clearly defined criteria, which enables a reasoned judgement to be made on significance of effect.

The findings are represented using a descriptive scale ranging from:

- Significant effect (positive or negative depending on individual judgement)
- Moderate effect (positive or negative depending on individual judgement)
- Slight effect (positive or negative depending on individual judgement)
- No effect
- Neutral (positive effect balances out negative effect)

Explanation of the significance criteria/ratings is provided in Table 6.4 below.

Table 6.4: Seascape Significance Criteria

Level of Significance	Rationale for Assessment of Significance
Significant effect (negative)	▪ The proposals are at considerable variance with the scale, form and pattern of the seascape; ▪ They are likely to degrade, diminish or even destroy the integrity of a range of characteristic features and elements or their setting; ▪ They would be substantially damaging to a high quality or highly vulnerable seascape; and ▪ They are in serious conflict with the landscape objectives of a designation.
Moderate effect (negative)	▪ The proposals are out of scale with the seascape, or at odds with the local pattern and form; ▪ They are likely to strongly contrast with or cause loss of characteristic features and elements or their setting; and ▪ They would compromise the landscape objectives of a designation.
Slight effect (negative)	▪ The proposals do not quite fit the form and scale of the seascape; ▪ They are likely to result in only small changes to characteristic features and seascape elements; and ▪ They would not compromise the landscape objectives of a designation.

Level of Significance	Rationale for Assessment of Significance
Neutral effect (negative)	▪ The proposals are well designed to complement the scale, form and pattern of the seascape; ▪ They would integrate into the existing seascape through siting and design; ▪ They would not cause loss or change to characteristic features and seascape elements; and ▪ They would avoid conflict with landscape objectives of a designation.
Slight effect (positive)	▪ The proposals fit well with the scale, form and pattern of the seascape; and ▪ They would maintain or enhance existing seascape characteristics.
Moderate effect (positive)	▪ The proposals considerably enhance the form and pattern of the seascape; and ▪ They would enable some sense of quality to be restored or enhanced to a seascape which is not of any formally recognised quality.
Significant effect (positive)	▪ The proposals constitute a major restructuring of a degraded seascape or one in poor condition.

The influence of the sensitivity of the seascape character types and the magnitude of the effect (degree of change) on the overall significance of an effect (positive or negative) is illustrated in Table 6.5 below.

Table 6.5: Determining Effect Significance

Sensitivity	Magnitude			
	Negligible	**Small**	**Medium**	**Large**
Low	Slight	Slight	Moderate	Moderate
Medium	Slight	Moderate	Moderate	Significant
High	Moderate	Moderate	Significant	Significant

Further information on potential effects is provided in Chapter 10: Generic Effects.

6.4.4 Visual Impacts

Development can change people's direct experience and perception of the landscape/seascape depending on the existing context, the scale, form, colour and texture of the proposals, the nature of activity associated with the development and the distance and angle of view. However, for there to be a visual impact there is the need for a viewer, usually referred to as a receptor. Receptors can include residential properties, workplaces, recreational facilities, road users, tourists, pedestrians and other outdoor sites and viewpoints which would be likely to experience a change in existing view as a result of a development.

GLVIA (Guidelines on Landscape and Visual Impact Assessment) acknowledges a relationship between the perception of landscape/seascape character and the experience of viewers or receptors. Although procedurally linked, they are separate and distinct assessments. Given the strategic nature of this assessment it has been considered that it is not possible to assess potential visual impacts associated with the device arrays as changes to visual amenity are a direct response to receptor locations. At a strategic level it is not possible to identify receptors (number or type) with any level of certainty and consequently specific visual impacts associated with the installation and operation of off-shore wind, wave and tidal devices within the study area have not been considered as part of this SEA.

Visual impact assessment is an important part of the EIA process and a full visual impact assessment should be undertaken when considering project specific off shore wind, wave and tidal developments. Visibility and key views of the sea from the landward, coastline and seaward components of the seascape should be identified and analysed as part of the visual impact assessment.

6.5 Cumulative Assessment (Part 3)

The cumulative assessment comprises six main elements:

- Identification of development scenarios for offshore wind, wave and tidal energy.
- Assessment of cumulative effects associated with varying levels of development within each of the individual resource zones.
- Assessment of cumulative effects associated with varying levels of development within a number of the different resource zones throughout all NI waters (whole NI study area).
- Assessment of effects associated with implementation of the SAP in combination with other marine development implemented through other marine plans and programmes. This part of the assessment will consider:
  - NI waters specific marine developments and plans and programmes e.g. NI Marine Bill
  - Wider transboundary effects associated with other UK, Scottish, Wales, Isle of Man or Republic of Ireland strategies for marine developments and marine renewable (offshore wind, wave and tidal) for example DECC Offshore Energy Plan and The Crown Estate Round 3 Offshore Wind and Scottish Government Marine Renewable Strategy).
- Assessment of effects associated with implementation of the SAP in relation to known environmental issues and problems.

6.5.1.1 Identification of Development Scenarios

In identifying the development scenarios the following information was taken into account:

- Consultation with DETI in relation to the current levels of interest shown by developers for certain locations within study area.
- Contribution of offshore wind and marine renewable energy to Northern Ireland renewable electricity targets.
- Consultation with The Crown Estate on proposals for a competitive licensing round for offshore wind and marine renewable energy development in Northern Ireland waters.
- Consultation with developers regarding current and future development plans in Northern Ireland (offshore wind and marine renewable energy).

The development scenarios also a need to take into account a number of development specific factors. These include:

- Method of connection to the grid (hubs or individuals cables etc).
- Configuration of a development e.g. footprint, device arrangements, alignments and spacing.
- Installation, maintenance and decommissioning requirements.

There is also a need to consider how individual developments will relate to each other e.g. spacing between developments and whether a number of developers would connect into one hub or each have individual landfalls (connections to grid). Further detail on the development scenarios is provided in Chapter 12.

6.5.1.2 Cumulative Effects in Specific Resource Zones (Chapter 12)

This part of the assessment focuses on assessing the cumulative effects associated with the deployment of a number of developments (offshore wind, wave and tidal) within the different resource zones. This part of the assessment builds on the results from the assessment of the resource zones (Part 2 discussed above), and includes:

- Assessment of different levels of generating capacity (MW) for certain types of development within each resource zone based on average sizes (MW) and scales (e.g. footprints) of different types of development (offshore wind, wave and tidal) e.g. development of two offshore winds of average size of 250 MW. Further detail is provided in the Cumulative Assessment Chapter (Chapter 12).
- Assessment of a combination of development types in one location e.g. combinations of offshore wind and wave or offshore wind and tidal power.

The main output of this part of the assessment is to identify optimum numbers, sizes (MW), and types of development (including combinations) in certain locations, taking account of methods of attachment to the grid and development configurations. This part of the assessment also takes into account possible solutions for managing competing interests and the implementation of mitigation measures for a number of developments (see Diagram 6.2 and Chapter 11).

6.5.1.3 Cumulative Effects Across the Study Area (Chapter 12)

The main focus for this part of the assessment is the assessment of potential cumulative effects on the SEA topics and associated receptors that are likely to occur as a result of development occurring within all, or a selection of (depending on the results from the previous assessments), resource areas across the NI study area. This part of the assessment also considers the varying levels of development that could occur within each of the resource areas as identified in the previous assessment.

6.5.1.4 Cumulative Effects in Relation to Other Plans and Programmes and Development (Chapter 13)

In addition to the cumulative effects of developing varying levels of offshore wind, wave and tidal energy within the resource zones across the study area, the cumulative assessment also considers the potential effects on SEA topics and associated receptors in relation to:

- Other marine developments proposed for the study area.
- Other plans and programmes that affect/influence the NI study area in relation to future offshore wind, wave and tidal developments.
- Transboundary effects on SEA topics e.g. seal populations or seascape.
- Transboundary effects in relation to other offshore wind, wave or tidal developments that could occur under UK (e.g. offshore wind Round 3 developments), Scottish, Isle of Man and Republic of Ireland (ROI) offshore wind and marine renewable energy strategies.

6.5.1.5 Cumulative Effects in Relation to Known Environmental Issues/Problems (Chapter 13)

This part of the assessment will consider the potential effects of implementing the SAP in terms of existing environmental issues or problems. For example, it will look at whether the SAP will contribute towards resolving or addressing the identified environmental issues and problems or whether it would exacerbate them. This will help to check the robustness of the SAP proposals in terms of the wider marine environment of Northern Ireland and give an indication of the overall sustainability of the proposals.

6.5.1.6 Presentation of Results

The following system of colour coding has been used in the presentation of the results from the cumulative assessment (both for the varying levels of development within the resource zones and in relation to other plans and programmes). These colours reflect the criteria described in section 6.3.2.2 above.

Table 6.6: Assessment Criteria Colour Codes

Assessment	Colour Coding
Significant Adverse	Significant Adverse
Negative	Negative
Negligible	Negligible
Neutral	Neutral
No Effect	No Effect
Positive	Positive
Unknown	Unknown

Section 2: Baseline Summary

7 Technologies

7.1 Introduction

Offshore energy can be extracted and converted into electrical energy by a variety of devices that make use of different sources of energy:

- Offshore wind
- Tidal energy
- Wave energy

In order to obtain up to date information about technologies currently in development, questionnaires were sent to a number of offshore wind and marine renewable developers in February 2009. Offshore wind developments and technologies are at a more advanced stage and relatively standardised compared to marine renewables, hence two different questionnaires were prepared, one for wind energy developers and the other for marine energy developers. Most of the information synthesised in this section is based on answers to those questionnaires, supplemented by information from other studies undertaken by Metoc and AECOM and information available in the public domain.

The questionnaires aimed at gathering information about the following key points:

- Constraints on the location of the device
- Installation and maintenance
- Interactions with the environment
- Size and energy density of commercial scale arrays

7.2 Device Types

7.2.1 Offshore Wind

Horizontal axis wind turbines, having a large generating capacity are the most common type of commercial scale offshore wind arrays. Offshore turbines are now each typically generating around 3MW plus and turbines of up to 5 MW have been prototyped.

A typical offshore turbine has a height to tip of around 80-120m with the tower height of about 60-80m, and blades approximately 40m long. Offshore wind turbines have, to date, generally been built in relatively shallow water, less than 30 metres in depth. Most developments will be installed on either gravity foundations or steel monopiles. Gravity foundations are structures, normally concrete, which settle and are stabilised by sand or water, with the turbine tower fitted onto them. Monopiles are long steel tubes which are hammered, drilled or vibrated into the seabed until secure, and then platforms and towers are installed on top.

Most developments in UK waters have, and are likely to continue to use, monopile foundations for the immediate future. Demonstrator projects for 5MW turbines on a quadropod jacket structure base in waters of around 45m have been undertaken, although the economics of this type of development have yet to be proven. A floating offshore wind platform using a moored buoy platform is currently being tested at full scale (see www.statoilhydro.com) which could enable windfarms to be developed in much deeper waters, in excess of 100m.

On 4 June 2008, The Crown Estate announced proposals for the 3rd Round of offshore wind farm leasing in GB waters. The 1st and 2nd Rounds have led to the leasing of sites with 8GW total generating capacity to offshore wind developers since 2001, while Round 3 considered leasing for an additional 25GW, based on a SEA commissioned by the Department of Business Enterprise and Regulatory Reform (BERR) in December 2007 for England and Wales. This latest round (Round 3) did not include Northern Ireland territorial waters.

Diagram 7.1: Example of Offshore Horizontal Turbines

North Hoyle offshore wind farm, Irish Sea

7.2.2 Wave Energy

Wave devices are at a much earlier stage in their development than offshore wind turbines, with only a small number of them currently at full-scale testing stage. However, the world's first commercial wave farm, using the Pelamis device and able to generate up to 2.25MW, was commissioned in September 2008, off the coast of Portugal.

In the UK, the European Marine Energy Centre (EMEC) located in Orkney, Northern Scotland provides facilities to test tidal and wave devices including a connection to the UK electric grid. The Pelamis wave device, amongst others, is currently being tested there.

Wave Hub, located off the coast of Cornwall, is also intended to provide an offshore facility for the demonstration and testing of arrays of wave energy devices. The Wave Hub facility is currently planned to service four types of devices which combined will deliver up to 20MW to the electric grid. The project is due for installation in 2010.

A similar energy testing facility for demonstration projects is also under development in Ireland at Belmullet.

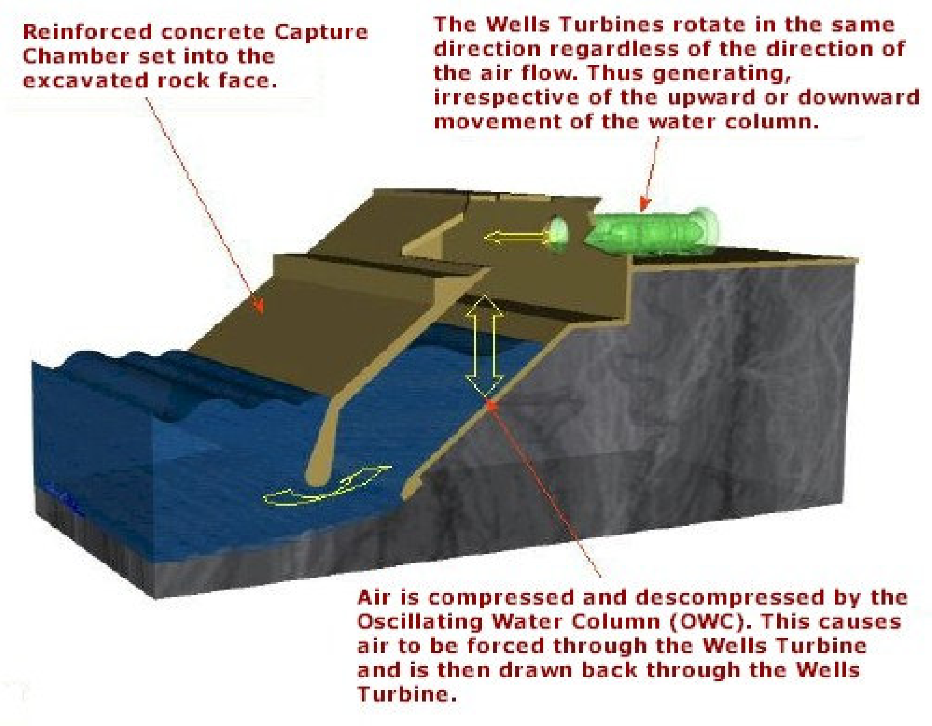
Offshore wave energy devices convert either the potential (wave height) or the kinetic (wave induced motion) energy of a wave into mechanical energy (turbine or rotor) which is then converted into electrical energy. One of the challenges for the extraction of wave energy is that wave power is available in low-speed and high forces, which the device has to resist. Moreover, the motion of forces is not in a single direction.

A brief description of some of the key device concepts used to extract wave energy is given below. The examples are illustrated by reference to some of the existing technologies, but are purely for illustrative purposes and are not intended to support any particular technology over another.

7.2.2.1 Oscillating Water Column (OWC)

These devices use changes in the height of the water surface that change the air pressure of a semi-enclosed chamber sitting above the water surface. The only exchange of air in and out of the chamber is through a turbine which is driven by changes in the air pressure of the chamber. This turbine is usually of the Wells type, which rotates on the same axis regardless of whether the air pressure increases or drops. An OWC can either be mounted on the shoreline, such as Wavegen's Limpet, or float offshore, such as Oceanlinx's device which is planned to be deployed off Cornwall as part of the Wave hub project.

Diagram 7.2: Example of Shoreline OWC



Source: Wavegen. (www.wavegen.co.uk/news_archives_limpet_for_press_release2.htm)

7.2.2.2 Point Absorbers

Point absorbers are usually buoys moored to the seabed. The vertical motion of the water surface, hence of the buoy, moves a piston up and down. The piston is situated either within the mooring system or in the buoy system.

A variant of this device is the submerged pressure differential. Instead of moving up and down at the sea surface, the device sits closer to the bottom and moves up and down as a result of the change of pressure due to the wave.

Based on the inventory of wave developers established by EMEC, a significant proportion of the wave devices currently in development are of the point absorber type.

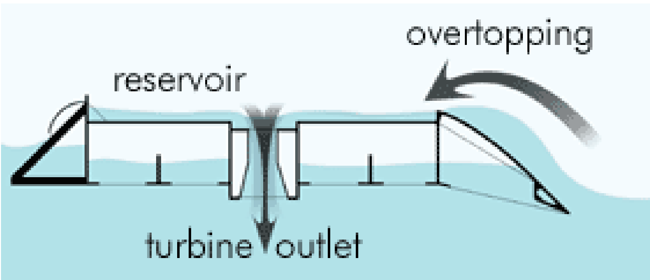
Diagram 7.3: Example of a (Multi-) Point Absorber

Source: UNENERGY. (http://www.unenergy.org/index.php?p=1_49_Wave-Power)

7.2.2.3 Overtopping/Collectors

Overtopping/collector devices are water reservoirs floating at the surface. Wave overtopping fills the reservoir, effectively storing the potential energy from the wave. The reservoir is then emptied through a turbine. Overtopping devices are usually moored and positioned offshore, in waters of depths 50-80m.

Diagram 7.4: Sketch of an Overtopping Device



Source: Wikipedia. (http://en.wikipedia.org/wiki/Wave_Dragon)

7.2.2.4 Attenuators and Terminators

Energy can be extracted via the relative motion of parts of an extended structure, such as attenuators and terminators. Attenuators extract energy along the axis of propagation of the wave while terminators are perpendicular to the axis of propagation.

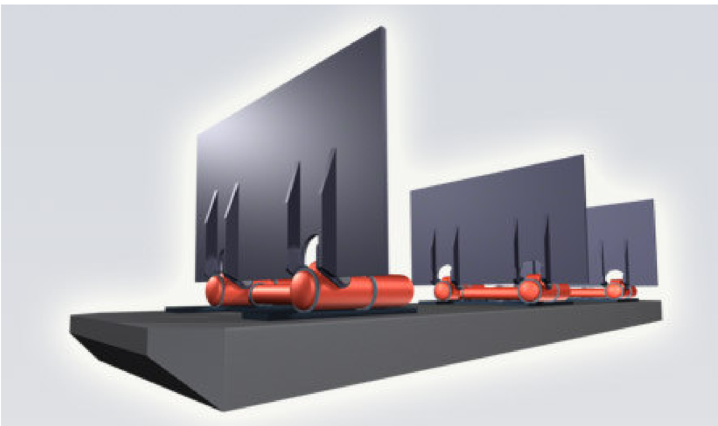
The Pelamis device is an example of attenuator whose efficiency has been demonstrated. It is the first device that has been deployed on a commercial scale, and will form part of the Wave Hub project offshore south west England. It is composed of cylindrical sections linked by hinged joints. The wave-induced motion of these joints is resisted by hydraulic rams, which pump high-pressure fluid through hydraulic motors. The hydraulic motors then drive electrical generators to produce electricity.

Diagram 7.5: Example of Attenuator

Source: Pelamis Wave Power. (http://www.pelamiswave.com/galleryimages.php)

Oscillating wave surge converters can also be considered as a type of terminator. They use the wave induced horizontal motion beneath the surface. Aquamarine's Oyster device and the Wave Roller System are examples of such devices. The energy is extracted from the horizontal oscillating motion of a vertical or inclined board perpendicular to the direction of the wave.

Diagram 7.6: Example of Oscillating Wave Surge Converter

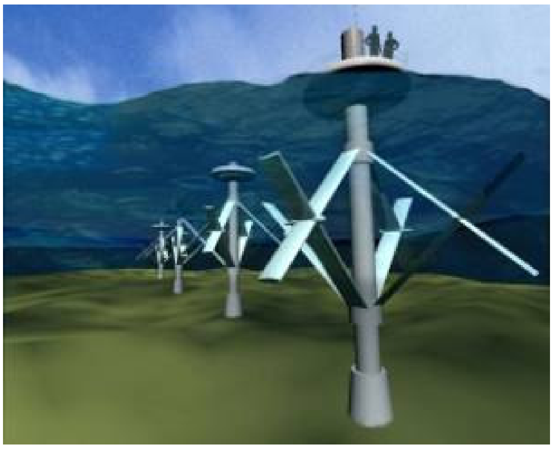


Source: AW Energy. (http://www.aw-energy.com/concept.html)

7.2.2.5 Wave Rotors/Turbines

Wave rotors/turbines are generally bottom-mounted devices which are located in shallow waters nearshore. The rotational motion created by the wave drives a turbine or rotor. Ecofys has developed such a device by combining two types of rotors on the same axis of rotation: a Darrieus rotor and a Wells rotor. Those two types of rotor have been designed so that the turbine rotates in the same direction independently of the direction of the flow. A grid connected prototype was deployed in August 2002 off the Danish coast.

Diagram 7.7: Example of Wave Rotor



Source: Ecofys. (www.ecofys.co.uk/uk/news/pressreleases2002/pressrelease02aug2002.htm)

7.2.2.6 Summary

Based on an inventory of wave devices compiled by EMEC, an estimate of the number of wave devices of each category currently under development has been made. The EMEC inventory is considered to be a representative sample of developers.

About half of the wave devices currently in development are of the point absorber type. Attenuators and terminators constitute 21.8% of the devices, and OWC 12.6%.

Table 7.1: Wave Devices

SEA classification	EMEC classification	Number of devices in category	Proportion [%]
OWC	OWC	11	12
Point Absorbers	Point absorber, Submerged pressure differential	44	51
Overtopping/Collectors	Overtopping	4	5
Attenuators, Terminators	Attenuators, Oscillating Wave Surge Converter	19	22
Wave Rotors/ Turbines	Others	9	10
All	All	87	100.0

Source: Modified from EMEC (www.emec.org.uk)

7.2.3 Tidal Energy

Tidal resources are regular and predictable, which is one advantage over wind and wave energy. Moreover, areas of high elevation and strong flows are often situated in bathymetric constrictions, hence close to land and in areas of quieter wave and wind climate, which provide advantages when considering electric grid connection and maintenance.

A variety of generic tidal energy device types exist such as horizontal axis turbines, vertical axis turbines, venturi effect devices. They also employ a range of methods of attachment to the seabed, including gravity bases, moored tethered foundations and piled foundations.

7.2.3.1 Tidal Barrages and Lagoons

The Strategic Action Plan, and therefore this SEA, does not consider tidal barrages or lagoons as a potential resource for Northern Ireland and are therefore not considered in this section.

7.2.3.2 Horizontal Axis Turbines

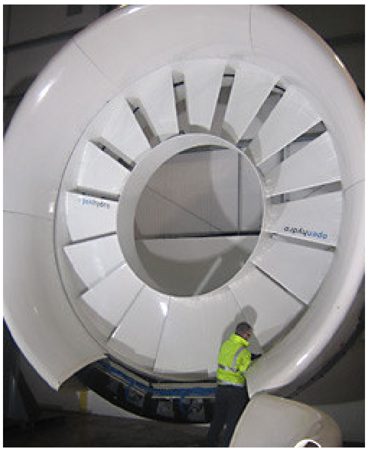
Tidal stream energy presents similarities with wind energy, although the engineering constraints are different. As water is 800 times denser than air and has a much slower flow rate, water turbines experience much larger forces and moments than wind turbines. This leads to the development of turbines with smaller diameters and blades with different designs.

Horizontal axis turbines are currently a main area of development for tidal power. Some of these devices are shrouded to increase their efficiency through flow acceleration due to the constriction.

A small number of prototypes or pre-commercial devices have been installed around the UK coast including Marine Current Turbine's (MCT) full size prototype of horizontal tidal turbine, SeaGen, which was installed in Strangford Lough in April 2008. The turbine began to generate at full power of just over 1.2 MW in December 2008.

Diagrams 7.8 and 7.9: Examples of Horizontal Axis Turbines

Source: Marine Current Turbines Ltd.
(www.openhydro.com/images.html)

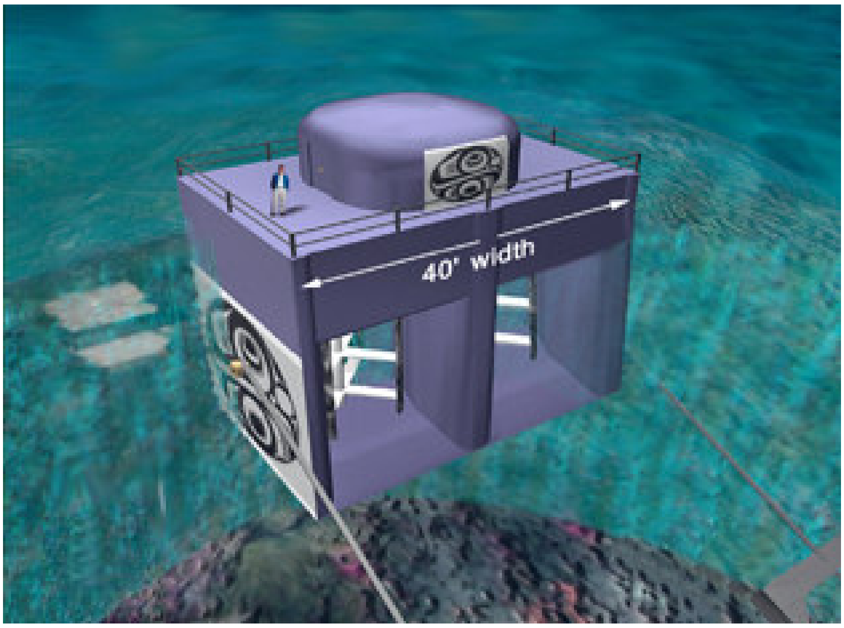


Source: Open Hydro.
(www.marineturbines.com)

7.2.3.3 Vertical Axis Turbines

Vertical axis turbines work in the same way as horizontal axis turbines, except that their axis of rotation is vertical. They are less common, and the differences in terms of performance between horizontal and vertical axis turbines are similar to offshore wind turbines. Vertical axis turbines can harness energy from flows in any direction and may be more efficient than horizontal axis turbines in low flow conditions. Horizontal axis turbines have a greater efficiency and survivability in strong flows.

Diagram 7.10: Example of a Vertical Axis Turbine



Source: Blue Energy. (www.bluenergy.com)

7.2.3.4 Venturi Devices

Venturi devices use shrouding to constrict the flow, thus leading to a pressure low after the constriction. This pressure drop can be used to suck air through a turbine which drives the generator, so that there are therefore no moving parts in contact with water.

Shrouding can also be used to simply increase the water flow through a turbine (shrouded turbine). Shrouded devices with water turbines are classified as horizontal axis turbines in this SEA.

7.2.3.5 Hydroplanes and Oscillating Hydrofoils

Hydroplanes and oscillating hydrofoils extract energy from the oscillations created by the tidal flow. For example, Stingray is a totally submerged device that consists of a hydroplane (an underwater wing) fixed to a system of levers that operate a pump then used to drive a hydraulic generator.

Oscillating hydrofoils are similar to turbines in that the oscillating motion occurs around an axis of rotation. However, the rotation is not complete for oscillating hydrofoils as the device oscillates between two angles. As for tidal turbines, oscillating hydrofoils can either oscillate around either a vertical or a horizontal axis.

Diagram 7.11: Example of a Hydroplane.

Source: British Broadcasting Corporation. (news.bbc.co.uk)

7.2.3.6 Summary

Based on the EMEC inventory of tidal developers, an estimate of the number of tidal devices currently under development has been made for each category. As stated previously, most of them fall into the horizontal axis turbine category (39.5%). It is also noted that a few of the technologies classified as 'others' and Venturi by EMEC could be classified as horizontal axis turbines, although they are usually based on more original designs.

Table 7.2: Tidal Devices

SEA classification	EMEC classification	Number of devices in category	Proportion [%]
Horizontal axis turbine	Horizontal turbine	17	40
Vertical axis turbine	Vertical axis turbine	8	18
Hydroplanes	Oscillating Hydrofoil	3	7
Venturi	Venturi	2	5
Others	Others	13	30
All	All	43	100.0

Source: Modified from EMEC (www.emec.org.uk).

7.3 Device Characteristics

In terms of the device characteristics, the following character areas have been identified:

- Location
  - Depth requirement
  - Space occupied by the device
  - Energy density and operability range
- Installation and maintenance
  - Installation (method of attachment to seabed)
  - Maintenance
  - Decommissioning
- Interactions with the environment
  - Moving parts in contact with the air and water
  - Chemicals
  - Noise
  - Electro-magnetic field (EMF)

7.3.1 *Location*

The geographical location of a device is constrained by:

- The depth in which the device can be deployed,
- The resource for which the device can generate energy,
- The connectivity to the UK national grid, which, with the depth requirements, largely set the constraints on the distance from the shore.

7.3.1.1 Depth Requirement

Offshore Wind

For offshore wind, the depth requirement depends on the foundation technique. Proven monopile technologies allow deployment in waters of up to 40m depths. Floating structures could potentially be deployed in much deeper areas. Floating turbines are currently in an early stage of development, and it is unlikely that this technology will be deployable at a commercial scale within the timescales of the SAP (e.g. by 2020). However to ensure all potential future developments are considered in the SEA, potential areas of wind resource within deeper water are considered in the assessment. Foundation structures are reviewed later in this section.

Wave Devices

Developers' answers to the questionnaire indicate that wave devices can operate in depths ranging between 4 and 100m, depending on the type of device. Shoreline oscillating water column devices operate in water depths of more than 4m, but require a sharp slope along the shore. Wave rotor devices operate in shallow waters of 10-15m depth. Point absorbers can be used for a wide range of water depths, between 5m and 100m depending on the design. Attenuators and overtopping devices generally require waters deeper than 50m to operate, and it is expected it will be possible to deploy them in waters up to 100m in the near future. Theoretically, using point absorbers as an example little has to be changed to the design of the device before it can be deployed in very deep waters. The main constraints are harsh wave climates, and distance from the shore.

High energy waves are associated with deeper waters (more than 50m). As water becomes shallower, the wave energy is attenuated by interaction with the seabed and, therefore, inshore arrays will comprise of devices that are designed to specifically to maximise energy extraction from these lower energy environments. However, most wave devices are designed for deeper more high energy waters where it is possible to extract higher levels of energy.

Tidal Devices

Tidal devices vary in depth requirement based on their configuration, so surface-piercing piled devices are typically located in the 25 to 30m depth range, whereas bottom-founded devices can currently operate in depths of 40 to 50 m. Most devices can be scaled to shallower water depths if required. The extent of the high energy tidal streams will dictate locations and heavily influence the types of devices that are economic to deploy at a given location. For tidal devices, the incentive to deploy in deeper water is not as great as for wave devices because the resource is also available in shallow waters; hence the upper limit of 80m presently given by developers is likely to be a good indication of possible deployment depths in the next 10-20 years. Deploying in deeper water is unlikely to become economically attractive before the areas of strong currents close to shore have been exploited.

7.3.1.2 Space Occupied by the Device

The environmental impacts caused by a device on its environment partly depend on the space it occupies in the air and in the water column.

Offshore Wind

As offshore wind devices exploit a resource above the sea surface and are attached to the seabed, they occupy the entire water column. The horizontal extent occupied in the atmosphere depends on the diameter of the rotor. For example, standard 5MW commercial turbines can have a nacelle height of 120m and a rotor diameter of 126m, leading to a total height of 183m. Recent developments have seen the introduction of 7+MW turbines. These achieve higher efficiencies with similar blade sizes through the optimisation of other parts of the wind turbine design. Consideration of wake effects, operational and maintenance workspace and supporting infrastructure requirements are significant influences on the overall footprint of an offshore wind farm.

Wave Devices

The majority of wave devices are driven by wave action at the sea surface and therefore the major components of the devices are located at or close to the sea surface. The devices are moored to the seabed resulting in most of the water column being occupied.

The majority of wave devices break the sea surface with only a small proportion being fully submerged. Wave devices that do break the sea surface or that float typically have between 2 and 14 m of freeboard visible above the surface. The size of a device at the surface depends on its type and is often correlated with the water depth and the wave climate of the waters in which it is to be deployed. Overtopping, terminator and attenuator devices have sizes up to 200m by 200m. Point absorbers are much smaller and typically cover an area of 20m by 20m. The space occupied by the cable that links the device to the mooring is small compared to the area occupied at the surface and at the seabed.

The horizontal extent occupied by the device at the seabed is largely set by the mooring technique used. Most devices occupy a larger horizontal extent at the seabed than in the rest of the water column. It is expected that the mooring for one device covers an area of up to $100m^2$.

Tidal Devices

Tidal stream resources are more equally distributed through the water column than wave resources. Therefore, tidal devices can be bottom-mounted and do not necessarily require structures at the sea surface to operate. However, some devices require surface structures to enable access for maintenance and repair and/or may need to be marked by buoyage or lights if they represent a hazard to navigation. Typically, devices that are bottom-mounted can be varied in size according to the water depth and tidal flow.

Most of the tidal devices currently in development are horizontal tidal stream devices. The turbine itself can be placed at different levels within the water column in order to exploit the strongest tidal current. Turbines for which it is possible to change the height in the water column (e.g. SeaGen) are generally attached to a column that protrudes slightly above the surface and the device occupies a horizontal extent of up to $500m^2$ at the level of the turbine. Bottom-mounted turbines are only present near the seabed and are expected to be a solution considered more and more by developers in the future, as they allow deployment in deeper waters and impose less constraint on navigation.

7.3.2 *Energy Density and Operability Range*

Offshore Wind

The UK offshore wind Round 1 led to the construction of arrays of typically 30 wind turbines of 2 to 3 MW, generating up to 90MW per array. In comparison, wind farm developments consented under Round 2 are generally much larger in size (e.g. approximately 300MW). This increase in array size reflects changes in economies of scale, with larger arrays being more economically advantageous. Table 7.3 contains examples of consented wind farm projects with their size and power densities.

Power densities are dependent on the rated power of the turbines used and on the distance necessary between devices, which should be 5 to 10 times the turbine rotor diameter. About 1km is typically allowed between 5MW turbines. Currently, typical power densities achieved are in the 8-10 MW/km^2 range. However, the use of 5MW turbines can allow an array to achieve power densities of up to 22MW/km^2. By 2011, an array of 140 turbines of 3.6MW is expected to be operational at Greater Gabbard, the world's largest offshore wind farm currently in construction. More ambitious projects under consideration include the Atlantic Array, which would consist of 350 wind turbines generating 1.5GW off the coast of North Devon.

Table 7.3: Examples of Wind Farm Sizes

	Name	Number of turbines	Power [MW]	Area [km^2]	Power Density [MW/km^2]
Round 1	Barrow	30	90	<10	9.00
	Burbo Bank	25	90	<10	9.00
	Gunfleet Sands	30	108	<10	10.80
	Inner Dowsing	27	90	<10	9.00
	Kentish Flats	30	20-90	<10	5.50
	Lynn	27	90	<10	9.00
	North Hoyle	30	60	<10	6.00
	Rhyl Flats	30	100	<10	10.00
	Robin Rigg	60	216	<10	21.60
	Scarweather Sands	30	20-108	<10	6.40
	Scroby Sands	30	60	<10	6.00
	Teesside	30	<90	<10	9.00
Round 2	Docking Shoal	100	375 - 500	74.9	5.84
	Dudgeon	60	230-300	34.97	7.58
	Greater Gabbard	<140	375 - 500	146.43	2.99
	Gunfleet Sands	20	48-64	4.99	11.22
	Gwynt Y Mor	<250	<750	124.17	6.04
	Humber Gateway	70	230-300	34.99	7.86
	Lincs	120	190-250	34.93	6.30
	London Array	~271	750-1000	245.29	3.57
	Race Bank	100	375-500	52.77	8.29
	Sheringham Shoal	45-108	240-315	34.99	7.93
	Thanet	60	230-300	34.99	7.57
	Triton Knoll	286	900-1200	206.99	5.07
	Walney	102	340-450	72.85	5.42
	West Duddon	140	375-500	66.68	6.56
	Westermost Rough	80	180 - 240	34.91	6.02
	Ormonde	30	108	<10	10.80
	Min	20.00	55.00	4.99	2.99
	Mean	81.66	271.77	47.67	7.87
	Max	286.00	1050.00	245.29	21.60

Source: Modified from www.thecrownestate.co.uk/interactive_map_offshore_windfarms_table

All wind turbines have a design point, i.e. an optimum wind speed at which they reach maximum efficiency. This efficiency, i.e. the ratio of the output electrical energy over the input wind energy, is theoretically less than 59.3% (Betz limit). According to the British Wind Energy Association, wind turbines start operating at wind speeds of 4 to 5 m/s and reach maximum power output at around 15 m/s (typical design point). They are shut down at very high wind speeds (25 m/s) to avoid being damaged.

Wave Devices

Wave energy developers responding to the questionnaire quoted numbers of devices between 20 and 600 for a full scale commercial array. However, it is very early in the development process for a number of these devices and it is most likely that the early commercial arrays will contain between 20 and 50 devices, built in stages over 2 to 3 years. The degree of interaction between devices is not yet fully understood and developers will look to evaluate this further in smaller pre-commercial arrays that may consist of 5 to 10 devices. A reasonable estimate for commercial array scale is that they will be formed of 20 to 50 devices each. It is noted that some devices, such as shoreline mounted OWC, will not necessarily be deployed as arrays. Rather, the devices will be joined in a continuous single structure containing for example 100 turbines generating 10MW over an area of 20m by 500m along the shore and reaching much higher power densities because spacing between devices is not an issue.

Similarly, devices such as offshore OWC and overtopping devices usually have larger sizes and generating power. For these, small arrays of 5 to 10 devices are considered although it might be more efficient to scale the device up than to deploy an array of them, depending on where they are to be located.

From the results of the survey, it appears that a typical array is expected to generate a rated power of 10-25 MW/km^2. This figure is consistent across a range of devices. For example, an array of 30 devices generating each 750kW like the Pelamis wave energy converter (attenuator) over 1km^2 would generate a rated power of 22.5MW while an array of 40 point absorbers (e.g. Wave Star Energy's C5) each generating 500kW would generate 20MW. See Table 7.4 for different configurations of arrays. As mentioned, overtopping devices such as the Wave Dragon have lower power density and extends over larger areas. For example eight Wave Dragon devices deployed in an area of 8.6km2 would generate a rated power of 56MW.

Table 7.4: Wave Array Size Assumptions

Type of device			Point absorber		Attenuator		Overtopping
Example			C5 (Wave Star Energy)		Pelamis		Wave Dragon
Generating capacity of one device		[MW]	0.5		0.75		7
Number of devices in an array*	Nx		5	5	4	5	2
	Ny		6	10	6	10	4
	Total		30	50	24	50	8
Generating capacity of an array		[MW]	15	25	18	37.5	56
Typical Separation	Nx	[m]	200		300		600
	Ny	[m]	200		10		700
Device Size	Nx	[m]	20		10		300
	Ny	[m]	20		150		200
Array size	Nx	[km]	1.1	1.1	1.24	1.55	1.8
	Ny	[km]	1.32	2.20	0.96	1.60	3.6
	Total	[km^2]	1.45	2.42	1.19	2.48	6.48
Power Density		[MW/km^2]	10.33		15.12		8.64

Note: Nx: characteristics along x-axis of the array. Ny: characteristics along y-axis of the array.

* Different configurations were considered for point absorbers (arrays of 30 or 50 devices) and attenuators (arrays of 24 or 50 devices)

By comparison, the Wave Hub project will cover 4 sites of 2km^2 each and generate up to 20MW. This gives an energy density of 2.5MW/km^2, which is much lower than presently indicated by developers. This is considered a low estimate and it is assumed that greater energy densities will be achieved in the future.

For some wave devices, operability and performance depend not only on the wave height, but also on the wave period. Wave dragon (overtopping) is an example of device which can operate in any wave climate, although it becomes more efficient for a significant wave height above 5m. Consultation with developers also indicates that most devices start generating power from significant wave heights of 0.5m. It is also worth noting that some devices can be automatically tuned to convert more energy from the actual wave height and optimise their efficiency. Terminators and attenuators, such as Pelamis, are particularly sensitive to wave period, which is roughly proportional to the wave height at a given location. Only a few of the developers consulted for this SEA gave an operability range in terms of wave period. However, according to the answers gathered, peak periods between 5 seconds and 15 seconds are adapted for wave energy recuperation.

Tidal Devices

Developers consulted for this SEA are considering early commercial arrays of around 40 devices, generating a rated power of 50MW/km^2. Some even mention power densities of up to 100MW/km^2, although these may not be achievable in the near future as the wakes created by the tidal stream devices currently have a limiting effect on the achievable power density. However, if projects can be developed in deeper waters where currents are stronger, it is likely that tidal arrays will have larger horizontal scales and higher power densities. In that case, there will also be technical constraints to overcome (installation, maintenance, access to electric national grid).

It is assumed that in the future tidal arrays will have two types of configuration, one of which will be adapted to coastal areas and the other to areas further offshore. In coastal areas, the tidal resource is localised, therefore relatively small scale arrays are to be expected. Due to its proximity to shore, it is likely to be the first resource that developers will look to exploit. As the spacing between devices is about 10 times larger in the direction of the flow than perpendicular to it, a typical configuration for early coastal arrays may be a small number of rows of devices. It is assumed that typical arrays will be formed of 1 or 2 rows of about 10 devices each. Such arrays would cover a typical area of 0.5 km^2, depending on the type of device, and generate an estimated 50-60 MW/km^2.

There is little information available to estimate the size of a future offshore array. They could be formed of up to 100 devices. As they will be deployed at greater depths where the tidal currents are stronger, the spacing between devices will probably be larger than for coastal arrays. An array of 50 to 100 devices, of dimensions 20m by 50m, such as MCT's SeaGen, and requiring 50m spacing perpendicular to the flow and 200m along the flow, would cover an area of 1.1 to 2.2km^2. The power density of this example array, if formed of devices generating each 1.5MW, would be 70MW/km^2.

Operability ranges depend on the design of a device and some devices can be scaled to adapt to the resource of the site where they are to be deployed. Typically, most horizontal axis devices reach their maximum efficiency at current speeds of 2-3m/s, although devices exist that can operate in tidal currents as strong as 5-6m/s. A typical average current speed across the tidal cycle of 1 to 2 m/s is sought by most site developers at present. The predictable nature of tidal current makes it easier to adapt the design of a device to the environmental conditions of a site than for wave energy devices. Devices such as hydrofoils or VIVACE, which extracts energy from the vortices created by a flow obstructed by a pole, could potentially efficiently harness energy from currents as weak as 1m/s.

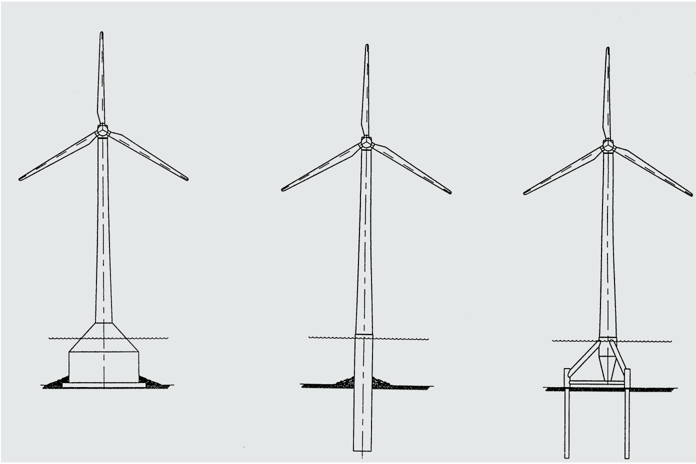
7.3.3 *Installation and Maintenance*

7.3.3.1 Installation

The constraints on the installation of a device are largely set by the mooring method. The key methods of attachment of devices to the sea-bed are as follows:

- Piling: monopiles (steel pile driven 10 to 20m into the seabed) and tripods (whose feet are driven into the seabed, as in the monopile case)
- Gravity structure (including caissons)
- Anchors
- Clump weights.

Diagram 7.12: Offshore Wind Turbine Foundations. Left: Gravity Structure; Centre: Monopile; Right: Tripod



Source: www.ramboll-wind.com\PDF\OMAE99.pdf.

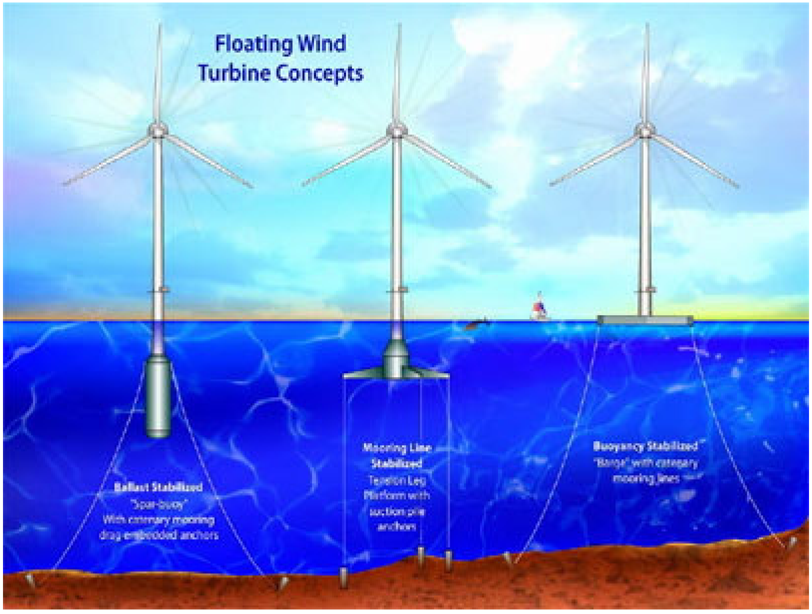
The complexity of the technique and invasive nature of the installation technique has potential to impact the timescales associated with installation of the devices. The choice of foundation is made based on the water depth, soil types, sediment movement, wind, current and wave loadings.

Recent developments have focused on foundations for turbines in deeper waters:

- Jacket foundations: They are four-legged platforms made from large tubular steel elements, whose design comes from the oil and gas industry. The wind turbine rests on the jacket platform, which is anchored to the seabed by pile foundations. The jacket is fabricated from steel pipes welded together in complex intersections, so as to resist loadings and vibrations. Such foundations have been used for the Beatrice Offshore wind farm in Scotland in water depths of up to 45m, and could be used to deploy offshore wind turbines in waters of 100m in the near future. Jacket foundations are treated in the piling category.

- Moored floating foundations: They come in various designs, and are still at the prototype stage. They could potentially be used for offshore wind farms on floating islands. As they are simply moored, they are adapted to virtually any seabed type and water depth. The main challenge and area of research is in stabilising them. It is expected that they could be deployed in depths up to 200m.

Diagram 7.13: Concepts for Floating Offshore Wind Turbine Foundations



Source: Modified from MIT (http://web.mit.edu/newsoffice/2006/wind.html)

Installation methods depend on the type of foundation used. The foundation is built first, then the turbine's tower is erected, and lastly the nacelle and rotor are put in place. The installation is done either from a jack-up barge, or a floating crane vessel.

Jack-up barges are mobile platforms. The supporting legs can be lowered to make the platform stable, resting on the seabed. At the end of the installation, the legs are raised above sea-level and the platform becomes mobile.

The time taken for full installation of a device varies between a few days to a few months. Consequently some commercial scale arrays can take a number of years for installation to be completed. It depends largely on the type of mooring, but also on the installation techniques. The devices assembled on shore and then towed to site take relatively little time at sea to install while for those that are constructed on site, more work is required on site. Some developers have designed their own vessel, adapted to their device, to install, maintain and decommission the device.

Diagram 7.14: Jack-Up Barge

Source: news.bbc.co.uk

Piling

Mooring using piles is limited to one type of wave device (the wave rotor) but several tidal devices are set on monopiles. Most wind turbines are also mounted on monopiles or tripod. Piles used to secure and mount commercial-scale renewables devices tend to be approximately 4 m in diameter and, typically, are driven some 20 m into the seabed. They allow deployment in water depths up to about 40m.

Piling location is surveyed to inform pile design, which usually involves drilling into the soil and rock layers below the sea-bed using a jack-up vessel. It may be necessary to prepare the seabed to level areas where the jack-up feet (spud cans) will sit on the seabed. The jack-up may take 3-7 days to drill, set, and cement a pile into position. Once the pile is set, the topside structure of the device has to be lifted on to the pile and secured. This is very dependent on the exact design of device and may take 1 to 4 days. Removal of the jack-up may involve waiting on suitable weather/tide conditions. In an array, the jack-up may move from site to site drilling and setting piles, then it or another vessel with a suitable crane will follow through lifting and setting topsides. The installation of rotors may be a subsequent operation or they may be lifted and fitted at the same time. This, again, depends on the exact design of the device.

Gravity Base

Gravity bases are used widely by both wave and tidal stream technologies. By their very nature they are bulky and heavy, although some designs may be ballasted down after they have been set on the seabed. They may be 20 to 40 m square or oblong with a variable aspect ratio from device to device. Good design of gravity bases involves inclusion of features that will assist removal of the gravity base at the end of its useful life.

Generally, following site survey and sea-bed preparation, the site will be marked with buoys and/or sonar devices and the gravity base (made buoyant by temporary closures of some elements, buoyancy bags or supported between barges) will be towed and positioned on site by tugs. The ballasting down operation will commence and be completed within, usually, a number of hours, so that the whole operation at site is completed within 1-2 days in a favourable weather window. These operations tend to be much quicker than monopile installation but are also more weather sensitive.

Anchors and Clump Weights

A large proportion of wave devices and a small number of tidal technologies are moored with anchors and chains or wires.

Generally, anchors are pre-set by a support vessel, which may be done over a period of 2 to 4 days. The device is then towed to the site, the anchor handler retrieves the anchor chains/wires and they are fastened to the device. It is highly desirable to complete the attachment of the device within daylight hours, so the duration of this stage of installation is very short.

Clump weights vary from being steel blocks at the smaller end of the size range to fabricated steel baskets that are loaded up with large link chain to provide weights of several tens of tonnes. They are pre-installed from a vessel with suitable lifting gear over 2 to 3 days. Subsequently the device is towed to site and attached to the chains or wires that are associated with each clump weight. The seabed disturbance is very similar to that for anchoring and is incurred only in the areas upon which the weights are placed.

7.3.3.2 Maintenance

Access to devices has safety implications and developers are responsible for ensuring that appropriate facilities are built into the device and proper procedures are developed for access and egress. Wherever possible, developers are planning to carry out most activities without actually accessing a device unless a properly designed platform is provided for that purpose. Developers are aware of the safety issues associated with device maintenance and will seek to comply with all safety requirements.

Ease of removal for repair and maintenance is an important factor in the overall concept of devices and the systems to facilitate removal in whole, or more frequently, in part, are key objectives of the design.

In general, device developers are seeking to design for minimum maintenance. Frequency and duration of maintenance can range from a few hours to a few days.

Planned interventions are arranged so that the minimum of offshore work is required. Some devices are taken off-site to a safe haven for maintenance to be carried out.

Access to devices for breakdown maintenance is likely to be limited by weather conditions. It is generally unlikely that operators will attempt to do other than inspection or minor work offshore for safety reasons.

Offshore Wind

Internal parts of the turbines, such as the gear box and the electro-magnetic generator may require maintenance. The submerged part of the turbine will also be subject to corrosion, so it is important that the turbine be monitored and maintained. It is estimated that scheduled maintenance operations will take 2 weeks every year, preferentially in summer. However, it has been learned from the onshore wind experience that faults and trips in the electrical and electronic control systems could create unplanned shut-down, so unscheduled maintenance operations should be expected. It is hoped that, with the development of more sophisticated condition monitoring systems, it will become easier to plan maintenance operations.

Access to the wind farm for these operations can be achieved by helicopter or boats, depending on the type of operation.

Wave Devices

A few wave devices require full removal of the device for repair and maintenance activities, whereas others require use of divers or remotely-operated vehicles to carry out on-site maintenance. Where removal is planned, design focus has been to minimise the specification of vessel required for the task to control costs as far as possible. Wave devices will be located in areas of rough wave climates, which makes the planning of in-situ maintenance operations sensitive to weather conditions. Planned maintenance operations are expected to be carried out 2 to 3 time a year, for period of a few days. Due to the early stage of development of some of the devices, some developers envisage additional visual inspection more often. For the same reasons, the estimated maintenance periods that have been given by developers are often an early estimate that will need to be updated after further testing of the devices.

Tidal Devices

Tidal technologies are, typically, fixed via piles or gravity bases and therefore rely on maintenance systems to remove or access the essential parts of the device where the turbine, gearbox or generator are located, rather than removing the whole device. These systems are quite specific and often a proprietary part of the technology. In-situ maintenance appears more adapted to tidal than to wave devices as tidal devices can be deployed in more sheltered areas. Developers indicate that expected maintenance operations should take place every 2 to 6 years and last between 4 and 6 weeks.

7.3.3.3 Decommissioning

Decommissioning of devices, from the tower to the blades, has similar constraints to the installation process, generally requiring the same methods. Decommissioning the foundations constitutes a more challenging problem. The methods for removing foundations have to also be taken into account in the development of a device as it is a statutory requirement for the methods for decommissioning to be included in an application for site lease consent from The Crown Estate.

Gravity foundations would have to be refloated. Decommissioning such a structure would involve lifting/towing heavy loads.

Monopiles can be decommissioned by cutting them at or below the seabed. It is unlikely that the whole part of the pile which is under the seabed will be removed.

The necessity for site clearance arises from the requirements of the OSPAR Convention which, in this case, is enforced by The Crown Estate. Developers are required to make provision for undertaking of site decommissioning and clearance by providing predicted methods and financial planning for decommissioning work as part of their lease agreements. A specific permit is required to leave or dump any item or parts on the seabed and such permits would be examined on a case-by-case basis.

Decommissioning entails a similar scale of works undertaken by similar mechanical means to construction and installation.

Good design of offshore renewable energy devices involves inclusion of features to facilitate removal and decommissioning. For example, a gravity base may have internal piping installed that enables connection of an air pump to jet out the mud below the gravity base and allow it to be lifted more easily for removal.

7.3.4 Interactions with the Environment

7.3.4.1 Moving Parts in Contact with Air and Water

Offshore Wind

All offshore wind turbines have moving part in contact with air. There are no moving parts in contact with water. Only wave and tidal devices have moving parts on contact with water (see below).

Wave Devices

The majority of wave devices have no moving parts in contact with water. Those that do include wave rotors, which have blades in contact with water and can use mesh protection to prevent fish, mammals etc from coming into contact with and being injured by the turbines. The blades are thought to rotate at approximately 25 revolutions per minute. Some wave devices have hinged sections which move with wave action, although these movements tend to be fairly slow.

Tidal Devices

All tidal devices apart from the air turbine Venturi type have moving turbine blades or hinges in contact with sea water. The turbine devices commonly operate at between 20 and 30 revolutions per minute and turbine diameters for commercial horizontal axis turbines are typically some 10 to 30 m but can be varied according to site characteristics. Information available on vertical axis turbines would suggest that turbine diameters also vary (from approximately 3 m to approximately 6 m in diameter and up to 6 m in height), depending upon the device configuration.

7.3.4.2 Chemicals

Coatings and Antifouling Chemicals

Fouling of offshore renewable devices by marine organisms such as algae and molluscs can reduce their efficiency. A small number of both wave and tidal device developers report that they use special antifouling coatings to prevent fouling of their devices by marine organisms, although most of them do not contain biocides. Most wave devices do not have any moving parts in contact with the water, hence reducing the need for antifouling chemicals.

Tidal devices do have moving parts in contact with the water, although they undergo strong currents, which limit marine growth. It is expected that the majority of developers will seek to use non-toxic antifouling materials as far as possible.

A method to prevent fouling that does not involve chemicals is to make the surfaces in contact with water smooth enough to prevent marine growth, and is used whenever possible on offshore wind turbines. Coating layers are used both to limit fouling and as a passive protection against corrosion. Among them, epoxy coating systems are the most popular in the offshore wind industry. Passive protection against corrosion such as coating systems is only sufficient in the atmospheric and splash zones, therefore active corrosion protection, such as using sacrificial anodes, is necessary for submerged and buried zones.

Sacrificial Anodes

It is usual to protect steel structures in corrosive environments (such as seawater) by attachment of sacrificial anodes.

A sacrificial anode is a piece of readily corrodible metal attached (by either an electrically conductive solid or liquid) to the metal being protected. This piece of metal (usually zinc or aluminium) corrodes first, and generally must dissolve nearly completely before the protected metal will corrode (hence the term “sacrificial”). They are classified as active corrosion protection because of the chemical reaction that results in their dissolution.

Based on a typical device installed in 50 m water depth, it is estimated that discharges of zinc or aluminium would add an extremely small percentage (1.31 x 10-5 % per year) to the ionic material that makes up the mean inorganic content of seawater.

Hydraulic Fluids

Devices that use hydraulic systems will normally be designed such that at least two seals or containment failures are required before a leaking fluid reaches the sea. It is not possible to be definitive for every device currently under consideration as a number of them are still at concept stage and this aspect is a matter for detailed design. However, the industry’s design guidelines (Carbon Trust, 2005), if followed, would lead developers to minimise risks of hydraulic fluid leakage. Details of the risk of leakage would need to be considered for individual developments. The possibility of leakage of oil from mechanical equipment or lubricated joints in contact with sea water is difficult to quantify and determine.

Furthermore, design leakage rates will be small as part of the approach to creating low-maintenance devices which, in this context, means that device developers aim to design devices that do not require frequent oil replacement or grease injection into bearings. The general approach used by developers would be to select efficient containment systems that minimise leakage.

Where a device design will result in some unavoidable seepage to the sea, biodegradable options are likely to be selected for both hydraulic and lubricating oils and greases. As part of the questionnaire, some developers indicate that they are using biodegradable fluids or even water as hydraulic fluids.

7.3.4.3 <u>Noise</u>

Noise is generated during site investigation and device installation, operation and decommissioning. Noise generated during operation is of lower amplitude than noise generated at the other stages, but is generated on longer durations. A detailed noise study investigating the sources of noise during the different stages of deployment was undertaken to inform the Scottish SEA, whose conclusions are summarised here.

During site preparation and device installation, the main sources of noise are:

- Geophysical survey, shipping and machinery
- Dredging

- Pile driving or drilling

Pile driving generates high amplitude noise over a broad range of frequencies (20Hz to 20kHz) and is understood to be the greatest source of environmental impacts.

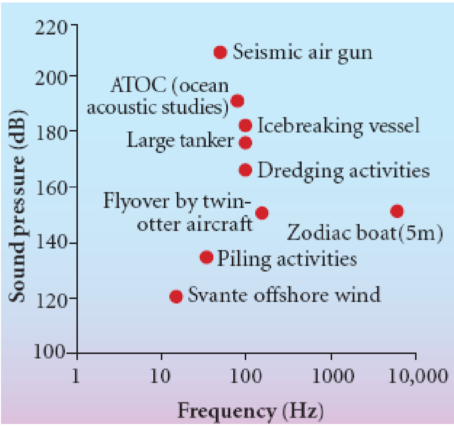
During operation, noise is generated by:

- Moving air or water (e.g. through a turbine)
- The device's moving parts, including rotating machinery or flexing joints
- Structural noise
- Electrical noise
- Instrumentation noise

While developers will seek to minimise noise from their devices in operation, faults can significantly increase noise levels.

The noise study commissioned to inform the Scottish SEA indicates that the noise generated by an array of devices will depend on the geometry of the array, and more particularly on the spacing between devices.

Diagram 7.15: Comparison of Selected Anthropogenic Noise Source



Source: Vella, Gero. 2001. The Environmental Implications of Offshore Wind.

7.3.4.4 Electro-Magnetic Field (EMF)

Any electric current generates an EMF whose magnitude depends on the intensity of that current. Although electric fields can be contained within a cable envelop, magnetic fields emanate from the cable in a plane perpendicular to the axis of the cable (along which the electric field is directed) and have a magnitude that depends on the electric current in the cable and that decrease with the distance from the cable. Charged particles such as ions moving in a magnetic field induce an electrical field, whose magnitude depends that of the magnetic field and on the number of charged particles.

Most wave and tidal devices emit a small undersea EMF due to the generator. This EMF will be device specific and depend, for example, on the location of the power generating unit of the device within the water column. Little is known yet about the characteristics of this EMF.

EMFs are also generated by the inter-device and export cables and have magnitudes directly related to the intensity of the current circulating along cables. Inter-device cables collect power from all the devices of an array to collection points. Export cables connect collection points to shore, therefore transmit more power and generate EMFs of higher magnitudes than inter-device cables. Developers who answered the survey indicate that the EMFs generated by the cables may be of larger amplitude than those generated by the devices themselves.

It is noted that the EMFs generated by an array of devices will not only depend on the devices and cables used, but also on the design of the array itself. The spacing between devices and therefore cables will be a key issue as EMFs generated by closely spaced elements can interact to lead to a larger field.

7.3.5 *Summary*

Table 7.5 summarises the characteristics of the wave devices considered in this SEA. Table 7.6 summarises the characteristics of the wind and tidal devices considered.

Table 7.5: Summary of the Characteristics of Wave Devices Considered in the SEA

Device category		OWC shoreline	OWC nearshore/ offshore	Overtopping	Terminator	Attenuator	Point Absorber	Wave Rotor
Resource		**wave**						
Location	**Water Depth**	>4m, getting deeper rapidly	10-50m	50-80m	30-100m	50-80m	5-100m	10-15m
	In Water Column	Entire	Mainly at the surface (20m by 20m to 200m by 200m) + mooring (0.1km2 footprint) at the seabed					Mainly at the seabed
Installation	**Mooring Method**	Depends on seabed type and water depths.						
		Most widely used: anchors. Clump weights and gravity structures are also widely used.						Monopile
Maintenance	**Where**	On site				Mostly offsite		Device dependant
	Frequency	2 to 3 time a year						
	Duration	Between a few hours and 2 weeks.						
Environmental Impacts	**Noise**	Yes, during operation, but mostly during installation and decommissioning.						
	EMF	Mainly from power cable						
	Anode	Some do (Zinc and aluminium)						
	Moving parts in contact with water	None	None	Turbines	Hinges		Piston	Turbines
	Shrouded	N/A	N/A	N/A	N/A	N/A	N/A	N/D
	Anti-fouling	Most of them use some, but mainly non-toxic chemicals.						
	Hydraulic fluids	Yes, but biodegradable ones. Some use water as hydraulic fluid.						
Commercial scale array	**Extent**	20m by 500m (0.01km^2)	~2km^2	~6-8km^2	~2km^2			N/D
	Number of devices	100 turbines joined in 1 structure	20	8	20-50			N/D
	Power density	~1GW/km^2	~10MW/km^2	~9MW/km^2	10-25MW/km^2			N/D
Number in category (EMEC)		**13%**		**5%**	**22%**		**51%**	**10%**

Table 7.6: Summary of the Characteristics of Tidal and Offshore Wind Devices Considered in the SEA

Device category		Horizontal Axis Turbine	Vertical Axis Turbine	Oscillating Hydrofoils	Horizontal Axis Turbine
Resource		**tidal**			**wind**
Location	**Water Depth**	10-80m	10-40m	N/D	0-40 (100*)m
	In Water Column	Entire water column or seabed only.		Seabed only	Entire column
Installation	**Mooring Method**	Depends on seabed type and water depths.			
		Mainly monopile and gravity structures. Also anchors and clump weights.	Gravity Structures, anchors, clump weights.	N/D	Mainly monopiles
Maintenance	**Where**	On site	N/D	N/D	On site
	Frequency	Every 2 to 6 years	N/D	N/D	Yearly
	Duration	Between a few hours and 2 weeks.	N/D	N/D	2 weeks
Environmental Impacts	**Underwater noise**	Yes, during operation, but mostly during installation and decommissioning			
	Underwater EMF	Mainly from power cable			
	Anode	Some do (Zinc and aluminium)			
	Moving parts in contact with water	Turbines		Oscillating board	N/A
	Shrouded	Some	N/A	N/A	None
	Anti-fouling	Most of them use some, but mainly non-toxic chemicals.			
	Hydraulic fluids	Yes, but biodegradable ones. Some use water as hydraulic fluid.			N/A
Commercial scale array	**Extent**	Coastal: ~0.5 (0.1-1)** km^2; Offshore: 1-2km^2	N/D	N/D	50 (5-250)* km^2
	Number of devices	Coastal: 10 (5-20)*; Offshore: 50-100	N/D	N/D	~100 (25-350)*
	Power density	50-70MW/km^2	N/D	N/D	~10 (3-22)* MW/km^2
Number in category (EMEC)		**44%**	**19%**	**7%**	**N/A**

8 Resource Areas

8.1 Introduction

The aim of this chapter is to outline the energy resource availability from marine renewables (wave and tidal stream) and offshore wind within the offshore area around the coast of Northern Ireland to the territorial boundary, defined by 12 nautical miles (nm).

This chapter has three objectives:

- Provide an overview of the theoretical energy resource availability for Northern Ireland based on previous available research and data;
- Set out the technical constraints applied to each resource type with justifications for the limiting criteria; and
- Using Geographic Information System (GIS) based analysis to generate maps presenting spatial data for theoretical energy resource with specific 'technical' resource areas highlighted which merit further investigation.

This SEA follows previous resource assessments and uses five specific energy resource categories. These are presented in Table 8.1.

Table 8.1: Resource Categories and Definitions

Effect	Development Phase
Theoretical	Gross energy content for the Northern Ireland offshore area
Technical	Theoretical resource limited by existing technical limitations such as water depth and other parameters
Practical	Technical resource limited by marine conditions such as wave exposure, sea bed conditions, shipping lanes, military zones and disposal sites
Accessible	Practical resource limited by environmental constraints specific to each site.
Viable	Accessible resource limited by commercial constraints including development costs and market reward

This chapter focuses on the theoretical and technical resource. The practical, accessible, and viable resource is considered in Chapters 11 and 12 where the environmental constraints on development are considered.

Throughout this chapter, reference is made to "the study area", which is a defined region that covers the entire Northern Ireland offshore region from Lough Foyle in the northwest to Carlingford Lough in the southeast, extending out to the 12 nm limit.

8.2 Renewable Targets & Electricity Demand

In January 2008, the European Union (EU) committed to a binding target that 20% of the EU's energy consumption must come from renewable sources by 2020. The UK's contribution the EU target was set to increase from 1.5% in 2006 to 15% by 2020 (DECC, 2008).

DETI has set targets for electricity generation from renewables of 12% from renewable energy by 2012 with 15% of renewable electricity generation from non-wind sources, as of November 2008, current levels of renewable electricity generated for Northern Ireland is at 6% (DETI, 2008a). The 12% renewable electricity target for Northern Ireland is expected to be met through onshore wind, which is the most developed source of renewable power currently supplying the electricity transmission network.

In the DETI consultation document “A Draft Strategic Energy Framework for Northern Ireland 2009” (DETI 2009), the Department proposes that Northern Ireland should set a new strategic goal to increase the amount of electricity from renewable sources to 40% by 2020. While onshore wind will continue to be the main renewable energy source in meeting the electricity targets, it is hoped that offshore renewables can contribute to the 2020 targets and, as the technology continues to develop, to post 2020 targets.

As identified in the recently published Draft Strategic Energy Framework 2009, the proposed target for renewable electricity generation in Northern Ireland by 2020 is 40%, a proportion of which will come from offshore wind, tidal and wave power. Based on the DETI study undertaken to inform the draft Strategic Energy Framework the total energy demand for Northern Ireland is estimated to reach around 11,000 GWh by 2020, which equates to an installed capacity requirement of approximately 4000 MW. Therefore to meet the target of 40% by 2020, a total of 1,600 MW installed capacity would have to be met from renewable energy sources.

The current target for renewable energy in Northern Ireland is 12% by 2012. At present around 8% of energy generated in Northern Ireland is from renewables sources, the majority of which is generated from onshore wind. It is expected that onshore wind will continue to be the dominant source of renewable energy in Northern Ireland. However, there is significant potential for other sources of renewable energy to contribute towards achieving the targets, including offshore wind, wave and tidal power.

8.3 Offshore Wind Resource

8.3.1 Resource Overview

The UK Government has signalled that the offshore wind is the preferred technology to deliver a large proportion of additional electricity generating capacity required to meet the UK’s target of 15% renewables by 2020. The Draft Offshore Wind Plan, published by the Department of Energy and Climate Change (DECC) and subject to the UK Offshore Wind, Oil and Gas SEA (DECC, 2008), set an objective of further offshore wind licensing rounds to deliver an additional 25 gigawatts (GW) of generating capacity to the UK grid.

The first (R1) and second (R2) licensing rounds for offshore wind aim to deliver 8 GW of installed capacity by 2020, which as of June 2009 according to British Wind Energy Association (BWEA) statistics, only 0.5 GW is currently operational. However, the remaining 7.5 GW of R1 and R2 is either in construction, under consent review or in the planning stages (BWEA, 2009). R1, R2 and the third round (R3) aim to contribute a total of 33 GW (including the 25GW above) of offshore wind installed capacity for the UK by 2020.

In Northern Ireland, onshore wind projects account for around 280 (MW) of installed capacity, with over 1000 MW of installed capacity either under construction or in the planning stages. There are no offshore wind projects operating in Northern Ireland waters.

The Renewable Energy Resource Assessment as part of the All Island Grid Study (DETI, 2008 B), was published in 2008 (referred to as the “All Island Grid Study”) and jointly commissioned by DETI and the Republic of Ireland’s Department of Communications, Energy and Natural Resources (DCENR). The All Ireland Grid Study assessed six electricity generation portfolios as options for renewable energy delivery by 2020 and considered an upper limit of 1GW generating capacity of offshore wind for the whole of Ireland by 2020. An update to the study which included consideration into the impact of Demand Side Management measures was published in 2009.

Earlier estimations of offshore wind resource availability for Northern Ireland were published by Action Renewables (Action Renewables, 2004), in March 2004, which predicted that 500 MW of generating capacity was available offshore of Northern Ireland.

8.3.2 Data Sources

The following data sources have been used to establish the wind resource in the study area:

- UK Marine Resource Atlas
- Northern Ireland Wind Atlas

8.3.2.1 UK Marine Resource Atlas

In early 2007, DECC, formerly the Department for Business, Enterprise and Regulatory Reform (BERR) commissioned an update to the Marine Resource Atlas (MRA) with revised data from the original version published in September 2004 (BERR, 2008).

Over the last five years, the UK MRA has provided the government, academic and private sectors with a good understanding of marine renewable and offshore wind energy resource for the UK continental shelf area with the view of development.

The MRA atlas provides predicted wind speed and power data as outputs from the Met Office UK Waters Wave model for wind and wave. The Meteorological (Met) Office Wave model describes the offshore wind resource for the UK continental shelf and nearshore areas at a resolution of 12 km. However, the MRA atlas notes that predictions for shallow nearshore areas may not robustly describe coastal effects. Consequently nearshore areas around the Northern Ireland coast are not well resolved by the MRA data.

8.3.2.2 Northern Ireland Wind Atlas

Wind resource data has been mapped in more detail specifically for the Northern Ireland marine region up to the 12nm territorial boundary (and also beyond although not included in this SEA) and published through the DETI commissioned Northern Ireland Wind Atlas (referred to as the “Northern Ireland Wind Atlas”) in 2004 (DETI, 2004). Commercial wind power projects that use large turbines need a mean wind speed of at least 7.5 m/s or a mean power value greater than 500 watts per square metre, W/m^2 (DETI, 2004).

The method of generating resource data in the Northern Ireland Wind Atlas involved using the MesoMap system which is driven by the MASS (Mesoscale Atmospheric Simulation System) numerical weather model. For the offshore area, wind power and wind speed outputs were produced for heights of 50m, 75m and 100m at a grid spacing resolution of 200m. GIS files of contoured data for wind resource have been made available to this project and used to map the wind resource in the study area.

8.3.3 Theoretical Wind Energy Resource Summary

This study has used the DETI Northern Ireland wind atlas GIS data and focused on mean annual wind speed at 100m height as the primary parameter for the assessment of wind resource. This parameter represents the theoretical wind energy resource in the Northern Ireland offshore area. Theoretical offshore wind resource for Northern Ireland is presented in Figure 8.1.

The results of the Theoretical Wind Energy Resource study confirmed that Northern Ireland has a significant offshore wind resource. All of the Northern Ireland offshore area is predicted to have a mean annual wind speed of between 7.0 and 10.5 m/s at 100m height above mean sea level (MSL). Generally, wind speed is predicted to increase further offshore, which is primarily due to the prevailing westerly winds on the UK continental shelf being diminished after crossing the Northern Ireland landmass.

8.3.4 Technical Wind Energy Constraints

A detailed overview of the renewable sector technology is available in Chapter 7. However, in terms of technical constraints considered in developing offshore wind power, two parameters have been evaluated with threshold values in Table 8.2.

Analysis of the bathymetry shows that maximum water depth in the Northern Ireland marine region up to the 12nm territorial boundary limit is approximately 260m below chart datum. Currently, fixed foundation offshore turbines are deployed in up to 40m of water, although future technology will potentially increase this water depth. Floating offshore wind turbines offer the possibility for deployment in much deeper waters. The most advanced prototype of a moored ballast stabilised turbine is StatoilHydro Hywind project, located 10km offshore of Karmøy, Norway, which begins testing in autumn 2009. StatoilHydro make reference to floating devices that could theoretically be deployed in water depths of 120 to 700 m (StatoilHydro, 2009). However, it is recognised that the potential for development of deeper water areas may not take place until later than 2020 and that early stage developments are likely to pursue site selection based on economic criteria until such time as the deeper water installations become established. The technical resource both taking into account the 40 m depth limit, and with no depth limit has therefore been mapped. For the purposes of this SEA, the focus has been given to the potential for, and impacts of developing offshore wind using proven monopole technology within water depths of up to 40 m.

Table 8.2: Technical Constraints for Offshore Wind Energy Resource

Parameter	Constraining Threshold
Water depth m to chart datum (CD) approximately equivalent to Lowest Astronomical Tide (LAT)	No depth limitation applied
Annual Mean Wind Speed at 100m height a MSL (m/s)	> 7.0 m/s mean annual wind speed at 100 m height

8.3.5 Technical Wind Energy Resource Summary

Figure 8.1 demonstrates that the entire study area has a mean annual wind speed of greater than 7.0 m/s. When accounting for the available resource and lack of restrictions on water depth, a large area of technical wind energy resource is available for practical and accessible resource assessment. The influence of environmental constraints on exploiting this resource is described in Chapters 11 and 12.

8.4 Wave Energy Resource

8.4.1 Resource Overview

The wave climate of the west coast of the UK is dominated by the North Atlantic, with the Irish Marine Institute stating that the Republic of Ireland is generally regarded as having the best wave energy resource in Europe.

However, due to the more sheltered nature of the coast around Northern Ireland, the theoretical resource is significantly lower than that identified for the Republic of Ireland Atlantic coast and the west coast of Scotland. A report from PB Power, commissioned by Action Renewables of renewable resource in Northern Ireland in 2004, indicated that Northern Ireland was sheltered from the North Atlantic swell and concluded that the wave resource for Northern Ireland is negligible, and that this conclusion confirms those of earlier studies by the UK Energy Technology Support Unit, (ETSU, 1999).

This SEA chapter focuses on extracting wave energy from marine areas up to the 12nm limit, as although onshore and nearshore converters have been developed, offshore (up to 12nm limit) converters are considered to offer the most efficient capture of energy from waves.

To date no high-resolution modelling or mapping of the wave resource specific to the coast of Northern Ireland has been undertaken. This SEA draws on two projects that have mapped wave resource of the Irish coast and the MRA that offers regional scale wave resource data. In terms of spatial extent, these two studies provide a complete assessment of offshore wave energy resource for the whole of Northern Ireland.

8.4.2 Data Sources

The following data sources have been used to establish the wave resource in the study area:

- Wave Energy Resource Atlas of Ireland
- UK - Marine Resource Atlas

8.4.2.1 Wave Energy Resource Atlas of Ireland

The accessible Wave Energy Resource Atlas of Ireland was published in 2005 with the aim of providing a comprehensive assessment of wave power potential in the waters off the Republic of Ireland and Northern Ireland (referred to as Irish Waters). The report states that the bulk of the annual incident wave energy arriving on the Atlantic Irish coast approaches from sectors of 240° to 300° with 270° predominating, with little seasonal difference in directionality. The same report makes reference to the Irish Sea wave climate, demonstrating that swell arrives from all directions but predominantly from the south-west. The Irish Sea coast of the island of Ireland is sheltered from the north Atlantic swell, and generally exhibits north-south directionality, influenced by the prevailing tidal streams and fetch.

The wave atlas assessment was based on a combination of the widely used National Ocean and Atmospheric Administration model, WAM (Wave Analysis Model) forecast model and measurements from six recording buoys around the Irish coast, which provided outputs as wave power and significant wave height contoured around the coast of Northern Ireland.

8.4.2.2 UK - Marine Resource Atlas

The MRA atlas provides the only publicly available predicted wave resource data for the Northern Ireland offshore area. As with the wind resource data, the MRA provides wave power and significant wave height (Hs) as outputs from the Met Office UK Waters wave model for wind and wave. The Met office Wave model describes the offshore wave resource across the entire UK continental shelf at a resolution of 12 km. However, similarly with the MRA wind resource outputs, there are nearshore limitations due to resolution and the transformation of deepwater offshore waves to towards shallower nearshore areas.

8.4.3 *Theoretical Wave Energy Resource Summary*

Due to the lack of high resolution wave energy resource mapping around the Northern Ireland coast, outputs from the regional-scale MRA have been used. In addition, the Irish Accessible Wave Atlas provides wave power outputs for the Republic of Ireland coastline, which puts the Northern Ireland wave resource potential in context.

The parameter used to evaluate theoretical resource is annual mean wave power in kilowatts per metre of wave crest (kW/m). Unconstrained theoretical wave power for the whole of Ireland is represented in Figure 8.2.

Figure 8.2 demonstrates that the wave energy resource for the entire offshore area is generally low, in the range of 0 – 10 kW/m.

The greatest resource of wave energy in Northern Irish waters can be seen in the offshore area north of Londonderry, adjacent to the 12 nm limit, where a range of 10 – 20 kW/m annual mean wave power is predicted by the MRA output. This can be seen in context with the exposed nature of the Irish Atlantic coastline, where a range of 30 to 60 kW/m is predicted, and far offshore of the west coast of Scotland, where wave power of greater than 60 kW/m is predicted.

8.4.4 *Technical Wave Energy Constraints*

The theoretical wave resource energy available in the Northern Ireland offshore area is generally low throughout the entire study area, as described above. A technical resource constraint of 100 m depth has been applied to the area of greatest wave resource within the study area, offshore of Londonderry. However, as stated above, compared to wave resources elsewhere in the UK and Ireland, this wave resource is still relatively low.

8.5 Tidal Resource

8.5.1 *Tidal Energy Resource Overview*

Tidal resources can be divided into two types; tidal range and tidal stream. This SEA focuses on the potential availability of tidal stream resource in Northern Ireland waters.

The Sustainable Development Commission (SDC), published a detailed study of the UK tidal energy resource (SDC, 2007), (referred to in this SEA as “Turning the Tide Report”), and state that the UK has “an excellent tidal stream resource, one of the best in Europe". The UK is at the forefront of tidal stream development, with an array of devices or converters, highlighted in Chapter 7 of this SEA, that are still in the demonstration and testing phases.

It has long been known that certain areas of the Northern Ireland offshore area experience high velocity tidal streams. Strong tidal streams generally occur when powerful tidal flows are constrained by land, either through a narrowed seaway connecting two open bodies of water or through a tidal inlet to an enclosed sea lough.

The North Channel connects the Irish Sea to the open waters of the west coast of Scotland and tidal stream resource has been mapped in detail. The SDC’s Turning the Tide Report, highlights the Rathlin Island site in the North Channel area to be of significant tidal stream resource, ranked 9th greatest in the UK at 0.9 TWh/year of theoretical power.

An earlier study, commissioned by SEI, published as “Tidal & Current Energy Resources in Ireland”, assessed different resource types (theoretical, technical etc.) for the whole of Ireland for tidal stream resources. The total resource potential reported in this study is presented in Table 8.3.

Table 8.3: Tidal Stream Energy Potential (by Resource Category) – SEI report

Resource Category	Definition of Resource Category	Resource Total (TWh/yr) All Ireland	% Electrical Consumption (2010) All Ireland
Theoretical	Gross energy content between 10m depth contour and 12 nautical mile territorial limit	230	500
Technical	Theoretical resource limited by existing turbine support structure and to minimum current of 2.0 m/s	10.5	25
Practical	Technical resource limited by wave exposure, sea bed conditions, shipping lanes, military zones and disposal sites	2.6	6.3
Accessible	Practical resource limited by environmental constraints specific to each site. Constraint indeterminate at report stage	2.6	6.3
Viable	Accessible resource limited by commercial constraints including development costs and market reward	0.9	2.2

The SEI report, assessed in detailed the practical and viable tidal resource at 11 key sites around the entire coast of Ireland. Four of the 11 sites are located in Northern Ireland and are presented in Table 8.4. The SEI report provided details of viable energy resource estimates, with the five Northern Ireland sites representing a total of 530 GWh/year, or 58%, out of the total estimated viable resource of 930 GWh/year for the entire island of Ireland.

Table 8.4 – Tidal Stream Energy Potential for Northern Ireland based on SEI, 2004

Site Name	Viable Tidal Energy Resource (GWh/yr)
North East Coast	273
Lough Foyle	2
Ram Race - Copeland Islands	125
Strangford Lough	130
Total	530

Many of the open water sites such as the North Channel pose engineering challenges to developmental testing of converters as they are exposed to harsh marine conditions of wave and wind. However, the more sheltered tidal inlet, Strangford Narrows, which connects Strangford Lough to the Irish Sea, experiences high tidal current velocity and suitable water depths. For these reasons, a horizontal axis turbine type tidal stream converter was installed within Strangford Narrows in April 2008. The converter was named, SeaGen, and is owned and operated by a subsidiary of Marine Current Turbines (MCT), and is rated at 1.2 MW. The SeaGen is a commercial scale converter and delivers electricity to the grid, and is being tested over a five year period.

8.5.2 *Data Sources*

This SEA has made reference to three sources of data that quantify tidal energy resource:

- UK Marine Resource Atlas
- Marine Current Energy Study (which is incorporated into All Island Grid Study)
- North Channel and Irish Sea Tidal Resource Assessment

8.5.2.1 UK Marine Resource Atlas

The UK Marine Resource Atlas, revised edition published in 2008, which provides both mean spring and neap current flow, and for the entire UK continental shelf at 1.8km grid cell resolution.

8.5.2.2 Marine Current Energy Study

All Island Grid Study incorporated the findings of an earlier research study commissioned by DETI in 2003 (DETI, 2003) which specifically assessed the potential for the use of marine current (tidal) energy in Northern Ireland (referred to as the "Marine Current Energy Study"). The Marine Current Energy study provided tidal stream model outputs for spring tide peak current flows, at both the regional scale and at three targeted areas that were considered favourable for future development. A key objective of the Marine Current Energy study was to predict tidal stream using a purpose built series of hydrodynamic models of varying grid resolutions, and highlighted the following three areas for further study:

- Strangford Narrows: it was estimated that a total of 30MW installed capacity could be utilised, based on a 15m model resolution.
- Off Copeland Islands: where lower magnitude current flows were predicted, which could support between 27 MW and 45 MW installed capacity depending on economic factors, based on a 45m model.
- The north east (NE) coast of Northern Ireland, between Fair Head, past Tor Head to Runabay Head, very strong currents provide significant resource potential, based on a 100m model.

From Marine Current Energy study report, only output images of spring peak current flow are available, and no geospatial data could be obtained for this SEA.

8.5.2.3 North Channel and Irish Sea Tidal Resource Assessment

A tidal resource modelling study was also available for use in the SEA (Metoc Report No: 1843 REV 1, Client Confidential). The model output covers the north and east of Northern Ireland at a resolution of 1km^2, although it does not include the offshore area between Dundrum Bay to Carlingford Lough. However, previous tidal resource assessments have not highlighted this area as containing any potential tidal stream energy development sites.

Data was available for peak flood and peak ebb tidal current flows under both mean spring and mean neap conditions.

8.5.3 Theoretical Tidal Energy Resource Summary

Theoretical tidal energy resource is presented in Figure 8.3, based primarily on outputs from the Metoc hydrodynamic model of the North Channel and northern Irish Sea.

An average peak tidal current flow was used to describe the theoretical tidal energy resource. This parameter was derived from modelled output grids of peak flood current flows that were averaged between peak flows on mean spring and a mean neap conditions. The modelled flood tide output was used to represent peak flow, as marginally higher flows were predicted than during the ebb tide.

As with previous assessments of tidal resource, the main areas of greatest current flow within the study area, can be seen in the North Channel where averaged spring/neap peak tidal flows are in excess of 2 m/s.

8.5.4 *Technical Tidal Energy Constraints*

The technical constraints considered in developing tidal power are presented in Table 8.5. Tidal energy converters typically require a minimum water depth of 20m. An upper operating depth of 80 m has been set, to account for future technology developments that will allow converters to be sited in deeper areas, either in terms of fixed foundation or future floating structures.

Table 8.5: Technical Constraints for Tidal Energy Resource

Parameter	Constraining Threshold
Water depth m to chart datum (CD) approximately equivalent to Lowest Astronomical Tide (LAT)	20 – 80 m
Peak Current Flow (Flood Tide) averaged between peak flood flow on a mean spring and mean neap tide	>1 m/s

8.5.5 *Technical Tidal Energy Resource Summary*

Figure 8.3 shows the defined areas that meet the criteria set out in Table 8.5. The main concentration of technical resource is in the North Channel around and to the south of Rathlin Island. The bathymetry of the North Channel drops quickly away below the 80m contour, which acts to constrain the theoretical resource available there. An area to the east of Copeland Islands is also highlighted as a technical resource area, which is consistent with the Marine Current Energy Study.

Figure 8.3 also presents several additional isolated resource areas, situated further offshore, where individual grid cells of the analysis could meet the technical criteria.

Due to the relatively coarse resolution of the model output available for this SEA (1km grid cell spacing), narrow tidal channels and inlets were not well resolved in terms of water depth, such as Strangford Narrows. As stated in section 8.5.2.2, Strangford Narrows is obviously a highly energetic environment that meets the minimum 20m water depth requirement and the minimum >1 m/s flow criteria.

8.6 Identification of Resource Zones

The Resource Zones are the areas within the study area that have been identified as having greatest potential for development based on the following factors:

- Development parameters (offshore wind, wave and tidal) discussed in Chapter 7 and summarised below.
- Areas of theoretical resource based on the information presented in this chapter (Chapter 8).
- Feedback from individual developers on current and possible future areas of interest for offshore wind, wave or tidal developments.
- Review of current development patterns taking into account technical feasibility of where development is likely to occur.

These different sources of information were compiled and reviewed. This helped to balance out the information in particular where there were notable gaps in the information on the theoretical resource available, for example for certain parts of the study area and resource types (wave) or where detailed data from geospatial models was not available due to licensing/ownership rights.

8.6.1 *Development Parameters*

The development parameters used to assist the identification of the potential resource zones are presented in Table 8.6 below.

Table 8.6: Development Parameters

Development/Operational Parameters		Wind	Tidal	Wave
Average Water Depth		15m to 100m	30 to 70m	Up to 100m
Approximate MW/km^2		10	50	10
Average Turbine/Device Generating Capacity		5 MW	1 MW	0.5 MW to 5 MW
Average Scale of Commercial Development	MW	300 MW	50 MW	30 MW
	Km^2	30km^2	1km^2	3km^2

8.6.2 *Consultation with Offshore Wind and Marine Renewable Energy Developers*

A meeting was held in July 2009 with a number of offshore wind and marine renewable energy developers in Belfast. The main focus for this meeting was to consult on the proposed areas that had been identified as potential resource zones for inclusion within the SEA. Comments received on the initial resource zones that were presented were taken into account in the preparation of the final resource zones used as the basis for the main assessment.

8.6.3 *Resource Zones*

In total eight resource zones were identified as part of this SEA. Based on the information that was available the only area where there is an overlap in the potential resource available for all three type of technology is off the North Coast. Elsewhere the main areas of resource tend to be relatively disparate as illustrated in Figure 11.1 and summarised in Table 8.7 below.

Table 8.7: Resource Zone Areas

Technology	Resource Zone	Location
Wind	Wind Resource Zone 1	North Coast
Wave	Wave Resource Zone 1	North Coast
Tidal	Tidal Resource Zone 1	North Coast
Tidal	Tidal Resource Zone 2	Rathlin Island and Torr Head
Tidal	Tidal Resource Zone 3	Maiden Islands
Tidal	Tidal Resource Zone 4	Copeland Islands
Tidal	Tidal Resource Zone 5	Strangford Narrows
Wind	Wind Resource Zone 2	East Coast

9 Baseline Environment

9.1 Introduction

The following chapter provides a description of marine and coastal environment of Northern Ireland with respect to the specific SEA topics listed in Chapter 1: Introduction. The information presented within this chapter is based purely on current available information and data sources. No additional survey or monitoring work has been undertaken as part of this SEA except for site visits undertaken as part of the seascape assessment.

Information presented within this chapter has been obtained from a range of different sources. These sources are listed below in respect to the relevant SEA topics. It should be noted that the datasets that have been included and referenced in this SEA have been closely reviewed for their appropriateness at this strategic level of assessment. Consequently, some of the datasets that have been made available for this SEA may not have been referenced specifically within this SEA.

The main reasons for the exclusion of a dataset include:

- Data being in a raw or un-interpreted format and therefore not being suitable for reference in a desk based study;
- Data being of a very high level of detail and therefore not being appropriate for a strategic level assessment (although the data is likely to be required at a more project specific level for the purposes of EIAs and other consenting requirements);
- Data being very specific to a particular part of the study area (where appropriate this data will have been used as part of the resource zone assessment, however, it should be noted that most of the area specific data that was made available was also very detailed and therefore not easy to apply at a strategic level. Again it is likely that this data will be very important for project level assessments e.g. EIAs.

It should also be noted that for some topics there are recognised gaps in the baseline data that is available. These gaps were identified at the scoping stage. Where appropriate and practical some of the gaps were filled for the purpose of the SEA, mainly the acquisition of the Shipping Density Data from Anatec. However, due to the scale of the study area, the nature of the data gaps that exist (e.g. some data acquisition would require significant modelling or survey work) and the timescale that would be involved in the collection of necessary data (e.g. from a couple of months to a few years), it was agreed, through consultation at the SEA scoping stage that it would not be practical or appropriate to fill all known data gaps as part of this SEA.

Where data gap do exist these have been identified and options for addressing these data gaps are discussed in Chapter 14: Plan and Project Level Mitigation.

In addition to listed the main data sources this chapter also provides a description of the current baseline conditions and characteristics (description of the baseline) and identifies key issues and future trends.

The information presented within this chapter has been used to inform the assessment of the individual resource zones for offshore wind, wave and tidal (Chapter 11) and the assessment of cumulative effects associated with varying levels of development (Chapter 12).

9.2 Water and Soil (Sediment)

9.2.1 Geology, geomorphology and Sediment Processes

9.2.1.1 Data Sources

- United Kingdom Hydrographic Office (UKHO) digital data
- Joint Irish Bathymetric Survey (JIBS) data
- JNCC Coastal Directories Series: Region 17 Northern Ireland (1997)
- The Geology of the Malin - Hebrides sea area; The geology of the Irish Sea (BGS UK Offshore Regional Reports)
- Technical reports on seabed and geology from BERR SEA 6 & 7
- BGS chart data and GIS data
- SSSI designations for geology; Sites of geological interest (NIEA)
- The Geology of Northern Ireland - Our Natural Foundation
- University of Ulster surveys

9.2.1.2 Baseline Description

Bathymetry

Bathymetry is a key factor in the siting of marine devices, which will have optimal water depth ranges within which they can operate.

Northern Ireland borders the Irish Sea to the east, the North Channel to the northeast and the Malin Sea to the north. The bathymetry off the northeast coast of Northern Ireland is dominated by the North Channel, the strait separating eastern Northern Ireland from southwest Scotland.

The Irish Sea is one of the smaller regional seas, about 58,000 km2 in area. In character, it has the form of a fairly shallow basin, with depths ranging from 20-100m over considerable areas, but with a deeper channel, exceeding 100m, extending north to south in the western part of the Irish Sea which reaches a maximum depth of 315m in North Channel. This deeper channel connects with the Celtic Sea via St George's Channel in the south, and with the Malin Sea which fronts the north coast of Northern Ireland through the North Channel.

The seabed shelves relatively gently off the southeast coast of Co. Down with overall gradients of approximately 0.17° to the southeast and water depths of about 100m at the 12nm limit. Seabed gradients increase off the northeast coast of Northern Ireland in the area of the North Channel, where overall gradients are approximately 0.45° towards the northeast. The centre of the North Channel lies at approximately the 12nm limit, where isolated deeps occur up to 284m. The axis of the North Channel runs approximately 5km to the north of Rathlin Island, where the seabed shelves relatively steeply with overall gradients of 3° and a maximum depth of about 240m. West of Rathlin Island, off the northeast coast of Donegal, the overall seabed gradient is relatively gentle, and approximately 0.29° to the north. An overview of the bathymetry of the study area is given in Figure 9.1.1.

The Joint Irish Bathymetric Survey (JIBS), conducted in 2007 and 2008 provides full-coverage multi-beam bathymetry data within the 3 nautical mile coastal strip from Fanad Head (Co. Donegal) to Torr Head (Co. Antrim) combined with an intensive grab sampling programme. The JIBS data provides detailed, high resolution bathymetry for this part of the study area, as well as valuable information about physical and biological habitats, althouth the interpreted dataset was not available in time to inform this SEA. The data plotted in Figure 9.1.1 is the lower resolution UK Hydrographic office bathymetry data.

Marine and Coastal Geology

The geological environment can be divided according to main groupings of material, based on age and geological processes;

- Bedrock geology - these are rocks older than 1.8 million years old formed before the last ice age
- Drift (Quaternary) geology - these are rocks deposited since the start of the last ice age and are from 1.8 million to 10,000 years old
- Seabed Sediments - these represent the youngest materials and formed from reworking of either the solid and Quaternary material, river inputs of sediments or the creation of new material such as biogenic shells

Bedrock Geology

The onshore geology of Northern Ireland is very diverse and is described in detail in "The Geology of Northern Ireland - Our Natural Foundation" (GSNI, 2004). Many of the rock units found onshore are also present offshore but the distribution of the rock types is quite different. Onshore the upland areas are dominated by hard rocks that are relatively resistant to erosion – the older Dalradian metamorphic rocks in the Sperrins, the basalts of the Antrim Plateau and the granites of the Mourne Mountains. Onshore rock units may extend several kilometres offshore from the coastal areas but most of the offshore area is underlain by less resistant sedimentary rocks – mostly Permo-Triassic mudstones and sandstones. In the areas off the north coast of Northern Ireland (Malin Sea and North Channel) rocky outcrops of basaltic rocks are locally significant.

The bedrock is relevant to the design and siting of seabed installations and, where these rocks occur close to the seabed, they may also exert control over sedimentary processes and affect both physical and biological habitats at the seabed.

Drift (Quaternary) Geology

The Quaternary Period has seen dramatic changes in climatic conditions leading to rapid changes in sea level and episodes of extreme glacial erosion and deposition. These processes, acting on the existing bedrock and superficial sediments, are largely responsible for the gross bathymetry of the offshore area. The distribution and thickness of glacial and glaciomarine deposits is very variable, ranging from areas of exposed bedrock to narrow glacially-eroded basins infilled with up to 300 metres of glacial sediment. These offshore glacial deposits can also have great variability both in size and composition of material. In certain areas the near-surface parts of these deposits have been reworked during the Holocene.

The nature of the Quaternary deposits is relevant to the design and siting of seabed installations and, where these rocks occur close to the seabed, they may also exert control over sedimentary processes and affect both physical and biological habitats at the seabed.

Seabed Sediments

The seabed around Northern Ireland can be divided into areas of net erosion and deposition (BGS, 1995). In areas of net erosion, where the sediments overlay Quaternary sediments or older bedrock, the thickness of the active seabed sediment layer is usually less than 2 metres, and there may be relict inactive bedforms formed at times of lower sea level. In areas of net deposition, banks of sand waves and megaripples can reach 30 to 40 m in height.

The areas of thin seabed sediments are usually composed of gravelly sand whereas sand wave complexes (e.g. between Malin Head and Rathlin) can be more sand-dominated (BGS, 1993).

A few areas of mud deposits also occur in the area further offshore from Dundrum Bay and extending across a wide expanse between the Isle of Man and the Irish coast (the Western Irish Sea mudbelt, BGS, 1995). An overview of the seabed sediment characteristics in the study area is given in Figure 9.1.1.

Seabed sediments, and the marine sedimentary processes of erosion, transport and deposition that control their distribution, character and thickness, are relevant to the design and siting of seabed/near-seabed renewable energy installations. Seabed installations can have potentially significant effects on these marine sedimentary processes.

9.2.1.3 Key Issues and Future Trends

Whilst certain types of seabed development such as capital and maintenance dredging, and marine installations may result in localised changes to marine sedimentary processes and seabed sediments, there is no evidence to suggest any general long term trends in marine geology.

The main issues affecting geomorphology are related to the interaction between the energy within coastal seas and the processes of erosion, transport and deposition. Climate change could cause an increase in frequency of extreme weather events. The intensity of storm events could impact associated wave heights and the energy within coastal seas, which in turn would affect erosion rates. As such, future trends are difficult to predict.

9.2.2 Sediment and Water Quality and Contamination

9.2.2.1 Data Sources

Available water and associated environmental quality data includes information on:

- Bathing water quality data (Northern Ireland Environment Agency, NIEA 2009). Data for faecal indicator organisms originating from domestic and farm effluent.
- Classification of shellfish harvesting areas (Food Standards Agency, FSA 2009). Shellfish waters are classified primarily on the basis of the presence of pathogenic organisms, but are also monitored for potentially toxic chemical parameters (heavy metals, chlorinated hydrocarbons, petrochemicals). All of the designated shellfish waters in Northern Ireland are enclosed, with access to the sea.
- Northern Ireland, regional report of the National Marine Monitoring Programme (Marine Pollution Monitoring Group, MPMMG, undated). Data for contaminants in seawater and sediments, from four offshore monitoring sites in Northern Ireland waters. These are representative of Atlantic Water, Western Irish Sea Water, mixed water from the North Channel and the outflow to Belfast Lough. In addition there are a number of monitoring sites within Belfast Lough.
- A Review of the Contaminant Status of the Irish Sea (Centre for Environment, Fisheries and Aquaculture Science, CEFAS 2005). Background information discussing the main sources of contaminants present in the Irish Sea.
- Quality Status Report 2000 Region III Celtic Seas, Chapter 4, Chemistry (OSPAR 2000)

9.2.2.2 Baseline Description

Sediment Quality and Contamination

Sediment quality across the study area is generally good, which reflects both the lack of proximate sources of contamination and the energetic nature of the marine environment in the waters of Northern Ireland.

Trace metal (Arsenic (As), Copper (Cu), Chromium (Cr), Cadmium (Cd), Mercury (Hg), Nickel (Ni), Lead (Pb), Zinc (Zn)) data reported in MPMMG (undated) indicates a lack of anthropogenic influence for sediments taken from all offshore monitoring sites. The absolute concentration of metals in the deeper water area between the Isle of Man and Northern Ireland is relatively high. This reflects a higher proportion of clay minerals in the sediments of this region, due to the low tidal energy in this area favouring sedimentation. By contrast Cd and Hg are both enriched in the inner waters of Belfast Lough, reflecting historical industrial inputs. Levels of trace metals in the coastal sediments of Northern Ireland are given in Table 9.1.

Table 9.1: Trace metals in the Coastal Sediments of Northern Ireland

	Al (%)	Organic carbon (%)	As (mgkg-1)	Cu (mgkg-1)	Cr (mgkg-1)	Cd (mgkg-1)	Hg (mgkg-1)	Ni (mgkg-1)	Pb (mgkg-1)	Zn (mgkg-1)
Belfast Lough	3.85	0.63-1.43	7.9	27.1	102	0.52	0.22	32.5	52	130.00
Off Belfast Lough	1.81	1.49	8.8	9.1	26	<0.06	<0.05	10.4	16.3	34.20
Dundrum Bay	6.6	1.62	9.3	18.0	91	<0.06	0.10	30.3	51.5	139.00
North Channel	1.92	1.69	11.3	4.5	31	<0.06	<0.05	11.5	11.2	27.10
North Coast	0.76	1.24	7.9	2.2	14	<0.06	<0.05	3.5	8.6	9.00

Source: MPMMG undated

Non-naturally occurring organic contaminants (e.g. polychlorinated bi-phenyls, PCB, and organo-chlorine pesticide residues) are generally close to or below detection limits at all the offshore monitoring sites. The only substance with consistently detectable concentrations was lindane (γ-HCH) within Belfast Lough; however, concentrations are not considered high enough to cause concern as they remain well with the UK environmental quality standards (MPMMG, undated).

There are a number of active licensed dredging spoil dumping sites off the coast of Northern Ireland (Figure 9.1.2). The extent to which these could be a measurable source of contamination depends on the nature of the spoil and the quantity. Licenses for the disposal of dredged material at sea limit the permitted contaminant loads for such material to levels which will not cause harm to the marine environment (NIEA 2009). Quantities of material deposited at the dumping sites over the past five years have been relatively small, and in the dynamic environment of the Northern Irish coastline fine material (which contains the contaminant load) is rapidly dispersed.

Table 9.2: Spoil Dumping at Open Sites 1985 – 2007

Site Designation	Site name	1985-2007	2002-2007
		Tonnes (dry weight)	Tonnes (dry weight)
IS 591	Belfast	1026532	117594
IS 620	Portavogie	941	0
IS 650	Kilkeel	100910	12813
IS 671	Warren Point	161367	114631
MA 501	Lough Foyle B	101172	54961
MA 545	Portstewart Bay B	1323220	69035

Source: CEFAS 2009

Radionuclide contamination in the sediments of the Irish Sea and adjacent waters have been studied extensively (CEFAS 2005). Discharges from Sellafield in Cumbria enter the eastern Irish Sea, and are transported northwards, through the North Channel, either in dissolved (e.g.Caesium-137) or particulate form (e.g. Plutonium and Americium isotopes). In both cases there is a sedimentary reservoir, but Caesium is readily released, while Plutonium and Americium are strongly associated with solid particles. Various studies by the Scottish Environmental Protection Agency (SEPA) and the UK Atomic Energy Authority (UKAEA) state that there is no environmental or human risk due to these discharges of radioactive materials outside the immediate vicinity of the Sellafield outfall.

It should be noted that the Radiological Protection Institute of Ireland (RPII) has been unable to report any health risks to the Irish population arising from Sellafield discharges. Elevated levels of artificial radionuclides are largely restricted to the eastern sector of the Irish Sea, in the immediate vicinity of Sellafield. However, there are also relatively high concentrations in sediments from the deeper waters between Northern Ireland and the Isle of Man, off Dundrum Bay. This is a result of the depositional environment in the basin between the Isle of Man and the Irish coastline which results in a relatively high proportion of fine material in the sediment.

Military waste may be present on the sea bed as a result of:

- Intentional disposal (official and unofficial).
- Live firing ranges and naval exercise areas.
- Wrecks of military vessels and some merchant ships.
- Minefields
- Migration from the original deposition site

The distribution and density of exploded and unexploded munitions (‘explosive ordnance’) on the sea bed varies depending on the history of the area – for example whether it has been used for warfare, naval training, disposal or weapons testing (Crown Estate 2006).

The deep water trough between Northern Ireland and south-west Scotland (Beaufort’s Dyke) was used as a dumping ground for military munitions between World War II and the 1970’s. During this period approximately 1,000,000 tonnes all types of munitions, including 14,500 tonnes of phosgene artillery shells and possibly fuses and detonators, were deposited. While the dumping site itself is outside the study area there is a potential risk of material migrating from the site.

In addition, throughout the study area there is a risk of encountering munitions associated with wartime wrecks, both of military and merchant vessels and of military aircraft (Scottish Executive 2007). In general, the risk of munitions contamination is somewhat less in the vicinity of wrecks than for dump sites, since the munitions still tend to be enclosed and immobile within the wrecks; however, munitions may have been thrown clear of the vessel as it sank, or may become exposed as the wrecks gradually break up.

While munitions during transport (including storage in ships’ magazines) are inherently safer than those which have been armed but failed to detonate (e.g unexploded bombs or shells retained in guns when a vessel sank) they may still constitute a hazard. While the positions of some wrecks are known exactly, those of others, particularly in deeper waters, are less well known (Qinetic 2007). There is also a risk of the presence of unexploded mines. It should be assumed that the North Cannel and adjacent waters are potentially at risk from unswept mines left over from the two world wars (Qinetiq 2007).

Water Quality and Contamination

The main sources of contamination to the waters of the study area are some distance away. Any contaminants in Northern Ireland’s water are therefore considerably diluted, compared to the main source areas, centred on the highly populated industrial centres of the North West of England and the Clyde. In addition there has been a marked decrease in inputs from these areas over the latter part of the 20th Century. Therefore, while there is evidence for increases in contaminant concentration with the decreasing influence of North Atlantic Water, there are no offshore sites which approached Environmental Quality Standard concentrations.

Bathing beaches are sampled for faecal indicator organisms, the presence of which is indicative of locally sourced contamination. With the exception of two urbanised beaches, one at the entrance to Belfast Lough (Ballyholme) and one on Dundrum Bay (Newcastle) all of Northern Ireland's 24 bathing beaches have consistently been rated either good or excellent over the period 2006 to 2008 (NIEA 2009). The rating of the two beaches which failed to meet the standards required is based on an unacceptably high concentration of bacteria (coliforms and streptococci) derived from domestic or agricultural sources in more than 20% of samples taken during each year. In each case adjacent beaches have been rated as good or excellent, indicating that the contamination is very localised.

FSA has consistently classified all of the Northern Irish Shellfish waters as either Class A (shellfish suitable for human consumption) or Class B (suitable for human consumption after a period of cleansing) (FSA 2009). While these classifications are based on the levels of pathogenic organisms in shellfish from the sites they are an indicator that there is a low level of contamination at such sites.

Artificial radionuclides, primarily from Sellafield on the Cumbrian coast, are detectable in the water column. However, their contribution to overall radiation levels is not significantly above the natural background (CEFAS 2005).

Table 9.3: Trace Metals and Organic Contaminants in the Coastal Waters of Northern Ireland in Seawater

Location	THC (ug/l)	PAH (ug/l)	PCB (ng/l)	Ni (ug/l)	Cu (ug/l)	Zn (ug/l)	Cd (ng/l)	Hg (ng/l)	Pb (ng/l)
Belfast Lough	bdl	bdl	bdl	<50-75	0.66-0.80	<2.5-2.53	<35	nd	<750
Off Belfast Lough	bdl	bdl	bdl	0.55	0.70	3.70	30	nd	<750
Dundrum Bay	bdl	bdl	bdl	0.62	1.80	6.60	46	nd	3600*
North Channel	bdl	bdl	bdl	0.65	0.85	2.90	35	nd	<750
North coast	bdl	bdl	bdl	<50	<0.65	<2.50	<35	nd	<750
EQS (current)	na	na	na	30	5	40	500	na	25000
EQS (revised)	na	na	na	15		10			10000

Source MPMMG undated

* Abnormally high result identified by MPMMG as being the result of possible contamination during sampling

9.2.2.3 Key Issues and Future Trends

Over the last decade, coastal water quality has improved dramatically as a result of the application of full treatment to sewage discharges, improved treatment of industrial effluents, and work to reduce diffuse pollution. The Northern Ireland Environment Agency (NIEA) is currently managing estuarine and coastal waters through River Basin Management Plans (RBMPs) to achieve good ecological status (GES), or good ecological potential for heavily modified water courses by 2015, as required under the Water Framework Directive (WFD), and to ensure no deterioration in water quality. Marine fish farming has expanded in extent and economic value, but has been managed and controlled to minimise its impact.

9.3 Biodiversity, Flora and Fauna

9.3.1 Protected Sites

9.3.1.1 Data Sources

In assessing protected sites within the study area, the following data sources have been used:

- World Heritage Sites (United National Educational Scientific and Cultural Organisation)
- Existing and proposed protected sites (Special Areas of Conservation (SACs), Special Protected Areas (SPAs), Areas of Special Scientific Interest (ASSIs), Ramsar Sites, Marine Nature Reserves (MNRs), National Nature Reserves (NNRs), Areas of Outstanding Natural Beauty (AONB)) (Northern Ireland Environment Agency (NIEA))
- NIEA Protected areas and biodiversity pages (NIEA 2009a and 2009b)
- Report from WWF and Ulster Wildlife Trust on marine reserves in Northern Ireland (Thurston *et al*. 2008)

9.3.1.2 Baseline Description

Although only 650km in length, the coasts and seas around Northern Ireland support a great diversity of marine wildlife and habitats. In recognition of this fact, more than 75% of the coastline is protected under a range of national, European and International legislation. Existing coastal protected sites in the study area are show on Figure 9.2.1 and summarised in Table 9.4.

International Sites

- Ramsar sites – wetlands of international importance designated under the Ramsar Convention on Wetlands (1971) – e.g. Belfast Lough
- World Heritage Sites – designated by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) – e.g. Giant's Causeway and Causeway Coast

Ramsar sites were originally intended to protect sites of importance for wildfowl habitat, but now this designation can be applied to a site which qualifies under any aspect of wetland conservation. The Convention recognises that wetlands are extremely important for biodiversity conservation in general and for the well-being of human communities. Six Ramsar sites with a coastal component are located in the study area.

The only World Heritage Site in Northern Ireland is The Giant's Causeway and Causeway Coast. It is a site of outstanding value and was designated as a World Heritage Site by UNESCO in 1986 in recognition of its geological and geomorphological values, its history of scientific study and its exceptional landscape values[13]. The site occupies approximately 70ha of land, and encompasses a further 160ha of sea along the North Antrim Coast (NIEA 2009a).

World Heritage Sites are not statutory designations, and their Management Plans have no statutory basis but are implemented within the context of local, regional, national and international policies (Environment and Heritage Service 2005). However, the Management Plan for the Giant's Causeway and Causeway Coast provides an agreed framework for the sustainable management of the site, and operates under 24 management objectives. The last of these, is to review the site boundary by 2010. Current proposals indicate that the site would be further extended offshore, although the size of any extension is not currently known.

[13] Giant's Causeway and Causeway Coast is designated under criteria (i) *is an outstanding example representing major stages of the earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features* and (iii) *it contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance*

European Sites

- Natura 2000 Sites – which include Special Areas of Conservation (SAC) designated under the Habitats Directive (92/43/EEC) and Special Protection Areas (SPA) designated under the Birds Directive (79/409/EEC) – e.g. Rathlin Island, classified as both SAC and SPA

Natura 2000 is a European network of protected sites which represent areas of the highest value for natural habitats and species of plants and animals which are rare, endangered or vulnerable in the European Community. As part of the designation, Member States are required to ensure that appropriate steps are taken to avoid the deterioration of habitats, and habitats of species, as well as significant disturbance of the species. The Conservation Objectives safeguard the habitats of the site, the range, numbers and supporting habitats of the qualifying species.

A total of six SACs and ten SPAs are located within the study area. These are listed in Table 9.4, and further detail is given in Appendix B. Potential SPAs (pSPAs) have also been identified for Belfast Lough Open Water and Copeland Islands (for details see Appendix B). These sites are likely to receive full designation in 2009/2010.

National Sites

- Marine Nature Reserve (MNR) – designated under the Wildlife and Countryside Act 1981 – Strangford Lough.
- National Nature Reserves (NNR) – designated under the Amenity Lands Act (Northern Ireland) 1965 – e.g. Strangford Lough
- Areas of Outstanding Natural Beauty – originally designated in Northern Ireland under the Amenity Lands Act (Northern Ireland) 1965, AONBs are now designated under the Nature Conservation and Amenity Lands Order (Northern Ireland) 1985 – e.g. Antrim Coast
- Areas of Special Scientific Interest – designated under the Nature Conservation and Amenity Lands (Northern Ireland) 1985 – e.g. Lough Foyle

Marine Nature Reserves (MNRs) are designated to conserve marine flora and fauna and geological features of special interest. However, the mechanism for designation was onerous and consequently only three are designated in the UK, one in Northern Ireland: Strangford Lough. This site is extremely important for marine and coastal habitats and species and consequently also qualifies for designation as a Ramsar site, NNR, SAC, SPA, AONB and ASSI.

National Nature Reserves (NNRs) are selected on the basis of best examples of wildlife, habitats and geology and their designation is a public recognition by Government of their importance. There are 16 NNRs designated with a coastal component within the study area. Further detail on these is given in Section 9.6.

Areas of Outstanding Natural Beauty (AONBs) are designated to protect and enhance the qualities of large areas of landscape of distinctive character and special scenic value. Of the nine AONBs in Northern Ireland, six have a coastal component, and are therefore located within the SEA study area.

Areas of Special Scientific Interest (ASSIs) (the equivalent to Special Sites of Scientific Interest in England, Wales and Scotland) have been developed as a national suite of sites providing statutory protection for the best examples of the UK's flora, fauna, geological or physiographical features. They are also used to underpin other national and international nature conservation designations. Within the study area, there are 24 ASSIs with a coastal component, or adjacent to the coast.

A summary of all the protected sites to be found in the study area is given in Table 9.4 and Appendix B.

Table 9.4: Summary of Protected Sites in the Study Area

County	Site Name	Designation							
		International		European		National			
		Ramsar	WHS	SAC	SPA	MNR	NNR	AONB	ASSI
ANTRIM	Antrim Coast			X	X			X	
	Ballycastle Coalfields								X
	Carrickarade								X
	Giant's Causeway		X				X	X	X
	Kebble						X		
	Larne Lough				X				X
	Portmuck								X
	Portrush						X		X
	Ramore Head & the Skerries								X
	Rathlin Island			X	X				X
	Runkerry								X
	Sheep Island				X				
	Torr Head								X
	White Park Bay								X
DOWN	Ballymacormick Point								X
	Ballyquintin Point						X		
	Belfast Lough*	X			X				X
	Carlingford Lough**	X			X				X
	Cloghy Rocks						X		
	Copeland Islands								X
	Craigantlet Woods								X
	Dorn						X		
	Granagh Bay						X		
	Killard						X		X
	Killough Bay	X			X				X
	Lecale Coast							X	
	Mourne							X	
	Murlough			X			X		X
	Outer Ards	X			X				X
	Quoile Pondage Basin						X		
	Strangford Lough	X		X	X	X	X	X	X
LONDONDERRY	Ballymaclary						X		
	Bann Estuary			X					X
	Binevenagh							X	
	Lough Foyle	X			X				X

County	Site Name	Designation							
		International		European		National			
		Ramsar	WHS	SAC	SPA	MNR	NNR	AONB	ASSI
	Magilligan			X			X		X
	Roe Estuary						X		
TOTAL = 68 designations		6	1	6	10***	1	14	6	24

Source: JNCC (2009), NIEA (2009b)
* Belfast Lough is part in County Down, part in County Antrim** Carlingford Lough is part in County Down, part in County Armagh. ***in addition, 2 pSPAs have also been identified.

Although Northern Ireland's coastal and marine waters have an abundance of sensitive and important species, only 4% of the territorial waters are subject to some form of protection (Thurston *et al.* 2008). NIEA are currently in the process of identifying sites for designation as marine SACs and SPAs, and extending existing coastal AONBs and SPAs into offshore areas.

9.3.1.3 Key Issues and Future Trends

Some of the key issues include, but are not limited to:

Habitat destruction – destructive fishing methods combined with other extractive activities such as dredging, impacts directly on habitats and the species they support.

Decrease in resilience – the multiple stresses affecting the marine habitats and species effects their ability to recover from disturbance. As a result, ecosystems are less resilient to invasive species and are less likely to recover and adapt to the impacts of climate change.

Increased protection – NIEA is currently identifying marine areas of European importance for designation under the Habitats and Birds Directives (offshore SACs and SPAs). Under the planned Northern Ireland Marine Bill additional Marine Conservation Zones (MCZ) for the protection of nationally important marine habitats and species will be introduced. These sites would include a range of possible levels of protection including highly protected marine sites.

Possible areas for designation as marine SAC or MCZ that are currently under consideration include the Skerries (for reef habitat and sandbank caves), Red Bay (for sandbank habitats and maerl), Maidens Islands (for reef habitat) and the Copeland Islands. These sites are not confirmed, but have been taken into account when assessing the impacts of wind, wave and tidal installations.

9.3.2 Benthic and Intertidal Ecology

9.3.2.1 Data Sources

In assessing benthic and intertidal ecology within the study area, the following data sources have been reviewed:

- Northern Ireland Habitat Action Plans
- Technical reports on benthos from the DTI Oil and Gas SEAs for Areas 6 & 7.
- Northern Ireland Sublittoral Survey 1980's. Sublittoral survey NI 2006-2008
- Mapping European Seabed Habitats (MESH) Project GIS maps
- Northern Irelands' Priority Species and Species of Concern list (National Museums Northern Ireland 2006-7)
- B9 Energy Offshore Developments Ltd and Renewable Energy Systems Ltd: draft and unpublished data from environmental assessment studies

9.3.2.2 Baseline Description

Benthic ecology is the flora and fauna living in, on or closely associated with the seabed. The European Habitats Directive describes in Annex I habitats that require designation as SACs for their protection and conservation. Table 9.5 list those Annex I habitats which are known to be present in Northern Ireland's waters, and the UK biodiversity action plan priority habitats which are likely to be found in these areas.

There are currently three SACs in Northern Ireland for which benthic ecology is either the primary reason for designation or is a qualifying feature (Rathlin Island, Murlough and Strangford Lough). In addition to this, a number of additional marine sites are currently under consideration for their benthic ecology, as described in Section 9.3.1.2.

Further to this, the possibility that currently unrecorded benthic habitats and species may also exist in areas outside of those already designated or under consideration for designation cannot be ruled out.

Table 9.5: Protected Marine and Coastal Habitats

SAC Feature	UK Biodiversity Action Plan priority habitat types likely to be found within the relevant SAC feature
Sublittoral Habitats	
Sandbanks which are slightly covered by seawater at all times	Maerl beds Sublittoral sands and gravels Seagrass beds
Large shallow inlets and bays*	Maerl beds Tidal rapids Mudflats Sheltered muddy gravel Seagrass beds
Estuaries	Maerl beds Tidal rapids Mudflats
Reefs*	*Modiolus modiolus* beds *Sabellaria spinulosa* reefs
Intertidal and Coastal Habitats	
Coastal lagoons*	Saline lagoons
Mudflats and sandflats not covered by seawater at low tide*	Mudflats Seagrass beds
Submerged or partially submerged sea caves*	-
Annual vegetation of drift lines	Coastal saltmarsh
Salicornia and other annuals colonising mud and sand	Coastal saltmarsh
Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)	Coastal saltmarsh
Reefs*	*Sabellaria alveolata* reefs *Mytilus edulus* reef Littoral chalk

* denotes priority habitats

The benthic environment of Northern Ireland's coastal and offshore waters is rich and varied, Intertidal habitats comprise muddy habitat on sheltered coasts and sea loughs, exposed and sheltered rocky shores characterised by a very diverse community, and sandy shingle and gravel shores. Subtidal habitats comprise sheltered mud occurring mainly in sea loughs, subtidal sand habitats offshore the north coast, subtidal gravel and cobble habitat which is mainly found in Strangford Lough and the Ards Peninsula, Lecale and the Mourne Coast, and rocky habitat characterised by bedrock or boulders colonised by kelp beds.

Detail is provided below on the most prevalent fully marine priority habitats that are known to occur in the study area. This information has been extracted from the Northern Ireland Habitat Action Plans (NIEA, 2009c). The benthic ecology of the study area is shown on Figure 9.2.2.

Tidal Rapids Priority Habitat

Areas of tidal rapids are widespread in the study area and are most commonly found within the entrances to sea loughs and between or around islands where accelerated tidal streams are found. This habitat type is characterised by rich under-boulder communities comprising sponges, hydroids, ascidians and bryozoans. Extensive beds of *Alaria esculenta* and *Saccorhiza polyschides* are often present, in association with encrusting fauna such as *Tubularia* spp. and *Verruca stroema*. Animals such as sunstars and *Corynactis viridis* that are normally found only in the subtidal are often found in the intertidal parts of tidal rapids. Tidal rapids are found at the following locations within the study area:

- Strangford Narrows
- Entrance to Carlingford Lough
- Dundrum Channel
- Killough harbour mouth
- Maiden Islands
- Entrance to Larne Lough
- Between Barney's Point and the Magheramourne spoil tip
- Outer coast of Rathlin Island
- Entrance to Lough Foyle between Greencastle and Magilligan Point
- Outer coast of the Skerries

Strangford Narrows, at the entrance to Strangford Lough is mostly comprised of tidal rapids, with rich communities found on the shores either side and also on the many shallow rocky areas found within the channel.

Maerl Beds Priority Habitat

The term maerl is used to describe several species of calcified marine algae which grow as unattached nodules on the seabed. Maerl is slow-growing, but over long periods its dead calcareous skeleton can accumulate into deep deposits, overlain by a thin layer of pink, living maerl. In favourable conditions maerl can form extensive beds and frequently supports a rich community of associated flora and fauna. Maerl beds typically develop in sheltered conditions where there is some tidal flow but may also develop in more open waters where wave action is sufficient to remove fine sediments, but not strong enough to break or disperse the brittle maerl branches. Maerl beds are known to occur at various locations around the coast of Northern Ireland. Two maerl beds are known to occur in Strangford Lough. Extensive beds have also been reported at Garron Point and Ballygally Head. Scattered mearl has been recorded form a number of other sites including Church Bay, Ringfad Point, Cushendun Bay and Carlingford Lough.

Sabellaria Spinulosa Reefs Priority Habitat

The polychaete worm *Sabellaria spinulosa* inhabits tubes made of sand grains cemented together. Over most of its distribution, the worm is solitary, attached to pebbles or stones, but in certain locations it can form reefs up to several metres across and 60cm deep. When found in reefs or crust form, the species provides structure for other organisms in the form of crevices and shelter. Only a few reefs of *S. spinulosa* have been identified around Northern Ireland. The most important known site is in Lough Foyle, offshore of Magilligan Strand, on low lying pitted bedrock outcrops in mobile sand. A wide range of species were recorded associated with the reef. Two other sites are recorded from the Marine Nature Conservation Review (MNCR) as occurring at Rinnagree Point near Portstewart and at Portstewart Point. The occurrence of *Sabelllaria spinulosa* has also recently been confirmed for these areas as part of baseline surveys for an Environmental Assessment (draft and unpublished data from environmental assessment studies).

Sublittoral Sands and Gravels Priority Habitat

This habitat takes in a range of physical environments, from sheltered gravels to mobile sandbanks and is a very common nearshore benthic habitat in Northern Ireland's waters (see Table 9.6). Sublittoral sands and gravels can be characterised by a range of community types. Key benthic communities known to inhabit the sublittoral sands and gravels within the study area are summarised in Table 9.6 below.

Table 9.6: Sublittoral Sand and Gravel Habitat Descriptions

Area	Key habitat type
Lough Foyle	Flat rippled sand *Mytilus edulis* beds
North Coast	Flat rippled sand *Sablellaria spinulosa*
Rathlin Island	Infralittoral coarse sediment Barren sand or gravel Circalitoral fine sand or circalittoral muddy sand Cobbles or pebbles on sand or gravel Circlittoral mixed sediment Hydroids and bryozoan turf with pebbles
Torr Head	Hydroid and bryozoan turf/pebbles and cobbles Thick turf of foliose algae on boulders and cobbles Medium to large boulders and bedrock dominated by *Flustra* plus tall, often thick hydroid turf
North East Coast	Consolidated pebbles and or cobbles on sand or gravel Pebbles and cobble amongst maerl Medium to large boulders – *Flustra* often thick hydroid turf Boulders and cobbles with interstitial gravel, pebbles and sand Short faunal turf, encrusting corallines and bare rock
Belfast Lough	Hydroid and bryozoan turf *Flustra* on pebbles and cobbles
Strangford Narrows	Pebbles and/or cobles on sand and/or gravel
East Coast	Coarse sediment and gravel Small to medium sized boulders with interstitial gravel, pebbles and sand Hydroids and bryzoans Medium to large boulders and bedrock dominated by *Flustra* plus tall often thick hydroid turf.

Source: extracted from MESH and NI Sublittoral Surveys

A variety of sublittoral sand habitats are found in Northern Ireland ranging from clean mobile sand to fine muddy sand. There are two significant areas of near-shore deposits, one along the northern coast and the other along the coast of County Down. The north-coast deposit extends eastwards from Lough Foyle along the Antrim coast and includes the Magilligan Foreland beach-ridge plain, on the north-east shore of the Lough.

One of the most important areas of sand habitat is reported to be in Outer Church Bay, Rathlin Island. This area has been recorded as being very stable and undisturbed and supports some of the most important sand communities in Northern Ireland.

Plains of highly mobile, soft, clean, well-sorted sand are present on the north coast. They are often thrown into megaripples in deep water, but are usually more gently rippled in shallow water. The sand is inhabited by shoals of the sand eel *Ammodytes*, and it has been suggested that it supports very little other life. The Hermit Crab *Pagurus bernhardus* and juvenile flatfish are the only other conspicuous species present. Large areas of rippled sand are found extending from the shore into deep water on the northern coast off Magilligan Strand in Lough Foyle, and around the Skerries at Portrush. Much of the north Antrim coast and parts of Lough Foyle - especially the main channel where the currents are strong - also contain this habitat (Erwin *et al*. 1986a).

Clean, firm, rippled sand with Sea Potato *Echinocardium cordatum* is present in a number of bays around the coast and is most frequent on the north coast and in Dundrum Bay. Associated with *E. cordatum ,* though not so frequently recorded, are the burrowing brittlestar *Amphiura brachiata* and the crab *Corystes cassivelaunus*. A number of bays and sea loughs also contain clean, fine sand with characteristic worm piles of *Arenicola marina*.

Sand is also present as muddy, fine sand, which can support beds of the sea pen *Virgularia mirabilis* in association with the burrowing brittle stars *Amphiura chiajei* and *Amphiura filiformis*. Muddy fine sand also supports extensive Common Mussel *Mytilus edulis* beds in Lough Foyle and Dublin Bay prawn *Nephrops novegicus* populations in the deep water off Kilkeel and Newcastle. It should be noted that this habitat blends into a mud in deep water habitat, for which a separate habitat action plan exists.

On Northern Ireland's exposed coasts where well sorted medium and fine sands occur, subject to frequent wave action or tidal currents, the community is often typified by polychaete worms such as *Nephytys cirrosa* and isopods such as *Bathyporeia* spp.

Where coarse sand occurs, it can develop into sand-wave formations which normally supports a highly impoverished infauna typified by small opportunistic *capitellid* and spionid polychaete worms and isopods (*Pontocrates arenarius*, *Haustorius arenarius* and *Eurydive pulchra*). This community type is adapted to living in a highly perturbed environment. The epifauna in these locations is characterised by mobile predators such as crabs (*Carciunus maenas* and *Liocarcinus* spp.), hermit crabs (*Pagurus bernhardus*), whelks (*Buccinum undatum*) and occasionally sand eels (*Ammodytes* spp.).

In contrast, where sand occurs mixed with cobbles and pebbles and is exposed to strong tidal streams, the community is often characterised by conspicuous hydroids (*Sertularia compressina* and *Hydrallmania falcata*) and bryozoans (*Flustra foliacea* and *Alycyonidium diaphanum*). These fauna increase the structural complexity of this habitat and may provide an important microhabitat for smaller fauna such as amphipods and shrimps. Examples of this community are found in Lough Foyle.

In places where sands or gravels occur in sheltered or deeper waters which are relatively stable, diverse marine habitats are found. These may support a wide range of anemones, polychaetes, bivalves, amphipods and both mobile and sessile epifauna. Clean stone gravel habitats are recorded from Strangford Narrows and Church Bay (Rathlin Island) which are characterised by the sea anemones *Halcampa chrysanthellum* and *Edwardsia timida*, associated with hydroid/bryozoan turfs and red seaweeds.

Extensive beds of gravel are found in a number of areas off the Northern Ireland coast. They tend to occur where strong tidal currents or wave action prevent the deposition of finer material. Most gravel beds are in water deeper than 10m, where boulder slopes inshore give way to gravel plains. In many cases these beds are circalittoral and animal dominated. Where they occur in the infralittoral, the communities present vary considerably depending on the composition of the gravel, the strength of the tide and the level of wave exposure (Erwin *et al.* 1986a).

Gravel habitats have been recorded from the north-east coast, north of Garron Point. The gravel beds here are generally in 15 to 20m of water and are clean, with little mud. Gravel is also present in Strangford Lough with an extensive area of coarse sand at the entrance to the Lough. Infralittoral beds of gravel are concentrated at the north end of the Narrows, in Marlfield and Ballyhenry bays and south of Dunnyneil Island. These are mostly muddy gravel with some cobble and pebble and shell debris and are dominated by the red algae *Stenogramme interrupta* (Erwin *et al.* 1986a).

Mud Habitats in Deep Water Priority Habitat

The largest area of mud deposits in Northern Ireland lies off the east coast and extends across a wide expanse between the Isle of Man and the Irish coast. Hardly any circalittoral mud is present on the North Coast (Barne *et al*. 1997). The presence of strong tidal streams, even at depth, prevents the establishment of this habitat in much of Northern Ireland waters.

Surveys of the Irish Sea mud patch by DARD, found that the deeper sites from the western Irish Sea are dominated by the burrowing crustacean *Calocaris macandreae* and the heart urchin *Brissopsis lyrifera*, while the shallower eastern side is dominated by the starfish *Asterias rubens* and more mobile taxa such as the swimming crab, *Liocarcinus depurator*.

Dublin Bay Prawn (*Nephrops norvegicus*), which is invariably associated with deep mud, has been recorded off Kilkeel and Newcastle at depths of between 26 and 39m, which probably represents the fringes of the Irish Sea *Nephrops* fishery.

Beds of the seapen *Virgularia mirabilis* have been recorded during the Northern Ireland Sub-littoral Survey (NISS) (Erwin *et al*., 1986b) in Carlingford Lough, Strangford Lough, Dundrum Bay and also off Cranfield Point where the beds were found in 20 to 25m of water in an area of firm sand. The shallow mud flats in the upper reaches of Carlingford Lough recorded the most extensive populations of *V. mirabilis* at between 1 and 5m depth. Deeper populations have been recorded from Strangford Lough, including parts of the Quoile Estuary. The burrowing brittle stars *Amphiura filiformis* and *A. chiajei* were also present within this area (Erwin *et al*. 1986b).

Mud habitats in deep water are used by several Northern Ireland priority species including the the sea pen *Virgularia mirabilis*, rugose squat lobster *Munida rugosa* and the sea cucumber *Ocnus planci.*

Modiolus Modiolus Beds Priority Habitat

The horse mussel *Modiolus modiolus* is a long lived (frequently living to 25 years or more) slow reproducing marine bivalve mollusc which can aggregate together to form a hard substratum in what would usually otherwise be a sedimentary area. They accumulate sediment of silt, organic rich faeces and pseudofaeces, and shell debris, forming raised beds, bound together by a matrix of byssus threads and horse mussels. In this way, they can significantly modify the habitat, forming biogenic reef structures which can be colonised by a wide variety of organisms. The bysuss threads secreted by *M. modiolus* have an important stabilising effect on the seabed, binding together living *M. modiolus*, dead shell and sediment.

The Strangford Lough Ecological Change Investigation (SLECI) (Roberts *et al*., 2004) found a total of 272 species living on or in the *M. modiolus* beds in Strangford Lough, including the variegated scallop Chlamys varia, queen scallop *Aequipecten percularis*, black brittlestar *Ophiocomina nigra*, common brittlestar *Ophiothrix fragilis* and the rugose squat lobster *Munida rugosa*. Large mussel beds are known to occur in Strangford Lough and there is an extended bed off the Millisle/Ballywalter coastline. Smaller areas occur in Carlingford Lough and inside the Skerries at Portrush.

9.3.2.3 Key Issues and Future Trends.

Sources of contamination, or seabed disturbing activities such as trawling, dredging and development, can all impact directly or indirectly on benthic communities, removing or destroying habitats. Whilst MESH provides a comprehensive overview, there are still data gaps in some areas. These data gaps are recognised in terms of the scope of this SEA. However, in order to inform assessments (e.g. EIAs) for individual developments, further surveying may be required to generate a greater understanding of potential effects on benthic habitats in hotspots for development.

In order to identify the location of key sensitive benthic habitats which, under the Habitats Directive, may warrant protection more detailed, study area wide (NI study area) monitoring or surveying programmes may be required. However, this is beyond the scope of this SEA.

NIEA is currently considering possible sites for designation as offshore SACs on the basis of their benthic ecology. This will increase the protection afforded to the designated sites, thus reducing potential for marine development to adversely impact benthic ecology in these areas.

9.3.3 Fish and Shellfish

9.3.3.1 Data Sources

In assessing fish and shellfish within the study area, the following data sources have been used:

- Information on nursery and spawning grounds from CEFAS (Coull *et al*. 1998)
- Northern Irelands' Priority Species and Species of Concern list (National Museums Northern Ireland 2006-7)
- DARD/MFA fisheries statistics (MFA 2009)
- Position statement on sharks, skates and rays in Northern Ireland waters (Agri-Food and Biosciences Institute 2009)

9.3.3.2 Background

Fish can be divided into two main categories, pelagic and demersal. Pelagic fish are those that live in the mid-water, often in shoals, such as herring and mackerel. Demersal fish are those that live at or close to the bottom. Some, such as the flatfish and ray, are more associated with the seabed while others such as the cod-like fishes forage in a layer that can be several tens of metres above the seabed.

Both pelagic and demersal species can make extensive migrations between spawning and feeding grounds. Migrations are usually revealed by tag, release and recapture experiments and although they indicate broad scale movements, they do not provide information on migration pathways. Pelagic fish species also undertake diurnal vertical migrations, which means they may occupy all depths in the water column at some point during the day; herring and Atlantic mackerel for example, can both descend to 100m, where depth allows.

Most finfish have pelagic eggs which, on hatching, pass through larval and post-larval stages before metamorphosing into the adult form. The eggs and larval stages drift with the currents and their ultimate destination will depend on factors such as the location of the spawning area, the currents and the duration of the larval stage. The metamorphosed juveniles may remain dispersed or they may aggregate on nursery grounds. Examples of the latter are herring, sprat and whiting in sea loughs or sheltered coastal areas and plaice in the intertidal zone of sandy beaches.

Therefore, for any assessment of the effects of wave, tidal or wind devices on fish, it is necessary to consider all life history stages that often differ quite considerably between species. Another consideration, is the mobility of the species at each of their life history stages and hence their ability to avoid potentially harmful devices.

9.3.3.3 Baseline Description

Northern Ireland's coastal waters are home to approximately 100 species of regularly occurring marine fish. This includes the basking shark, the second largest fish in the world. Several of the species present in the study area are listed on the International Union for Conservation of Nature (IUCN) (the World Conservation Union) Red List of Threatened Species (e.g. common skate, cod and haddock), and some are also UK Biodiversity Action Plan (UKBAP) species (e.g. the basking shark). In fact, there are 21 species of bony fish and 15 elasmobranch species listed as priority UKBAP species. Whilst they don't all have individual species action plans, their inclusion on the list means that actions have to be taken to maintain their current range and abundance.

None of the coastal or marine SACs in Northern Ireland area designated for the protection of marine fish or shellfish, although the North Antrim Coast SAC supports the only known living population of narrow-mouthed whorl snail (*Vertigo angustior*) (an Annex II species under the Habitats Directive) in Northern Ireland.

Analysis of fisheries statistics (2003 – 2008) from the Marine and Fisheries Agency (MFA) provides a good indication of the type of species present in the study area. It should be noted that this does not provide a definitive guide to the finfish and shellfish in the area and the levels of catch do not correspond directly to community structure. However, as many of the species found in the waters of Northern Ireland are commercially exploitable, it does serve as a useful indicator. The Irish Sea has been divided into a number of rectangles by the International Council for the Exploration of the Sea (ICES), which are used to report fisheries statistics. The study area of the SEA lies across ICES rectangles 36E3, 36E4, 37E3, 37E4, 38E4, 39E2, 39E3 and 39E4.

The most commonly caught species in the ICES blocks are given in Table 9.7. Approximately 85 speceis are caught within these ICES blocks, with catch dominated by *Nephrops*, herring (*Clupea harengus*), crabs, scallops, cod (*Gadus morhua*), spurdog (*Squalus acanthias*) and haddock (*Melanogrammus aeglefinus*). Demersal (bottom-dwelling) fish species are dominated by cod, and pelagic species dominated by herring.

Table 9.7: Commonly Caught Finfish and Shellfish

Demersal	Pelagic	Molluscs	Crustaceans
Cod Spurdog Haddock Skates and Rays Hake Conger Eels	Herring Sprat Mackerel	Scallops Queen scallops Mussels Whelks	Nephrops Crabs

Source: MFA (2009)

Data is also available regarding the spawning and nursery grounds within the study area (Coull *et al.* 1998). This data is of low resolution, but gives an indication of the type of species found in the waters around Northern Ireland. Spawning grounds which overlap with the study area occur for seven commercially important species (cod, herring, *Nephrops*, plaice, lemon sole, sprat and whiting); whilst there are nine nursery grounds (for cod, herring, haddock, mackerel, *Nephrops*, lemon sole, plaice, saithe and whiting).

There is evidence of 17 species of elasmobranch in Northern Ireland waters, 6 species of ray and 11 species of shark. The slow growth rates, late maturity and small litter characteristics of many elasmobranchs render them among the most vulnerable marine fish. Consequently, a number of elasmobranch species present in Northern Ireland waters are considered endangered and included on the IUCN Red List. This species group is therefore one of particular sensitivity to impacts of marine development. High sensitivity species present in Northern Ireland include common skate, white skate, spotted ray and spurdog.

Since 2000 there have been 60 records of basking shark (*Cetorhinus maximus*) sightings off the coast of Northern Ireland (IWDG). The main areas where basking sharks have been seen are Rathlin Island, Co. Antrim; Portrush, Co. Antrim; St. Johns Point, Co. Down; and Belfast Lough and Strangford Lough, Co. Down. The Ulster Wildlife Trust basking shark project 2004, funded by the Northern Ireland Environment Agency (previously Environment and Heritage Service), carried out a dedicated line transect survey for basking sharks during the summer. The survey observed five basking sharks in 2002 but none in 2003 or 2004 (Ulster Wildlife Trust 2006).

In recognition of the biodiversity which is found in Northern Ireland, the Northern Ireland Biodiversity Group developed a list of priority species (which require conservation action) and species of conservation concern (SOCC) which require monitoring because they may need conservation action in the future. The list comprises 457 Northern Ireland SOCC, 271 of which have been selected as priority species as they are considered to be under particular threat and require specific conservation action. This list covers species from algae, to vascular plants, to molluscs, fish, birds and mammals (National Museum Northern Ireland 2006-2007).

Twelve species of fish are identified on the list, seven of which are priority species. The priority species of fish and crustaceans known to be found in coastal and estuarine locations are discussed in more detail in Table 9.8.

Table 9.8: Priority Fish and Crustacean Species within the Study Area

Species Name	Conservation Information	Distribution description
Basking Shark (*Cetorhinus maximus*)	Population size: unknown. Endangered on North East Atlantic (NEA) IUCN Red List1; on Appendix 11 of CITES and Appendix 1 and 11 of the Bonn Convention on Migratory Species. Subject of a UK Species Action Plan (pub. 1999) Protection for the species being considered under review of Wildlife (Northern Ireland) Order 1985.	Most likely to be seen in coastal waters May – September. The sea around Rathlin Island, and waters off Strangford Lough are areas where basking sharks are regularly seen.
Common skate (*Dipturus batis*)	Classed as Critically Endangered on NEA IUCN Red List 2006 In 1977 the Irish Specimen Fish Committee (all-Ireland remit) removed the common skate from the list of eligible species in order to discourage capture and killing of large individuals by anglers.	Found occasionally throughout Northern Ireland coastal waters, especially on the north coast. Until 1960s species was abundant – Strangford Lough was famous for large skate (>2m long, 90kg mass). Since then, common skate rare in the Irish Sea, though less scarce off the north coast.
Allis shad (*Alosa alosa*)	The status of allis shad in Northern Ireland is unknown and requires urgent investigation. Listed as a UK priority species, there is also a UK Species Action Plan (pub. 1995) Irish Red Data Book1 classified as vulnerable.	Found in lower reaches of rivers and in estuarine and coastal waters. Spawning takes place from May – June but it is not known if spawning has ever occurred in Northern Ireland. Species has been recorded in Lough Foyle.
Twaite shad (*Alosa fallax*)	The current status of twaite shad in Northern Ireland is unknown and requires urgent investigation. The species is listed as UK priority species. A UK Species Action Plan was published in 1995. Irish Red Data Book1 classified as vulnerable.	Species have been recorded in Lough Foyle, Belfast Lough and the County Down coast. It's preferred habitat is estuarine or coastal waters, and it spawns from May – June when it comes into the lower reaches of rivers.

Species Name	Conservation Information	Distribution description
Smelt (*Osmerus eperlanus*)	A rare species, classified as Vulnerable in the Irish Red Data Book2.	Smelt have been recorded in Lough Foyle, Larne Lough and Belfast Lough. They are found in shallow coastal and estuarine waters. In lower reaches of rivers and estuaries, they can be seen during spawning (February – March)
A hermit crab (*Cestopagurus timidus*)	A rare species which has a possibly declining population, which has no legal protection.	Known at only two sites in Northern Ireland, both on Rathlin Island. Found in intertidal and shallow sublittoral muds and soft sands, especially in/around eelgrass and algal beds.
Rugose Squat Lobster (*Munida rugosa*)	Widespread in Northern Ireland, the species has no legal protection. Populations are thought to have declined due to habitat loss.	Found throughout the Northern Ireland coast in intertidal habitats to ~100m depth, on muddy/sandy areas with stones and rocks. Can be seen throughout the year. Northern Ireland holds >50% of the total Ireland population.
Crawfish (*Palinurus elephas*)	A priority species on account of its scarcity and decline. It has no legal protection, but is covered by fisheries regulations administered by Fisheries Division of DARD(NI).	Known only from Rathlin Island area and one other site on the north coast. Inhabits subtidal rock faces, and rocky seabed. Can be seen throughout the year.
A crab (*Atelecyclus rotundatus*)	Although it is widespread in Northern Ireland and part of the Republic of Ireland and UK, it is likely that Northern Ireland holds the majority of sites and population in an all-Ireland context. The species is listed as declining and this is due to habitat loss. There is no legal protection for this species of crab.	A round crab found in numerous locations around the Northern Ireland coast, including: Bann Estuary, Portush Skerries, Rathlin Island, Copeland Islands and at the entrance to Strangford Lough. Mainly found in shallow sublittoral sands and gravels to depths of over 300m, throughout the year.
A crab (*Inachus leptochirus*)	Listed as a priority species because of the importance of the population and the possibility of it declining due to habitat loss. There is no Species Action Plan or other legal protection for this crab.	A small spider crab found in sublittoral areas of the Northern Ireland coast in habitats of mud and muddy sands. Found at numerous sites, including Rathlin Island, Red Bay and Strangford Lough.

Source: National Museum Northern Ireland (2006-7)

[1]The Northeast Atlantic IUCN Red List, refers to a report (*The Conservation Status of Northeast Atlantic Chondrichthyans*) of the IUCN Shark Specialist Group produced at the Northeast Atlantic Regional Red List Workshop (13-15 Feb 2006)

[2]The Irish Red Data Book lists species whose continued existence is threatened in Northern Ireland. It is a national publication of the IUCN (International Union for the Conservation of Nature and Natural Resources) international list.

In addition to the priority species of fish and crustaceans listed in Table 9.8 above, the study area is also known to support priority species of molluscs (e.g. fan mussel and flat oyster), sponges, cnidaria (e.g. anemone species and sea pen), bryozoa (e.g. a rose coral) and echinoderms (e.g. sea cucumbers, northern starfish and purple sunstar).

Migratory Species

Diadromous fish species, such as Atlantic salmon (*Salmo salar*), sea trout (*Salmo trutta*), allis and twaite shad and eel (*Anguilla anguilla*), spend part of their lifecycle in fresh water and part at sea. Salmon and sea trout spawn in fresh water and then migrate to sea to mature, while eel mature in freshwater and reproduce at sea. These species occur within the study area as there are a number of rivers which flow out to sea and are known to contain populations (Barne *et al*. 1997). These include:

- The Foyle, Faughan, Roe, Lower Bann, Bush and Glensheak rivers along the North Coast
- The Glendun, Glenariff and Glenarm rivers along the north east coast
- The River Lagan which flows into Belfast Lough
- The Moneycarragh, Shimna, Annalong and Kilkeel along the south east coast
- The White Water, Cassy Water and Newry rivers which flow into Carlingford Lough

The degree to which these areas are sensitive to interaction with renewable energy development will change depending on the species and time of year. Shad, for example, feed in estuaries before moving upstream to spawn (April – July). Salmon, however, leave their river homes in spring and early summer, and migrate towards feeding areas in the Nordic Seas and West Greenland. In contrast, sea trout are more likely to remain in nearshore waters rather than undergoing extensive migrations. For eels, peak migration takes place on the increasing tides in April and May (DTI 2009).

9.3.3.4 Key Issues and Future Trends

Some of the key threats to fish populations include, but are not limited to:

Over-fishing – stocks for some commercially important species are being fished at unsustainable levels. Recreational fishing is also a concern in particular localities where mature individuals are targeted.

By-catch and discards – some fisheries are partially non-selective and consequently catch non-target species (by-catch). This extra catch is often discarded (thrown back over the side), especially if the fish do not have a commercial value, are under-sized or over quota.

Habitat destruction – offshore and coastal developments can lead directly and indirectly to habitat destruction either through removal of habitat or smothering of benthic communities.

Common Fisheries Policy Reform – The Common Fisheries Policy which determines fisheries policy for all quota species is due to be reformed by 2012, and it is anticipated that policy reform will aim to include measures to achieve the long-term ecological sustainability of fisheries.

9.3.4 Birds

9.3.4.1 Data Sources

In assessing birds within the study area, the following data sources have been used:

- Seabird vulnerability in UK waters (JNCC 1999)
- SPA sites (NIEA 2009a; JNCC 2009)
- NIEA Biodiversity pages (NIEA 2009b)
- Important Bird Areas (Skov *et al*. 1995)
- Northern Irelands' Priority Species and Species of Concern list (National Museums Northern Ireland 2006-7)

9.3.4.2 Background

Birds are very mobile and for this reason, accurate assessments of their temporal and spatial distribution are difficult to make, particularly offshore. Assessments have been made largely from the available information on SPAs and Important Bird Areas (IBAs) which indicate the areas that area of greatest importance for seabird populations, whether that be for wintering or migratory populations or important breeding grounds.

9.3.4.3 Baseline Description

The study area contains nationally and internationally important seabird populations of a large number of species of seabird. These are protected under the EC Birds Directive, through the establishment of SPAs, for the conservation of breeding, migrating and wintering birds. There are 14 SPAs designated in Northern Ireland, ten of which have a marine component and are designated for the protection of breeding seabirds. For example Strangford Lough supports 19.5% of the all-Ireland breeding population of common tern, 13.5% of the all-Ireland population of sandwich tern and 8.4% of the all-Ireland breeding population of Arctic tern. The locations of coastal seabird populations, based on JNCC surveys are given in Figure 9.2.3. In addition to the 10 SPAs designated, two sites for potential SPAs (pSPA) at Belfast Lough Open Water and Copeland Islands have also been identified. It is expected that these will receive formal designation in 2009/2010. A full description of all SPAs and pSPAs which overlap with the study area is provided in Appendix B.

Work is also currently underway by the JNCC and the four country nature conservation agencies[14] to identify further SPAs with marine components that will comprise a suite of entirely marine SPAs. Sites that are currently being considered for designation include:

- Seaward extensions of existing designated (SPA) seabird colonies. At present this appears likely to be restricted to within a few kilometres of breeding sites
- Offshore aggregations of seabirds
- Important feeding locations for particular species

In addition to designated SPAs, BirdLife International has identified a network of sites – Important Bird Areas (IBAs), at a biographic scale, which are critical for the long-term viability of bird populations (Skov *et al*. 1995). The areas, which are selected because of the bird numbers and species they hold, are particularly important for species which congregate in large numbers. Although the sites are not afforded any statutory protection, they do serve as a useful indication of which areas of UK waters are of particular importance to seabirds. Sites within the study area with a coastal component are outlined in Table 9.9.

Table 9.9: Important Bird Areas in the Study Area

Name of site	Description	Importance
Antrim Plateau	An extensive upland plateau that supports fine remnant semi-natural oak woodlands and is drained by fast-flowing streams. Human activities include commercial peat extraction.	The area supports a typical assemblage of upland bird species.
Belfast Lough	A sea lough with an area of tidal mudflats reduced in size by development. The outer shores are mainly rocky with a few sandy bays.	The IBA is important for wintering waders and wildfowl, with man-made lagoons in the Inner Harbour holding the main wader roost.
Carlingford Lough Including Green Island	The IBA comprises a narrow sea lough with significant expanses of mudflat and saltmarsh, and several small rock and shingle islands. Mountains surround the lough.	The IBA is important for breeding terns (*Sternidae*) and wintering waterbirds.

[14] Council for Nature Conservation and the Countryside, the Countryside Council for Wales, Natural England and Scottish Natural Heritage

Name of site	Description	Importance
Dundrum Inner Bay	The IBA covers an enclosed sandy bay with extensive mudflats, which is fed by four small rivers.	
Killough Harbour and Coney Island Bay	The IBA comprises a small estuary with tidal mudflats and shingle banks.	The site is important for wintering waterbirds.
Lough Foyle and River Foyle	A large shallow estuary comprising extensive mudflats, shell ridges, Mytilus beds, low-lying reclaimed farmland and limited areas of saltwater marsh.	The IBA is internationally important for wintering wildfowl and waders.
Lough Neagh and Lough Beg	The IBA comprises shallow waterbodies with associated damp grassland, reedbed Phragmites, islands, fen and pasture. Lough Neagh is the largest UK freshwater lake, with water levels subject to erratic, artificial change.	The IBA is important for wintering *Anatidae*. It holds 100,900 wintering waterbirds on a regular basis.
Outer Ards Peninsula	The IBA covers a section of the flat, east-facing shoreline of the Irish Sea, and contains rocky outcrops, a number of islands and long sandy beaches.	The site is important for wintering waders and geese.
Rathlin Island	A large island with cliffs and stacks on the north and west shores. Further inland there are wetlands, a limited amount of maritime heath and a mosaic of unimproved and improved grazing.	The IBA is important for breeding seabirds. It holds 52000 pairs of seabirds and 11200 pairs of breeding waterbirds on a regular basis.
Sheep Island	An exposed marine island with steep cliffs and rocky shores.	The IBA is important for breeding seabirds.
South Down Coast	A long section of rocky and sandy coastline extending from Cranfield Point to St John's Point.	The IBA is important for wintering waders and waterbirds
Strangford Lough and Islands	The IBA comprises a shallow sea lough with an indented shoreline and a wide variety of marine and intertidal habitats. The west shore has numerous islands typical of flooded drumlin topography.	This is Northern Ireland's most important coastal site for wintering wildfowl, and is also of importance for breeding terns (*Sternidae*).

UK BAP Species

There are 59 species of birds which are listed on the UK BAP list of priority species (UK BAP 2007), however, only one UK BAP species, the herring gull, is found within the study area. Whilst this species has been identified as a priority species it does not have a specific species action plan as yet, despite showing a marked decline in the UK.

Northern Ireland's Priority Species and Species of Conservation Concern

There are 116 bird species identified as SOCC, 29 of which are listed as priority species. Those which are seabirds are discussed in further detail in Table 9.10.

Table 9.10: Priority Bird Species of Conservation Concern within the Study Area

Species Name	Conservation Information	Distribution Description
Pale bellied brent goose (*Branta bernicla hrota*)	Recent population estimate (2004) for the 'Irish' light-bellied brent goose is at an all-time peak of 32,000 birds, 26,000 of them spend part of the winter in Strangford Lough. Nearly 100% of the entire world population winters in Ireland.	Brent geese can be encountered from September – April on many of Northern Ireland's estuaries and sea loughs. A large population can be seen at Strangford Lough.
Common scoter (*Melanitta nigra*)	The species is protected on Schedule 1, Part 1 of The Wildlife (Northern Ireland) Order 1985. Listed on Appendix III of the Bern Convention. Red-listed in both Ireland and the UK (Birds of Conservation Concern). Dundrum Bay holds internationally important wintering numbers.	The best place to see the species is in Dundrum Bay. Post-breeding birds arrive in August. Flocks from December to February can be >1,000 birds and sometimes more than 2,000 can be seen. Smaller numbers are found in Belfast Lough, Lough Foyle and off Magilligan.
Black-tailed Godwit (*Limosa limosa*)	Red-listed in UK Birds of Conservation Concern (BOCC) due to historical declines in UK breeding population. In Irish BOCC it is Amber-listed because it is a rare breeding bird, an internationally important wintering/passage population. The wintering population is localised: >50% concentrated in ten or fewer sites.	Primarily seen in Northern Ireland on passage and during winter months, mainly frequenting estuaries and coastal habitats in winter. Peak numbers usually occur in September to April. Belfast Lough supports internationally important numbers in winter, with 4-500 regularly present. Passage numbers are much higher, with counts of >1,000 birds from Belfast Lough not unusual.
Curlew (*Numenius arquata*)	The Irish population is estimated 2,500 to 10,000 breeding pairs. Outside the breeding season, numbers of curlew in Ireland are swollen by immigration of birds from Britain and Northern Europe. Wintering numbers may vary, but in general 6,500 – 7,000 birds	A wading bird, the curlew is found mainly in coastal areas in winter, and upland areas in summer. In Northern Ireland, most breed around Lough Erne, with smaller populations in the Antrim hills and southern Sperrins.
Redshank (*Tringa totanus*)	UK and All-Ireland priority species. Priority species in the Northern Ireland Biodiversity Strategy.	This wading bird frequents both coastal and freshwater wetlands. It is present throughout the year, but majority of birds arrive from August for over-wintering at estuaries and other coastal sites. The most important sites for over-wintering and migratory redshank are Strangford Lough and Belfast Lough which are of international importance for the species.

Species Name	Conservation Information	Distribution Description
Herring Gull (*Larus argentatus argenteus*)	Protected under the terms of the Wildlife (Northern Ireland) Order 1985.	The herring gull is abundant in Northern Ireland, and easily seen around all coasts, though most numerous in autumn and winter. Belfast Lough records numbers in excess of 4,000 birds in winter. The herring gull breeds on coastal islands, with a tiny inland population in County Fermanagh. Small colony on Rathlin Island (declined during 1985-88 from 4037 birds to 14).
Roseate Tern (*Sterna dougallii*)	Listed as a UK and All-Ireland priority species. Listed as Endangered in the Irish Red Data Book: Vertebrates.	The roseate tern has only one active breeding colony in Larne Lough. It is a summer visitor from May – August.
Chough (*Pyrrhocorax pyrrhocorax*)	The chough is extremely rare in Northern Ireland. The species was extinct in Northern Ireland for nearly 10 years, but in 2008 started to breed again on Rathlin Island, after a 19-year gap (BBC 2009). An all-Ireland priority species (red-listed) UK Amber-listed Species.	In Northern Ireland, it breeds on the north coast of County Antrim. It prefers coastal cliffs and grassland, and is present all year round. Populations are also present on Rathlin Island.
Lapwing (*Vanellus vanellus*)	An all-Ireland Priority species (red-listed) UK Amber-listed Species Breeding population has declined in excess of 60%	Mainly coastal species but flocks can be found in open areas throughout. It is present year-round but most common in winter.

Species of conservation concern (SOCC) which are of important consideration within the study area include divers (e.g. red-throated diver), shearwaters (e.g. Manx shearwater), fulmar (e.g. Northern fulmar), seaducks (e.g. common eider), gulls (e.g. black-headed gull), terns (e.g. Arctic tern) and auks (e.g. guillemot, razorbills).

9.3.4.4 Key Issues and Future Trends.

Issues affecting seabirds include, but are not limited to:

Food availability – poor availability of food can lead to starvation of chicks and force adults to spend longer periods away from the chicks as they forage for food. This leaves chicks susceptible to predation and chilling.

Poor weather conditions – this can restrict foraging and lead to chilling or washing away of nests during storms.

In the future, **climate change** is likely to be a key issue. This could result in the displacement of fish stocks (their main food source), an increase in extreme weather events and changes in sea levels and temperatures.

Increased protection – protected sites are considered important for increasing resilience to change within a population. As discussed above, plans are underway to create a suite of entirely marine SPAs as well as designate further SPAs with a coastal component to afford a greater level of protection to birds in the marine environment.

9.3.5 *Marine Mammals*

9.3.5.1 Data Sources

Detailed information on seal abundance and distribution is available from an intensive study coincident with the installation of a tidal stream energy device at Strangford Lough and from monthly boat counts carried out by the Northern Ireland Environment Agency. The majority of cetacean data for Northern Ireland are found on the Irish Whale and Dolphin Group website (all records are validated and available on www.iwdg.ie).

Berrow (2008) reviewed cetacean sightings for Northern Ireland and identified the key sites for cetaceans as being: Portrush and Portballintrae, Co. Antrim; Rathlin Island, Co. Antrim; Portmuck, Islandmagee, Co. Antrim, and Whitehead, Co. Antrim. Offshore cetacean distribution and abundance information has also been collected on SCANS surveys. However, overall baseline data on marine mammals in Northern Ireland is sparse; there is little information on cetacean abundance and distribution and no data on habitat usage. Data on seal habitat usage exists for all the main haul-out sites, including Larne Lough, Belfast Lough, Carlingford Lough and the Mournes Coast, Minerstown, Rathlin Island, Strangford Lough, Outer Ards and the Copelands, Maidens and Skerries islands. Dedicated monitoring will be required to assess the overall importance of the Northern Irish coast to marine mammals.

9.3.5.2 Background

This section provides a summary of the known distribution and abundance of marine mammals off the coast of Northern Ireland. Twenty species of marine mammal are known to occur in these waters (17 cetacean, 2 seal and 1 otter). Harbour seal (*Phoca vitulina vitulina*), grey seal (*Halichoerus grypus*), harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*) and minke whale (*Balaenoptera acutorostrata*) are frequently observed while Risso's dolphin (*Grampus griseus*), killer whale (*Orcinus orca*), pilot whales (*Globicephala melas*), humpback whales (*Megaptera novaengliae*) and sei whales (*Balaenoptera borealis*) have been known to occur occasionally. Further detail is provided in Appendix C.

Table 9.11: Seals and Cetacean Species within the Study Area

Species Present	Special Area of Conservation	Known Areas of Abundance
Harbour Seal	Strangford Lough* Murlough*	Strangford Lough, Murlough, Carlingford Lough
Grey Seal	N/A	Strangford Lough, Copeland Islands, North Rocks Ards Peninsula.
Harbour porpoise	N/A	Portrush, Islandmagee, Newcastle, Rathlin Island, entrance to Belfast Lough and Strangford Lough
Bottlenose dolphin	N/A	Portrush, Islandmagee, entrance to Belfast Lough, Rathlin Island
Common dolphin	N/A	Portrush, Islandmagee
Minke whale	N/A	Portrush, Islandmagee, entrance to Belfast and Strangford Lough, Rathlin Island
Risso's dolphin	N/A	Unknown
Pilot whale	N/A	Unknown
Killer whale	N/A	Unknown
Sei whale	N/A	Unknown
Humpback whale	N/A	Unknown

*present as a qualifying feature but not the primary reason for site selection

9.3.5.3 Baseline Description

Grey Seals

The grey seal is the larger of the two seal species which inhabit Northern Ireland. Grey seals come ashore on remote islands and coastlines to give birth to their pups in the autumn, from September to late November, to moult from February to April, and at other times of the year to haul-out between foraging trips at sea where they feed on a variety of fish and cephalopods. Information gathered from tracking studies of tagged grey seals has shown that they can feed up to several hundred kilometres offshore during foraging trips lasting several days (McConnell *et al*. 1992). Individual grey seals based at a specific haul-out site often make repeated trips to the same region offshore, but will occasionally move to a new haul-out and begin foraging in a new region. They spend approximately 40% of their time near or at haul-out sites (McConnell *et al*., 1999).

In Northern Ireland the main breeding colonies for grey seals are within Strangford Lough, on the Copeland Islands at the mouth of Belfast Lough and on the North Rocks off the southern end of the Ards Peninsula. On the Copeland Islands in 2005, the maximum pup count was 16 and on North Rocks the maximum count was 9 pups (Duck & Mackey 2007). Monthly counts of seals within Strangford Lough are carried out by the National Trust and the NIEA. These counts show that approximately 40 grey seal pups are born within the Lough, and the seals here breed 3-4 weeks earlier than those breeding on the North Rocks. This suggests that approximately 100 grey seal pups were born in Northern Ireland in 2005 (Duck & Mackey 2007). Total grey seal counts in Strangford Lough have increased at 8% per year (95% CI: 6-10%) from 1994-2006 equivalent to an overall 200% increase (SCOS 2007). Grey seal populations in the UK are generally either slowly increasing or stabilising (SCOS 2008).

Common Seals

Common seals pup in June and July, and moult in August and September. Therefore, between June and September there are increased numbers of common seals on shore. Common seals haul-out on tidally exposed areas of rock, sandbanks or mud. Individuals are generally faithful to particular haul-out sites within a season. Common seals normally feed within 60 km of their haulout sites (Thompson *et al*. 1996). A study on the diet of common seals in Dundrum Bay, Co. Down showed that the diet consisted primarily of small flatfish and gadoids such as whiting, haddock, pollack and saithe (Wilson *et al*. 2002).

Northern Ireland holds approximately 4% of the UK's total common seal population, while Scotland holds approximately 85%, and England 11% (SCOS 2007). A thermal imaging survey of the entire coast of Northern Ireland during the moult in August 2002 counted 1,248 common seals (Duck, 2006). Strangford Lough represents a significant proportion of common seals in Ireland. Recent data from Strangford Lough suggest that common seal counts have declined by 3% per annum (95% CI: 1-5%) producing a 35% decline over the period 1994 to 2006 (SCOS 2007). The UK common seal population is generally in decline (SCOS 2008). Recent tracking studies of seals tagged within Strangford Lough have suggested that the population feeds mainly in the Irish Sea and that seals that occur within the Lough also regularly haul out at sites out-with the Lough.

Harbour Porpoise

Harbour porpoises are the most common small cetacean in the eastern north Atlantic and are abundant in waters off Ireland, Northern Ireland (Wall *et al.*, 2006, Ulster Wildlife Trust 2006) and north west Scotland (Goodwin & Speedie 2008). The most recent abundance estimate for harbour porpoises in the North Sea and European Atlantic shelf waters is 385,617 (95% CI= 261,266-569,153) (Hammond 2008). Harbour porpoises are regularly seen from the Northern Irish coast with sightings recorded in every month of the year and concentrations off Portrush, Islandmagee, Belfast Lough and Newcastle (IWDG).

Surveys in coastal waters west of the UK in July 2004 estimated harbour porpoise abundances of 387 individuals (95% CI = 170-877) off Northern Ireland, and 1,645 individuals (95% CI = 823-3,289) in the Firth of Clyde, with estimated densities of 0.387 and 0.823 animals per km2 respectively throughout the study areas (Goodwin & Speedie 2008). In UK waters, mating and calving are estimated to take place between May and September. Harbour porpoises from Irish waters feed mainly on *Trisopterus* spp. (Rogan & Berrow 1996) while sandeel and whiting are important off the Scottish coast (Santos *et al.* 2004).

Bottlenose Dolphin

There are regular sightings of bottlenose dolphins made from the Northern Ireland coastline (IWDG, Wall *et al.*, 2006). Bottlenose dolphins can show a degree of site fidelity, and there are semi resident groups in the Shannon Estuary, Ireland (Berrow *et al.*, 1996), Cardigan Bay, Wales (Bristow & Rees, 2001) and the Moray Firth, Scotland (Wilson *et al.*, 1999). The most recent abundance estimate for bottlenose dolphins in the North Sea and European Atlantic shelf waters is 12,645 (95% CI= 7,504-21,307) (Hammond 2008). Recent photo-identification surveys of bottlenose dolphins off the coast of Northern Ireland indicated matches with all four coasts of Ireland, including Galway, Cork and Dublin Bays (O'Brien *et al.*, in review). Santos *et al.* (2001) published dietary information for ten stranded bottlenose dolphins off the east coast of Scotland, where they found the main prey items to be cod, saithe and whiting.

Common Dolphin

Common dolphins are the sixth most frequently recorded cetacean, with c. 156 individuals reported to date. The mating and calving period for this species in the north east Atlantic extends from May to September (Murphy *et al.* 2005). In European waters common dolphins are known to feed on a variety of fish and squid.

Risso's Dolphin

Sightings of Risso's dolphins have been recorded north-east of Malin Head in waters of 40-55m (Wall *et al.* 2006), and have also been seen off the coasts of Co. Down and Co. Antrim (IWDG). Risso's dolphins are the fifth most frequently recorded cetacean, with c. 60 individuals reported to date. They are generally assumed to restrict their feeding to cephalopods although they may also consume crustaceans, and occasionally small fish.

Killer Whale

Killer whales are the fourth most frequently recorded cetacean, with c. 44 individuals reported to date. In 2009, photo-identification confirmed an animal using Northern Ireland waters is part of one of the Scottish 'West Coast' community pods. In UK waters, killer whales are found along the shelf edge, especially north of Shetland, and in inshore Scottish waters around the Northern and Western Isles (Bolt *et al.*, 2009). Killer whales forage near pelagic trawlers, taking advantage of the mackerel and herring fisheries off Northern Scotland, primarily between January and February (Luque *et al.* 2006).

Pilot Whales

In British and Irish waters, pilot whales occur mainly along the continental shelf slope and feed primarily on cephalopods. Pilot whales have been observed off the Antrim coast (IWDG).

Baleen whales (Minke, Sei and Humpback Whales)

Minke whales are often seen in the waters around Ireland, and there are confirmed sightings in Northern Irish waters (IWDG, Ulster Wildlife Trust 2006). Wall *et al.* (2006) recorded minke whale sighting off the North Donegal/Derry coast. The most recent abundance estimate for minke whales in the North Sea and European Atlantic shelf waters is 18,614 (95% CI 10,445-33,171) (Hammond 2008). Within UK waters, minke whales are most frequently sighted in the north-western North Sea, the Hebrides and in the Irish Sea (Reid *et al.* 2003, MacLeod *et al.* 2004). Analysis of the stomach contents of minke whales stranded along the coast of Scotland, Pierce *et al.* (2004) found that the diet comprised mainly of sandeel and clupeids. Humpback whales and sei whales have been observed in Northern Irish waters, but are not frequently sighted.

Otters

Although otters (*Lutra lutra*) are widely distributed throughout Northern Ireland, there are currently no coastal SACs with otters as a qualifying feature. In general, otter distribution in Northern Ireland is concentrated inland with low occurrence at coastal sites (Preston *et al.*, 2006).

9.3.5.4 Key Issues and Future Trends

By-catch: The incidental catch and entanglement in fishing nets is one of the main threats to marine mammals (Lewison *et al.* 2003). Global by-catch of marine mammals has been estimated at almost 600,000 animals a year (Read *et al.* 2006). Small cetaceans are most at risk from fishing on the continental shelf (Northridge, 2009).

Phocine distemper virus: (PDV) outbreaks in 1988 and 2002 caused huge mortality in the European common seal population and cases were recorded in Northern Ireland (Barrett *et al.* 2003). Toxic algal blooms have also been linked to deaths and neurological dysfunction of marine mammals (Scholin *et al.* 2000).

Climate change: An increase in sea temperatures caused by global warming could have many effects on marine mammals. A rise in sea temperatures may lead to changes in prey availability which can affect marine mammal distribution, abundance, health and reproduction, and in turn affect whole populations. A study of cetacean strandings and sightings off the west coast of Scotland showed an increase in warmer water species in recent years and a decline in colder waters species (Macleod *et al.*, 2005). Rising sea levels may decrease available haul out areas for seals (Moore 2009).

Legislation: Cetaceans are protected under the European Commission's Habitats Directive and are listed in Annex IV (species of community interest in need of strict protection), meaning it is illegal to deliberately kill, capture or disturb these species. Harbour porpoises and bottlenose dolphins are Annex II species which means the presence of these species requires the designation of SACs. In Northern Ireland, whaling is illegal under the Fisheries Act 1981, and all cetaceans are protected under the Habitats (NI) Regulations.

There are currently no SACs designated for cetaceans in Northern Irish waters. Common seals and grey seals are also Annex II species. The presence of seals was a qualifying feature, but not the main reason for the site selection of two SACs in Northern Ireland: Strangford Lough and Murlough.

Strangford Lough was named Northern Ireland's first marine nature reserve. Grey and common seals are also protected under the Habitats (NI) Regulations. In the future, marine mammals could be afforded further protection through the UK Marine and Coastal Access Bill. As very little data exist about marine mammal distribution, abundance and habitat use, and therefore past trends in Northern Ireland, it is very difficult to predict future trends.

Habitat Loss: Habitat destruction and pollution are the main threats to otters. In Northern Ireland, the otter is listed in Annex II and IV of the EU Habitats Directive as a species which is of European interest and which requires strict protection and designation of special conservation areas. Otters are also protected under of the Wildlife (Northern Ireland) Order 1985 and the Conservation Regulations (Northern Ireland) 1995.

9.3.6 Marine Reptiles

9.3.6.1 Data Sources

In assessing protected sites within the study area, the following data sources have been used:

- Review of marine turtle records in Northern Ireland, which provides an overview of recorded sightings of marine turtles in Northern Ireland (King, 2006)
- Northern Ireland's Priority Species and Species of Concern list (National Museums Northern Ireland 2006-7)
- Offshore Energy SEA (DECC 2009b)

9.3.6.2 Baseline Description

Two species of turtle have been observed in Northern Irish waters: leatherback turtles (*Dermochelys coriacea*) and loggerhead turtles (*Caretta caretta*). There are 36 records of turtles in Northern Ireland; 80% of which were leatherback turtles. Leatherback turtles are the largest of all marine turtles and migrate huge distances between their feeding grounds and where they lay their eggs. Although leatherback turtles are rarely seen in Northern Ireland's waters, they have been sighted throughout the coast. Higher numbers have been observed off Portrush and Strangford Lough (King *et al*. 2006). The majority of sightings (78%) occur between July and September.

Both species are considered endangered on the IUCN red list, and marine turtles are listed on Annex IV of the EU Habitats Directive, with the loggerhead turtle also listed as a priority species on Annex II. Marine turtles are also listed in Appendix I of the Convention on the International Trade in Endangered Species of Flora and Fauna (CITES), Appendices I and II of the Bonn Convention on Migratory Species and Appendix II of the Bern Convention. In addition, all species of turtle are listed as SOCC and priority species in the Northern Ireland Biodiversity Strategy. They are also collectively listed in a Grouped Species Action Plan with the UK BAP.

9.3.6.3 Key Issues and Future Trends

Issues affecting marine turtles include, but are not limited to:

Marine litter – marine litter can persist for a long time and is sometimes mistaken for prey by turtles. Plastic carrier bags especially can be mistaken as jellyfish, but once ingested can block a turtle's digestive track leading to starvation or reduction in the desire to feed.

Ship strikes – as turtles regularly need to surface to breathe, they are vulnerable to boat strike and propeller injuries.

By-catch – turtles are susceptible to accidental catch on fishing hooks, or become scooped up or entangled in trawl/drift nets. Discarded fishing gear also presents a problem, as turtles can become entangled, leading to drowning.

In the future, **climate change** could impact upon their distribution as a result of displacement of their food source, or changes to sea levels and temperatures.

9.3.7 *Bats*

9.3.7.1 Data Sources

There are currently no available data sources on the distribution of bats in offshore areas (the Northern Ireland territorial waters).

9.3.7.2 Background

It is becoming increasing recognised that wind farms could potentially have significant adverse effects on bat populations. The importance of assessing the potential effects of wind farms on bats was reinforced in guidance issued by Natural England in May 2008. However, at present there is very little evidence or data available on the potential effects of wind farms on bats, both onshore and offshore.

In terms of offshore windfarm developments, it is thought that impacts on bats are most likely to occur on migratory routes rather than foraging or roosting areas (EUROBATS 2006). However, further information is required on bat behaviour and migratory movements around the Northern Ireland coastline and territorial waters to confirm this assumption.

At present there is no available data for the behaviour of bats at sea or the distribution of bats, including migratory routes, in offshore locations. Data on the distribution and abundance of bat species in onshore locations is generally well documented and recorded, although the effects of wind farms on bats have been less well studied and documented.

Most data that is available on the impacts of wind farms on bats has been collected in America and relates mainly to bat fatalities associated with wind farms. One study carried out over a six week period estimated that there were 1,764 and 2,900 bats fatalities recorded at two wind farms in West Virginia and Pennsylvania (Arnett EB-technical editor (2005). The studies found that the fatalities were highest during the summer and autumn when bats started the autumn migration.

Data on bat fatalities from the UK and Europe is more limited. This has mainly been attributed to less consistency in terms of developing methodologies for collating data and carrying out research (Nicholls B, Racey PA (2007). Although, there has been some recent progress on this subject in the UK following the appointment of the Bat Conservation Trust (BCT) and the University of Bristol by DEFRA to carry out a research study into the impacts of wind turbines on bats (http://www.bats.org.uk/pages/wind_turbines.htm).

This study has been split into two phases, the first focusing on establishing what current research data is available on the subject and developing a research protocol and methodology for carrying out research as part of Phase 2. Phase 2 commenced in the summer 2009 and will be carried out over a three year period in which the effects on both onshore and offshore wind farms on bats will be studied.

9.3.7.3 Baseline Data

There is currently no specific baseline data for the distribution of bats in offshore areas within the Northern Ireland territorial waters.

9.3.7.4 Key Issues and Future Trends

Bats are subject to a number of threats onshore mainly relating to the loss of important roosting and foraging areas and removal of flight corridors. However there is very limited understanding of the potential issues affecting bats in offshore locations.

9.3 Cultural Heritage Including Archaeological Heritage

9.3.1 Marine and Coastal Archaeological Potential

9.3.1.1 Data Sources

- Northern Ireland Sites and Monuments Record (NIEA 2009).
- UKCS Offshore Oil and Gas and Wind Energy Strategic Environmental Assessment: Archaeological Baseline (Wessex Archaeology 2009)
- Strategic Environmental Assessment SEA 6: Irish Sea Maritime Archaeology (Wessex Archaeology 2005).
- Strategic Environmental Assessment SEA 6: The scope of Strategic Environmental Assessment of Irish Sea Area SEA 6 in regard to prehistoric archaeological remains (Flemming 2005)

9.3.1.2 Background

The earliest known human occupation of Northern Ireland is dated to about 10,000-9,000 BP (the site of Mount Sandel, Co. Derry). As is the case with much of the northern part of the British Isles the possibility of early habitation of the Northern Ireland coastal zone is related to the extent of past glaciation and sea level. Almost all of Ireland was glaciated at the height of the last Ice Age, some 20,000 years ago. Large-scale ice retreat occurred from about 16000 years before present (BP) exposing land along the Northern Ireland coastline. As the ice continued to retreat, the land rebounded such that sea-levels between 14000-10000 BP were lowered by up to 30m moving the coastline seaward of its present position. (McCabe *et al.* 2007; Brooks *et al.* 2008). Sea-levels then rose again reaching present levels by 5000-6000 BP. There is therefore a possibility of early (i.e. 14000-6000 BP) settlement sites being found offshore. Later (i.e. post-6000 BP) sites are restricted to the intertidal and coastal zones.

The Historic Monuments and Archaeological Objects (NI) Order 1995 acts to provide protection for scheduled monuments both on land and within UK territorial waters adjacent to the coastline of Northern Ireland. It also obliges the finder of archaeological objects to report them, and (if portable) to deposit them with the authorities.

9.3.1.3 Baseline Description

There are a considerable number of known intertidal sites, such as fish traps and quays, which are associated with settlement dating from the Mesolithic to the historic period. (A number of these are also scheduled)

Currently there are no known submerged archaeological sites in Northern Ireland. However, the potential preservation of such sites is strongly suggested by the existence of submerged forests in Strangford Lough, exposed intertidal peats at Portrush West Strand and possible buried beach and estuarine deposits in Belfast Lough (Flemming, 2005; Kelley et al. 2006).

The optimum conditions (Flemming, 2005) for preservation of submerged archaeological sites and landscapes are characterised by low energy, combined with the protection of the remains by burial beneath stable sediments. The conditions promoting subsequent discovery are low net sediment accumulation rate since initial burial, so that the artefacts are not buried too deeply. It is at sites such as these that the greatest potential for archaeological artefacts to found exists.

Particularly favourable sites for early habitation include caves, river valleys, sheltered bays and archipelagos. Representative sites are most likely to be found within the sheltered waters of existing sea loughs, though isolated sheltered areas along more open coasts may also have favoured preservation of archaeological remains, including the possibility of early seagoing craft.

It should be noted that the best conditions for preservation of archaeological remains are unlikely to be found in areas where tidal and wave energy resources are most likely to be exploitable. However, seabed surveys and infrastructure installations may reveal such sites adventitiously. Wind farm sites may; however, be in areas where water conditions are less energetic.

Any finds dating to the earlier periods of human development (Palaeolithic, to about 11500BP or Mesolithic, 11500-6000BP) would be of great importance to the archaeological understanding of the early settlement of the area, as there is currently no record of Palaeolithic habitation in Ireland, while knowledge of the early Mesolithic, particularly its coastal component, is still poorly constrained. By contrast Neolithic (6000-4000BP), Bronze Age (4000-1600BP) and Iron Age settlement of the Northern Ireland is well understood with many known land sites. The most significant remains from this period provides evidence for transport routes, either through complete or partial remains of trading vessels or their cargoes.

9.3.1.4 Key Issues and Future Trends

The key issue for managing the cultural heritage resource is knowing where material is located in advance of any proposed work. Extensive surveys of coastal and intertidal archaeology have been conducted in Northern Ireland over the last decade, with newly discovered sites incorporated into the Sites and Monuments Record. Thus far, surveys of Strangford Lough and Rathlin Island have been completed with a survey of the north coast scheduled for completion in the next few years.

Systematic Investigation of submerged archaeological landscapes in Northern Irish waters has been ongoing only since late 2008 and has, so far, only examined the north coast. It is anticipated that within the next decade, more extensive and more detailed baseline information of submerged and intertidal archaeology will be available.

9.3.2 Wrecks

9.3.2.1 Data Sources

- Northern Ireland Wrecks Database
- Seazone Wrecks Database

9.3.2.2 Background

Wreck sites are generally defined as sunken ships and aircraft, and any material associated with such vessels. This includes vessels ranging from prehistoric logboats to modern metal ships and aircraft.

There are three main UK laws which apply specifically to shipwrecks:

- The Merchant Shipping Act (MSA) 1995,
- The Protection of Wrecks Act (PWA) 1973, and
- The Protection of Military Remains Act (PMRA) 1986

Between them these provide for protection of specified historic, including military, shipwrecks and the remains of all military aircraft (Maritime and Coastguard Agency, 2007).

9.3.2.3 Baseline Description

There is one historic, protected wreck in the study area. This is the La Girona, which was part of the Spanish Armada, and which was lost in 1588 off Lacada Point, Co Antrim (55° 14' 51'' N 06° 30' 3'' W). There is a 300m exclusion zone round the wreck, and diving is prohibited without a licence from the NIEA (NIEA 2009).

Recorded vessel losses and sites of charted wrecks in the study area are shown on Figure 9.3.1.

Data from the Northern Ireland Wrecks database includes details of about 2050 recorded wrecks within Northern Ireland territorial and inland waters. This data primarily refers to documentary losses within Northern Ireland waters. The Seazone database lists 145 charted wrecks within, or immediately adjacent to Northern Ireland territorial waters. Part of the north coast of Northern Ireland, from the border with the Republic of Ireland to Torr Head, has been surveyed as part of the JIBS initiative (Quinn et al 2009). They have identified seven wreck sites, with a further 220 possible sites (JIBS database) within the survey area. Table 9.12 shows the numbers of recorded and known wrecks within each of the zones of interest.

Table 9.12 Recorded Vessel Losses and Charted Wrecks in the Zones of Interest for Development

Area		Resource	Recorded Wrecks[1]	Charted wrecks[2]
1	North Coast	Wind/Wave Tidal	99	10
2	Rathlin Island and Torr Head	Tidal	140	15
3	Maiden Islands	Tidal	43	1
4	Copeland Islands	Tidal	156	5
5	Strangford Narrows	Tidal	143	2
6	East Coast	Wind	245	7
	Total		826	40

Source: [1]Northern Ireland wrecks database; [2]Seazone wrecks database.

Included among the recorded losses are a number of military aircraft, dating from WWII, reported (Irishwrecksonline 2009) as lost off County Londonderry. These are protected under the PMRA, although their whereabouts are not known.

Known wreck sites in the study area range from single isolated items to virtually complete vessels and cargoes. It is highly probably that more 'undiscovered' wrecks and their associated material culture exist in the waters off Northern Ireland.

Whilst the nature of shipwrecks, particularly prior to the 20th century, means that the majority of vessels are likely to have been broken up as a result of impact with coastal features, some items can be preserved even in the most adverse conditions. In particular metal ingots and ceramic objects are resistant to destruction or relocation, and can be found even in extremely high energy environments. Where vessels have sunk in harbours or enclosed or sheltered waters a considerable degree of preservation can result through burial, although such wrecks are likely to have been subject to some degree of looting or salvage.

Further, throughout the period, and particularly during the 20th century a proportion of vessels (including aircraft) will have been lost through incidents not involving grounding (e.g. adverse weather, icebergs, human error, fire, enemy action). The locations of wreckage from such incidents are likely to be unknown or, at best, unsure; particularly in deep water or where smaller vessels were concerned. However, this situation may be rectified in future by ongoing analysis of high resolution bathymetric data, such as provided by the JIBS. Designated wrecks (and all military aircraft remains) are protected under a number of regulations and such protection applies even where the current location is not known. Wartime wrecks may also contain munitions and while these are normally considered safe on the seabed they may become highly unstable or toxic on the surface.

9.3.2.4 Key Issues and Future Trends

The key issue for managing the cultural heritage resource is knowing where material is located in advance of any proposed work. The current Northern Ireland database of shipwrecks is heavily based on documentary sources supplemented by reports from sport divers and the UK Hydgoraphic Office wreck record. It is therefore biased to ships lost within the last 250 years (i.e. when documenting shipwreck incidences became more common and because modern wrecks tend to be more visible on the seabed). Moreover, much of the positional information derived from the documentary sources is vague or inaccurate.

It is envisaged that this situation will be redressed along the north coast of Northern Ireland by analysis of the recently acquired Joint Irish Bathymetric Survey multibeam bathymetry data. This will facilitate the detection of shipwreck remains while also providing accurate positional information. Therefore, within the next 5 years, the baseline wreck data for the north coast should be much improved. A similar survey has yet to be conducted between Fair Head and Carlingford Lough, hence wreck baseline data in this area will remain poor until such a venture has been completed.

9.4 Population and Human Health

9.4.1 Commercial Fisheries

9.4.1.1 Data Sources

The following sources of data have been used to inform the assessment of Commercial Fisheries:

- DARD/MFA fisheries landings statistics
- Report of the International Bottom Trawl Survey Working Group (IBTSWG) ICES IBTSWG REPORT 2008
- The Rising Tide - A Review of the Bottom Grown (BG) Mussel Sector on the Island of Ireland
- Northern Ireland Fleet Futures Analysis (2004-2013) - Methodology and Results (currently being updated)
- Sustainable Mariculture in northern Irish Lough Ecosystems (Smile) report
- Inshore fisheries review
- SEA 6,7 and UK offshore energy SEA technical reports

9.4.1.2 Background

During the scoping phase of the project Commercial Fisheries was identified as a key sea use in the study area that had scope for interactions with offshore renewable development. Scoping also identified a gap in the available data on spawning and nursery grounds, lobster fisheries and inshore fisheries. These gaps have been addressed and are discussed further in this section.

Commercial fishing is a significant industry in Northern Ireland and is based largely around the three east coast ports of Ardglass, Kilkeel and Portavogie, from which the bulk of the fleet of vessels in excess of 10m length operates. These vessels depend mainly on fishing opportunities in the Irish Sea and the North Channel and the local fleet constitutes the main UK fishery interest in the Irish Sea. Landings are dominated by *Nephrops* and whitefish fished mainly from outside the 12 nm limit. However there is considerable fishing activity within the overall inshore area, both in coastal areas and further offshore towards the 12 nm limit, by vessels operating from small harbours around the coast along with the three main ports. In addition to *Nephrops* the main species in terms of value of landings are crab, lobster and scallop.

Shellfish aquaculture has also developed into a significant industry in the inshore area, most notably in the five sea lough systems located along the coastline – Carlingford Lough, Strangford Lough, Belfast Lough, Larne Lough and Lough Foyle. The main species produced are blue mussel and Pacific oyster. In addition there is a limited level of finfish production from coastal cage units for Atlantic salmon.

9.4.1.3 Baseline Description

Commercial Fishing Activity

The size and composition of the Northern Ireland fishing fleet has changed over the last 10 years with an increase in the number and proportion of vessels of less than 10m in length, and a decrease in the numbers of vessels in excess of 10m (see Table 9.13). The smaller vessels less than 10m tend to operate on daily trips fishing in inshore waters, and their number has risen from 44% of the fleet in 1995 to 59% in 2005.

The inshore sector has therefore become of increased significance in recent years and is an important source of income to the local area. Much of the decline in the fleet has been in the whitefish sector due to the decline in whitefish stocks, which has resulted in successive quota cuts, reductions in fishing days, and the closure of the Irish Sea cod spawning grounds every spring since 2000.

Table 9.13: Change in Composition of the Northern Ireland Fishing Fleet from 1995 to 2005

Port area	1995			2005		
	Vessels <10m	Vessels >10m	All vessels	Vessels <10m	Vessels >10m	All vessels
Kilkeel	34	105	139	50	62	112
Ardglass	9	23	32	22	26	48
Portavogie	4	61	65	8	41	49
Others	114	17	131	136	22	158
Total	**161 (44%)**	**206**	**367**	**216 (59%)**	**151**	**367**

Source: MFA/DARD fisheries statistics

Pot Fisheries

Pot fishing for shellfish is a major feature of the inshore sector targeting lobster, brown crab, velvet crab, whelk and some pot-caught Nephrops. Potting takes place along all parts of the Northern Ireland coast mainly for lobster, brown crab and velvet crab at the locations shown on Figure 9.4.1a. The County Antrim coast from Rathlin to Larne is the principal lobster fishing area in Northern Ireland waters while the County Down coast is considered to be the most productive area for brown crab. Strangford Lough is fished by 12 boats based in Portaferry with most income derived from velvet crab.

The range of the pot fishery is restricted somewhat by the size of boats involved (<10m), as they tend to operate on day trips and therefore cannot venture far from their harbour base. In the south east the use of static gear (pots) is restricted to the inshore area due to trawling activity for *Nephrops* in muddy substrates further offshore.

There are over 150 boats under 10m in length fishing the inshore area for lobster and crab, many on a full-time basis with others operating only during the summer/autumn period. There are 2 organisations representing lobster fishermen in Northern Ireland – the North Coast Lobster Fishermen's Association which covers the section of coast extending north from Carrickfergus, and the North-East Lobster Fisherman's Co-operative Society Ltd (NELCO), which covers the area from Bangor to Carlingford Lough.

Both groups have received funding for stock enhancement through v-notching programmes which have been in operation since the 1990s. V-notching is a method of preserving lobster stocks which involves the return of egg-bearing female lobsters after cutting a v-notching the tail flap. If subsequently recaptured, a v-notched lobster must be returned to the water live, and fishermen are compensated by receiving half the market value of each lobster released. This scheme is now protected by legislation, making it illegal to land a v-notched lobster. Fines of up to £5,000 are payable by fishermen who contravene these regulations. In terms of stock enhancement the initiative is viewed as having been successful.

In April 2004 it became a compulsory requirement for vessels of less than 10m with a shellfish entitlement to make returns of landing – data for 2004-2008 is presented in Table 9.14.

Table 9.14: Landings of Lobster, Crab and Whelk into NI Ports, 2004 - 2008

Species	2004		2005		2006	
	Weight (Tonnes)	Value (£)	Weight (Tonnes)	Value (£)	Weight (Tonnes)	Value (£)
Velvet crabs	67	83,251	80	109,563	241	376,445
Edible crab	441	312,027	368	229,033	918	640,700
Green Crab	-	-	-	-	5	3,373
Lobsters	22	244,882	12	131,415	52	485,515
Whelks	22	11,144	6	3,730	163	107,991

Source: MFA/DARD fisheries statistics

Table 9.15: Landings of Lobster, Crab and Whelk into NI Ports, 2004 - 2008 (continued)

Species	2007		2008	
	Weight (Tns)	Value (£)	Weight (Tns)	Value (£)
Velvet crabs	228	355,591	224	338,990
Edible crab	1,173	967,713	852	675,541
Green Crab	12	6,014	44	2,500
Lobsters	59	579,776	56	537,964
Whelks	141	89,813	114	66,531

Source: MFA/DARD fisheries statistics

Legislation to address the issue of unlicensed fishing was introduced by DARD in 2008 in order to improve the management and conservation of lobster and crab in Northern Ireland waters.

Scallops

King scallop are taken in Northern Ireland waters by small vessels towing a group of spring-loaded dredges attached to a beam. Up to 15 Co Down based vessels represented by the Northern Ireland Scallop Fishermen's Association operate mostly off the east coast (Figure 9.4.1a). A small number of Scottish and Isle of Man boats also participate in this fishery, dredging the east Antrim coast during November/December. In addition small quantities of scallop are taken by divers around the Copeland Islands.

Since 1986 scallop fishing has been prohibited in ICES fishery area VIIa of the Irish Sea from 1 June to 31 October to facilitate scallop spawning. During this period of closure up to eight of the vessels move north to fish scallop grounds off Lough Foyle and the County Donegal coast (Figure 9.4.1a). It is not possible to operate a 12-month fishery in the north coast area due to weather restrictions. Landings of scallop into Northern Ireland ports over recent years are shown in Table 9.16.

Table 9.16: Landings of King Scallop to Northern Ireland Ports, 2004-2008

Year	Scallop landings	
	Weight (tonnes)	Value (£)
2004	580.56	750,938
2005	453.35	615,797
2006	346.52	495,479
2007	442.73	623,424
2008	601.94	1,708,771

Source: MFA/DARD fisheries statistics

Scallops must have a minimum shell length of 110mm to be legally landed for commercial use. This minimum legal landing size within ICES rectangle VIIa ensures that scallops spawn at least twice before becoming vulnerable to direct fishing mortality. Further conservation regulations were introduced in 2008 reducing the permitted daily fishing time, limiting the number of dredges fishable by each boat and extending regulation to "fishing by any means" including divers.

Nephrops

In terms of both landings and value, *Nephrops* is the most important species targeted by the Northern Ireland fishing fleet through deployment of single-rig and twin-rig trawl gears by vessels larger than 10m. The Irish Sea fishery for *Nephrops* in Division VIIa is considered a single management unit by ICES and is divided into 2 functional units (FUs) for the collection of data on quantities landed/discarded, fishing effort, CPUE etc. used in analytical assessments of the stock. Irish Sea West (FU15) is the area fished by vessels from Northern Ireland and ROI, and this area contributes to more than 90% of the overall landings in the Irish Sea.

Nephrops require a muddy habitat to excavate their burrows and are therefore generally confined to sediments with relatively high clay and silt fractions of 30-100% (ICES, 2005a). The fishery is concentrated on an expansive area of muddy sediment between Northern Ireland and the Isle of Man which extends from inshore waters to well outside the 12 NM limit (see Figure 9.4.1a). *Nephrops* trawlers are active year-round with the greatest catches during the summer months and during periods of weak tide.

In 1991 the Northern Ireland fleet had 230 trawlers (>10m in length) engaged in this fishery but the numbers have reduced significantly through a series of decommissioning rounds to the current level of 140 vessels.

Semi-Pelagic Finfish

Whitefish are targeted by trawlers (>15m in length) using semi-pelagic gear in the Irish Sea, North Channel and along the north coast to the west of Rathlin Island (see Figure 9.4.1a). The Irish Sea and North Channel grounds are fished mainly by County Down based vessels while the north coast area is exploited by vessels from Greencastle and Moville in Co Donegal and some smaller boats from Portrush and Portstewart.

The main species of interest are cod, haddock, hake, whiting, plaice and sole but landings have declined significantly due the deteriorating state of Irish Sea stocks and the lowering of TACs, most notably for cod and whiting. Landings of the main demersal species are presented in Table 9.17. Whilst not all fish landed are taken in local waters, these figures give some idea of the level of catch of the main species together with landings of non-quota species.

Table 9.17: Demersal Fish Landings to Northern Ireland Ports for Selected Species, 2004 - 2008

Species	2004		2005		2006		2007		2008	
	Weight (Tonnes)	Value £	Weight (Tonnes)	Value £	Weight (Tonnes)	Value £	Weight (Tonnes)	Value £	Weight (Tonnes)	Value £
Cod	582	1,114,506	548	1,083,181	567	1,271,208	407	950,210	529	1,200,980
Haddock	460	499,585	365	399,678	411	337,316	522	508,674	502	507,627
Hake	345	805,604	302	692,986	220	571,390	135	348,900	234	614,202
Plaice	67	65,307	84	70,729	94	89,891	44	33,065	58	43,471
Sole	12	68,269	13	68,926	11	366,793	13	73,659	11	67,436
Whiting	94	48,982	48	26,984	37	33,625	4	3,052	14	8,939
Pollack	157	247,985	98	146,159	62	111,485	22	39,050	50	98,279
Saithe	185	69,968	75	31,445	21	12,818	2	1,132	9	3,949
Monks or Anglers	194	332,106	143	270,165	139	281,105	140	294,504	110	267,631
Spurdog	686	639,509	289	241,662	118	132,031	75	53,164	36	33,332
Skates and Rays	258	246,907	150	116,073	60	56,215	58	44,014	73	57,597
Conger Eels	302	118,478	187	66,882	70	27,355	42	13,564	64	27,924
Gurnard and Latchet	233	137,872	112	42,338	57	48,158	41	15,601	34	14,473
Other	459	525,255	984	545,752	741	384,432	167	283,119	184	273,744
Total Demersal	4,035	4,920,333	3,398	3,802,961	2,609	3,723,821	1,671	2,661,708	1,906	3,219,584

Source: MFA/DARD fisheries statistics

Following ICES advice on the imminent collapse of cod stocks, the "spring closure" was put in place by the European Commission in 2000 establishing a temporary closure of fishing in the Cod Box from 14 February to 30 April to protect spawning stocks (Figure 9.4.1b). The Cod Recovery Plan has been renewed each year with minor modifications but has failed to deliver a recovery in the Irish Sea stock.

On the north coast vessels of more than 15 m (50 feet) in length are prohibited from fishing inshore of a straight line extending from the Whistling Buoy off Inishowen Head to Bull Point, Rathlin Island and then to Fair Head. This line traverses the north-west corner of the proposed development site so that larger vessels are effectively excluded from fishing in this area (Figure 9.4.7). However the area remains an important fishery for smaller vessels.

Herring

The Irish Sea herring stock complex supported a major fishery from 1969 to 1980 and still operates at a lower level through the activities of larger pelagic vessels operating out of the three main ports (Figure 9.4.1a).

This is an autumn spawning stock comprising two separate spawning groups, Manx and Mourne. The Mourne herring spawns off the east coast of Northern Ireland/Republic of Ireland, in an area extending approximately from St John's Point (County Down) south to Dunany Point (County Louth). An inshore fishery developed around the autumn spawning migration to the Mourne area (Figure 9.4.1b), and during this period the catch of Mourne herring made up over a third of the total Irish Sea catch. This fishery was carried out by Northern Ireland and Republic of Ireland vessels using trawls, seines and drift nets, but it declined and ceased in the early 1990s (ICES, 1994).

The Irish Sea stock complex experienced very low biomass levels in the late 1970s with an increase in the mid-1980s after the introduction of TACs and quotas. The stock then declined from the late 1980s to its present level. During this time period the contribution of the Mourne spawning component has declined and the biomass of Mourne herring, determined from larval production estimates, is now only 2-4% of the total Irish Sea stock (Dickey-Collas *et al*. 2001). Reduced fishing effort has resulted in a lowering of fishing mortality which appears to be at historic low levels in recent years (ICES 2005).

The Mourne Box is one of several restricted areas protected by EU legislation to preserve the herring stock during the spawning season and to prevent the exploitation of juveniles. This area was closed completely to herring fishing during the early 1990s (Figure 9.4.1b) but subsequent legislation in 1998 now permits a traditional fishery based on vessels not exceeding 12.2m (40 ft). These vessels operate from 21 September to 31 December, and using only drift nets of specified minimum mesh size (EC 1998). Currently there are 34 boats licensed to operate in this fishery.

Table 9.18: Landings to Mourne Herring Fishery, 2005-08

Year	Quota allocation (tonnes)	Total landings (tonnes)	Licensed vessels
2005	120.0	109.9	n/a
2006	40.1	19.1	34
2007	53.7	32.6	n/a
2008	155.7	136.9	21

Source: MFA/DARD fisheries statistics

Catches for recent years are shown in Table 9.18. The fishery has shown some level of recovery in the last few years but is still well short of the catches recorded in the 1980s.

Mariculture

Mariculture, or marine aquaculture commenced in Northern Ireland during the mid 1970s with a Pacific oyster production facility in Strangford Lough. Since the 1990s the industry has experienced major expansion mainly through the development of bottom culture of mussels in Carlingford Lough, Belfast Lough, Larne Lough and Lough Foyle. In Northern Ireland waters at present there are in the region of fifty sites licensed for shellfish production and two for finfish (see Figure 9.4.2).

Significant areas of Lough Foyle and Carlingford Lough come under ROI jurisdiction and are major production areas for shellfish. Lough Foyle is currently largely unregulated but this situation is due to be rectified in the near future with the introduction of licensing controls by the Loughs Agency. Shellfish production from the major areas of the coast in recent years is summarised in Table 9.19.

In addition to production in NI waters there is major shellfish production from ROI waters - in Carlingford Lough production is in the order of 5,000 tonnes while Lough Foyle production reached 15,000 tonnes in 2003 but has since reduced.

In 2004 DARD initiated the SMILE project, a two-year study with the aim of “developing dynamic ecosystem level carrying capacity models for the five sea lough systems in Northern Ireland” (SMILE Report, 2007).

Table 9.19: Aquaculture Production from Main Areas of NI Coast, 2004-2007

Area	Species	2004		2005	
		Weight (Tonnes)	Value £	Weight (Tonnes)	Value £
Carlingford Lough	BC Mussel	1,170	677,110	1,260	1,063,000
	P Oyster	46. 5	55,500	51.5	75,500
Belfast Lough	BC Mussel	1,635	983,520	3,505	2,008,000
	P Oyster	nil	n/a	nil	n/a
Larne Lough	BC Mussel	200	55,000	163	81,500
	P Oyster	14.6	20,000	7.2	9,300
Strangford Lough	BC Mussel	nil	n/a	nil	n/a
	P Oyster	193.9	283,094	210	307,860
Other areas	BC Mussel	79	84,000	70	86,200
	P Oyster	23	24,000	11	12,000
Combined		3,316	2,182,224	5,278	3,643,360

Source: MFA/DARD fisheries statistics

Table 9.20: Aquaculture Production from Main Areas of NI Coast, 2004-2007 (continued)

Area	Species	2006		2007	
		Weight (Tonnes)	Value £	Weight (Tonnes)	Value £
Carlingford Lough	BC Mussel	2,110	2,810,000	1,530	1,878,000
	P Oyster	100.75	160,500	107	195,800
Belfast Lough	BC Mussel	3,370	2,022,000	2,724	2,710,600
	P Oyster	nil	n/a	nil	n/a
Larne Lough	BC Mussel	nil	n/a	nil	n/a
	P Oyster	0.6	1,245	1.05	1,450

Area	Species	2006		2007	
		Weight (Tonnes)	Value £	Weight (Tonnes)	Value £
Strangford Lough	BC Mussel	nil	n/a	nil	n/a
	P Oyster	233	371,169	235	324,300
Other areas	BC Mussel	67	80,250	55	72,800
	P Oyster	16	31,000	25	52,000
Combined		5,897	5,476,164	4,677	5,234,950

Source: MFA/DARD fisheries statistics

Blue Mussel

Mussel farming is based on the bottom culture of mussels laid as seed (or spat) for growing on to harvest size. The spat is dredged from known areas around the Irish coast where it has settled in abundance - this takes place between July and November. The seed is then transferred to prepared areas where it is re-laid at lower density to promote improved growth and meat content. Harvesting of mussels is generally between November and March but can occur throughout the year.

Mussel cultivation is very much constrained by the availability of seed mussel which has been unable to fully meet the demands of the industry through a period of rapid expansion. Most of the seed mussel for the industry is dredged from the south-west Irish Sea but there are significant seed settlement areas at the mouth of Lough Foyle, inside the Copeland Islands and at Skullmartin on the County Down coast. A Seed Mussel Allocation Committee (SMAC) comprising representatives from the Republic of Ireland: Irish Sea Fisheries Board (BIM) and Department of Communications, Energy and Natural Resources (DCENR), and Northern Ireland: DARD and the Loughs Agency, and joint organisations: Cross Border Aquaculture Initiative (CBAIT) considers the supply and allocation of seed throughout Ireland.

Pacific Oyster

Pacific oyster are grown in Strangford Lough, Carlingford Lough, Larne Lough, Lough Foyle and Dundrum Bay. Seed is imported during the summer and the oysters are kept in bags on trestles placed on the inter-tidal area and reach market size in 2-3 years. The produce is harvested during the winter months for sale to specialist outlets in Europe.

Other Species

Small quantities of native oyster (*Ostrea edulis*) and clams (*Venerupis semidecussata*) are also produced while Atlantic salmon are grown at two sites on the Antrim coast.

9.4.1.4 Key Issues and Future Trends

In recent years the focus of the commercial fishing industry has shifted from whitefish to Nephrops due to the depressed level of whitefish stocks and the apparent sustainability of the Nephrops stock – three large pelagic vessels remain active but operate mainly outside the Irish Sea. Nephrops exploitation is limited by TACs which have been set by the EC due to concern about collateral damage to whitefish stocks landed as by-catch.

The future of commercial fishing in Northern Ireland waters will therefore be closely linked to the exploitation of *Nephrops* stocks at a sustainable level and the current level of whitefish stocks and their potential for recovery. For example, it would appear that cod in the Irish Sea will remain at a low level of stock as restrictions to protect the spawning stock have to date produced little evidence of recovery. Similarly, fishing potential for the local fleet will depend on future EU policy in relation to the setting of future quota limitations and further rounds of vessel decommissioning. These factors have increased the significance of the inshore sector as a feature of the local fishing industry and it would appear that this trend is likely to continue.

However, there is also increased competition for the exploitation of marine resources in a wider sense, with increasing interest in the potential for development of offshore renewable energy resources, and for the extraction of aggregate from the seabed for use in the building industry. In addition, the designation of marine habitats under EU legislation may restrict fisheries activity in specific areas – for example, a prohibition on the use of mobile gear may soon be introduced within the Rathlin Island SAC area (M McCaughan, DARD; pers comm).

With regard to aquaculture, it seems likely that production will continue to be dominated by bottom grown mussel, while growth potential is currently limited by a moratorium on expansion of mussel production in NI waters as the four main Lough systems are estimated to be functioning close to carrying capacity.

9.4.2 *Ports, Shipping and Navigation*

9.4.2.1 Data Sources

The following sources of data have been used to inform the description and assessment of effects on ports and shipping:

- Shipping Density Data (Appendix D). Two main data sources are used to produce this dataset, the ShipRoutes database and survey data. The number of ship movements is based on port logs as well as the latest ferry and freight timetables for major operators. ShipRoutes was developed mainly for offshore waters, with routes generally defined up to the entrances to estuaries and ports. The routes taken by ships between ports were obtained from several data sources, including radar and AIS (Automatic Identification System) surveys, satellite tracking individual ship passage plans and Admiralty Sailing Directions. The main limitation of this dataset being that it only covers merchant ships (vessels above approximately 100 gross registered tonnes) and excludes vessel activity which is termed as non-routine, i.e. ships not sailing economically between ports but taking part in special operations. This includes military, fishing and recreational vessels, as well as vessels at anchor or moored. The shipping density data is developed mainly for offshore waters, with routes generally defined up to the entrances to estuaries/ports/Loughs. However, it can be assumed that the level of intensity at the entrance to Loughs in the study area continues to any ports/harbours within those Loughs.
- Department for Transport (DfT) Maritime Statistics 2007. This data provides statistics for ships entering and leaving main ports in the UK. It can be used to identify the most heavily used ports for commercial shipping and to describe the general levels of shipping activity in Northern Ireland.
- Marine Environmental High Risk Areas (MEHRAs): MEHRAs have been identified in areas where there is a perceived risk of pollution from merchant shipping combined with an environment considered sensitive to such pollution. The assessment of risk takes into account past analysis of incidents resulting in pollution (such as collisions, groundings and fires). These sites therefore represent areas where the prevailing conditions have in the past led to a higher rate of incidents has been experienced compared to surrounding areas.
- UKHO Hydrographic Office (UKHO) Digital Data: This data has been used to give an overview of traffic management features in the SEA study area.
- Marine and Fisheries Agency (MFA) and Department of Agriculture and Rural Development (DARD statistics.

9.4.2.2 Background

During the scoping phase of the project shipping and navigation was identified as a key sea use in the study area that had scope for interactions with offshore renewable development. Scoping also identified a gap in the available shipping data. Therefore, in order to aid the identification of areas where shipping could conflict with offshore renewable development, shipping density data, provided by Anatec, has been used to plot vessel traffic in the study area.

The Ports, Shipping and Navigation baseline environment is described in terms of the types of vessels transiting the study area - identifying any patterns in the types of routes taken, the variation in the intensity of shipping across the SEA study area, and navigational features and considerations.

As an island nation, shipping is an important part of the UK's economy. 95% of the UK's international trade in goods travels by sea and the combined net overseas earnings of maritime services and shipping is worth approximately £2.5 billion a year (DfT 2009). There are several large ports in the vicinity of the Irish Sea area that form an important focus for shipping in the waters around Northern Ireland.

9.4.2.3 Baseline Description

Ports

There are several ports in Northern Ireland ranging from large port facilities to numerous smaller ports which are essential for ferry traffic and local trade and supplies (Figure 9.4.3).

Commercial Ports

Northern Ireland's ports handled 4% (23,868,000 tonnes) of the UK's foreign and domestic traffic in 2007. Belfast is the largest and busiest port in Northern Ireland, handling over 50% of the country's foreign and domestic traffic (13,416,000 tonnes). Larne is the second busiest port with approximately 20% of Northern Ireland's traffic, while Warrenpoint and Londonderry account for approximately 8% each. Some traffic also passes through the port of Coleraine although this was less than 1% of Northern Ireland's traffic for 2007 (DfT 2007). Use of ports in the study area by merchant vessels can be seen in the shipping density data displayed in Figure 9.4.3.

Fishing Ports

The Northern Ireland licensed sea fishing industry is concentrated at the fishing ports of Ardglass, Kilkeel and Portavogie, located on the East coast (Figure 9.4.3).

According to Marine and Fisheries Agency (MFA) statistics, for those ICES rectangles that are within Northern Irish waters, between 2003 and 2008 the most used fishing port (based on live weight tonnage of fish landed) was Kilkeel followed by Ardglass, Portavogie, Bangor and Warrenpoint. The tonnage of fish landed at these ports is given in Table 9.21. Several other smaller ports in the study area are frequently used by local fishing boats.

Table 9.21: Five Busiest Northern Ireland Fishing Ports in terms of Landings Between 2003 and 2008

Landing Port	Total landings (LWT) for 2003 to 2008	Yearly average
Kilkeel	24,567	4,095
Ardglass	14,968	2,495
Portavogie	14,483	2,414
Bangor	2,222	370
Warrenpoint	1,555	259

Source: MFA/DARD fisheries statistics

Shipping

Commercial Vessels

The shipping density data (Figure 9.4.3) implies that merchant vessels use distinct routes through the study area. Larger vessels, including tankers and some cargo ships, tend to pass through the study area in a north-south direction via the North Channel accessing major ports in and around the Irish Sea, e.g. Liverpool, Milford Haven, Clyde, Belfast, and Manchester.

In the study area tankers deviate from their north-south transit to make port calls to Lough Foyle, where the Coolkeragh Power station is located, and to the Port of Belfast. Cargo vessels have less defined routes through the study area; their movements appear to be concentrated on the east coast with east-west routes connecting Larne and Belfast Port to the ports of Scotland, England and the Isle of Man and south-westerly routes to Ireland. The data shows that cargo vessels transit Rathlin Sound in an east-west direction, most likely calling at Londonderry Port.

Passenger Vessel Routes

Passenger vessels (or ferries) provide transport from Northern Ireland to Scotland, England and the Isle of Man, with major ferry ports located in Belfast and Larne. These routes are represented in Table 9.22 and Figure 9.4.3.

Table 9.22: Waterborne Passenger Movements from Northern Ireland in 2007

Route	Frequency*	Number of Passengers (thousands)
Larne – Cairnryan	10 crossings daily	646
Larne - Fleetwood	1 to 3 crossings daily	61
Larne - Troon	2 crossings daily	231
Belfast - Liverpool	6 crossings daily	187
Belfast - Stranraer	5 to 7 crossings daily	1,217
Belfast - Douglas	2 crossings weekly	N/A
Warrenpoint - Heysham	12 crossings weekly	N/A

Source: Department for Transport (DfT) Maritime Statistics 2007; Information from individual ferry company websites
*Frequency based on timetables for June 2009

Ferries are also an important mode of transport within Loughs and especially between Rathlin Island and the mainland of Northern Ireland, where nine crossings operate daily. Regular ferry crossings also exist within Strangford Lough, Lough Foyle and Carlingford Lough. There was also a ferry service operated by Cal Mac which ran from Campletown (Scotland) to Ballycastle, and although this service was withdrawn in summer 2000 there have been discussions between the Department of Enterprise, Trade and Investment and the Scottish Government regarding the possible reinstatement of this ferry service.

Ferries tend to take very distinct routes and in certain areas (e.g. Rathlin sound) due to bathymetry and other characteristics there is no, or limited, scope for adjustment of routes. Ferry routes often overlap with entrances to Loughs which can represent a good tidal energy resource.

Recreational boating is addressed in Section 9.4.3.

Navigational Infrastructure

The North Channel is a 'recognised sea lane essential to international navigation' and as such development consent cannot be granted where installations would be likely to interfere with the shipping lane (MCA 2008). Also the Government has recommended that care should be taken not to have a negative impact on regularly used shipping routes that are not covered by law (DECC 2009).

The International Maritime Organisation (IMO) is an international body that adopts routeing measures for international shipping to aid navigation of certain ships or ships with certain cargoes. IMO routeing measures include traffic separation schemes, areas to be avoided and deep water routes which are areas surveyed for obstacles. Given the importance of the North Channel to international shipping there is a Traffic Separation Scheme (TSS) in place between Rathlin Island and the Mull of Kintyre.

There are no other IMO measures in the Study area although there is an area noted for the movement of high speed craft (in this case high speed ferries) also within the North Channel area. The speed at which high speed craft move requires other vessels to maintain a particularly good lookout and can indicate areas of higher risk for shipping.

Marine Environmental High Risk Areas (MEHRAs) have been established, following the Donaldson Inquiry in 1994, to protect environmentally sensitive marine areas that are at risk from shipping. The only MEHRA within the study area is Island Magee which is on the northern edge of Belfast Lough with adjacent shipping routes to and from the nearby ports of Belfast and Larne. MEHRAs are notified by a Marine Guidance Note to mariners, who will be expected to exercise an even higher degree of care than usual when passing through them. They will also be marked on Admiralty charts.

As with civil and military aviation radar wind turbines have the potential to interfere with marine radar, including shore based radar systems. A number of ports in the study area use shore based radar systems.

9.4.2.4 <u>Key Issues and Future Trends</u>

In order to meet renewable energy targets significant investment needs to be made in construction ports in the UK. At least six locations, distributed around the UK, need to be available for development from 2014 onwards for the offshore wind industry alone (DECC 2009b). Port of Belfast is an established wind farm construction port having provided services to the Robin Rigg and Barrow offshore wind farms, it also features in the Governments UK Offshore Wind Ports Prospectus (DECC 2009c). Both the investment in ports and the increase in offshore renewable developments will inevitably result in increased shipping traffic in the UK and potentially the study area.

9.4.3 Recreation and Tourism

9.4.3.1 Data Sources

The following sources of data have been used to inform the baseline description of marine and coastal recreation and tourism in Northern Ireland:

- Royal Yachting Association (RYA) coastal atlas of Recreational Boating
- RYA report identifying Recreational Cruising Routes, Sailing and Racing Areas within the SEA 6 Area
- Northern Ireland Tourist Board (www.discovernorthernireland.com)
- SEA 6,7 and UK offshore energy SEA reports
- Marine Irish Digital Atlas

9.4.3.2 Background

This chapter provides an overview of key tourism and recreation activities within the study area.

It's generally unpolluted and pristine coastlines give much appeal to Northern Ireland as a tourist destination. From the mouth of Lough Foyle around to Belfast, the largely unspoilt coastline is one of the most beautiful stretches of coast in the British Isles.

A review of tourism in relation to Northern Ireland's economy recently undertaken, on behalf of Northern Ireland Tourist Board and DETI identified that 5.2% of jobs in Northern Ireland are directly supported by tourism which supports £1,782 million sales by Northern Ireland producers (Cogentsi, 2008).

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

For the purpose of this assessment a distinction is made between potential direct effects on tourism and recreation activities (e.g. wave or tidal devices deployed in an area used for sailing) and indirect effects (e.g. how changes to seascape character may subsequently affect the popularity of tourism and recreation activities). At this strategic level there are considerable uncertainties associated with the latter issue as it deals with human responses to changes in environmental character and only very general comments can be made.

9.4.3.3 Baseline Description

Tourist Attractions and Sightseeing

The quality of Northern Ireland's environment, heritage and culture has strong national and international appeal and tourism is therefore an important activity in the study area. The north coast of Northern Ireland has a developed tourist infrastructure and a number of coastal attractions. The Causeway Coast Way, for example, takes in attractions like the Giant's Causeway, Dunluce Castle ruins, and the Carrick-a-rede Rope Bridge.

Access to the coast is relatively easy, with a good infrastructure in place, although car parking facilities are in short supply in some areas. Long distance footpaths, notably the 16 km long North Antrim Cliff Path, allows exploration of less accessible sites. Of the top ten most visited tourist attractions in Northern Ireland in 2007, three are marine or coastal.

Further details are provided in Table 9.23. The Giant's Causeway which is located within the study area was the most visited attraction, attracting more than twice the number of visitors than any other attraction in Northern Ireland.

In addition to the sites listed in the table below, Carrickfergus Castle - a castle with Norman architecture in Northern Ireland is also a popular coastal tourist destination, situated in the town of Carrickfergus in County Antrim, on the shore of Belfast Lough.

Table 9.23: Top 10 Most Visited Tourist Attractions in Northern Ireland in 2007

Rank	Attraction	Visitor numbers
1	**Giant's Causeway Visitor Centre**	712,714
2	Belfast Zoological Gardens	294,935
3	W5 (interactive discovery centre in Belfast)	247,506
4	**Carrick-a-Rede Rope Bridge**	222,613
5	Oxford Island National Nature Reserve	216,713
6	Historic Walls of Derry	213,415
7	**Belfast Lough RSPB Reserve**	210,000
8	Belleek Pottery	171,569
9	Ulster Folk & Transport Museum	168,866
10	Ulster American Folk Park	157,325

Source: Northern Ireland Tourist Board, 2009

There are nine Areas of Outstanding Natural Beauty (AONB) in Northern Ireland, seven of which are along the coastline. Also with eight species of cetacean and two species of seal, either inhabiting or visiting the coastal waters of the study area, wildlife watching tours are popular with visitors.

There are four links golf courses in Northern Ireland: Castlerock (27 holes), Portstewart (45 holes), Portrush (36 holes), and Royal County Down (36 holes).

National Trails and Long Distance Routes

There are a number of National Trails around the coast of the UK that traverse areas of distinctive coastline, often coinciding with National Parks or Areas of Outstanding Natural Beauty. These are major attractions for an increasing number of outdoor enthusiasts intent on walking part or the entirety of a trail, often camping along the way. Table 9.24 indicates the location of the 18 national trails in Northern Ireland.

Table 9.24: National Trails and Long Distance Routes on Northern Ireland's Coastline

Trail name	Length	Summary
Antrim Hills Way	35 km	This route lies within the Antrim Coast & Glens AONB and affords spectacular views of Slemish and the coastline
Lecale Way	64km	Within the Lecale Coast AONB, features of this area include St Patrick's Monument, sandy beaches, seabirds and seals.
Mourne Way	42km	Within the Mourne AONB, this trail traverses the foothill of the Mourne Mountains from Newcastle on the Irish Sea to Rostrevor on Carlingford Lough.
Moyle Way	32km	Within Antrim Coast & Glens AONB. Principal interest features are five of the Glens of Antrim and Glenariff Forest Park

Source: DECC, 2009

Watersports

Yachting is popular in the more sheltered coastal waters, bays and sea loughs, and in addition particular routes are used to traverse the coast, and between islands. Around 5,000 people are believed to sail regularly on Strangford Lough, using around 2,000 craft). There are 25 Royal Yachting Association (RYA) clubs, seven marinas, and 28 training centres along the marine coastline of Northern Ireland. The east coast from south of Carlingford Lough round to Ballygalley, including Carlingford Lough, Strangford Lough and Belfast Lough is identified by RYA as a general sailing area. Carlingford, Strangford, Belfast Loughs (RYA) and Lough Foyle (Irish Yachting Association) are also identified as racing sailing areas. These sites, as well as RYA cruising routes are shown on Figure 9.4.4.

The study area is known for its clear waters and diverse marine life. Diving attractions within the study area include both wrecks and marine wildlife. There is localised diving around the population centres in the region and some dive boat charters to more remote areas. Particular areas of interest include the historic wrecks of HMS Drake, MV Alastor and Girona, and the areas of Portstewart, Portmuck, Causeway coast, Whitehead and Rathlin Island.

The majority of coastal surf shops and outdoor activity operators within the study area are located on the north coast in the vicinity of Portrush, or along the coast of Belfast Lough. These centres offer a range of marine related activities including surfing, wind surfing, kayaking and angling. The coast of Northern Ireland receives swell waves from the Atlantic Ocean. The main surfing areas are situated along the stretch of coast between Magilligan in the west to Ballycastle in the east, with the most popular surfing location is around Portrush.

Sea Angling

Recreational sea angling is an important contributor to coastal tourism. Key areas for angling in the UK appear to be along the south and northeast coasts of England and Wales. The Directory of Charter Boats UK (CBUK) hold records on 476 charter boats in the UK of which five are registered in Northern Ireland (two operating out of County Down, and three out of County Antrim).

Recreational Beach Use

Northern Ireland's beaches are used in the summer months, most of which are rural in nature. There are 24 beaches designated under the EC Bathing Waters Directive which are used for recreation predominantly during the tourist season. Designated bathing waters in the study area are given in Table 9.25 and shown on Figure 9.4.4. Several seaside resorts, such as Newcastle, Bangor, Portrush and Portstewart have a strong traditional accommodation base due to their historic popularity for tourism. Portstewart, with carparking on the beach, attracts high numbers of visitors in good weather and has one of the most popular beaches. Good railway connections to Belfast also contribute to the popularity of the beaches at Portrush and Portstewart.

Table 9.25: Northern Ireland's Bathing Waters

Site	Location	Site	Location
Ballycastle	Antrim Coast	Tyrella	South Down
Waterfoot	Antrim Coast	Murlough	South Down
Carnlough	Antrim Coast	Newcastle	South Down
Ballygalley	Antrim Coast	Nicholson's Strand	South Down
Brown's Bay	Antrim Coast	Cranfield Bay	South Down
Helen's Bay	North Down	Magilligan Benone	North Coast
Crawfordsburn	North Down	Magilligan Downhill	North Coast
Ballyholme	North Down	Castlerock	North Coast
Groomsport	North Down	Portstewart	North Coast
Millisle	North Down	Portrush (Mill Strand)	North Coast
Ballywalter	North Down	Portrush (Curran Strand)	North Coast

Wildlife Watching

The generally unspoilt and undeveloped nature of much of Northern Ireland's coastline makes it ideal for wildlife related tourism. Notable sites include Rathlin Island, which is popular with birdwatchers for its extensive bird populations and undeveloped landscapes, and Strangford Lough where wildlife watching for grey and common seals, otters, porpoises, aggregations of wintering cormorants and terns takes place.

Whale watching and angling vessels can also be chartered from a range of locations off the northern coast of Northern Ireland. Sightings off the coast of Northern Ireland have increased over recent years as whale-watching becomes more popular. The best places for whale-watching are headlands, islands and bays when the sea is calm.

9.4.3.4 Key Issues and Future Trends

The economic recession that the UK is currently experiencing has potential to affect tourism in the study area. It is unknown, as yet, whether this will have a positive effect, by increasing the numbers of local visitors unable to afford international holidays, or whether the impact will be negative, as with many other industry sectors.

In Northern Ireland, as well as on a global level, the 11th September crisis at the end of 2001 cancelled out all the tourism growth that had taken place that year. The world tourism economy stagnated in 2002, but in 2003 Northern Ireland tourism arrivals rebounded by 9 %. Since then an annual increase in tourism of about 0.6% has been seen. The strongly growing sectors of demand are believed to be incoming overseas visitors and increased day trip activity by residents of Northern Ireland (Cogentsi, 2008).

Results from surveys conducted by the Northern Ireland Tourist Board (NITB) indicated that spending by visitors to Northern Ireland increased by just over 10 per cent in 2004 and 14 per cent in 2005.

9.4.4 *Aviation*

9.4.4.1 Data Sources

The following sources of data have been used to inform the baseline description of marine and coastal recreation and tourism in Northern Ireland:

- NATS En Route plc (NERL) operational infrastructure interference maps/data. NERL have produced data relevant to a range of blade tip heights (20 to 140m), for the purpose of the SEA the maximum height available, 140m, has been used.
- Civil Aviation Authority (CAA) safeguarding maps
- CAA Policy and Guidelines on Wind Turbines
- DTI Wind Energy and Aviation Interests - Interim Guidelines

9.4.4.2 Background

The safety of aviation operations is a concern for offshore wind developments in the study area. There are two ways in which aviation operations may be affected by windfarm development; the physical obstruction caused by a tall structure and the effects that the supporting structure and rotating turbine blades can have on communications, navigation and surveillance (CNS) systems (including radar).

The Ministry of Defence (MoD), Civil Aviation Authority (CAA) and National Air Traffic Services (NATS) have a statutory duty to safeguard certain sites and airspace from radar interference in the interests of national security and for the safe operation of passenger and military aviation. In order to streamline the pre-planning consultation process the CAA and NATS En Route plc (NERL - responsible for the safe and expeditious movement in the en-route phase of flight for aircraft operating in controlled airspace in the UK) have produced publicly available GIS datasets that indicate consultation requirement and level of radar interference, respectively, for the UK.

Safeguarding maps produced for civilian sites indicate areas within which consultation is required before a development takes place (see Figure 9.4.5). Consultation is required where development is proposed within (CAA 2009):

- 30km of an aerodrome with a surveillance facility
- 17km of non-radar equipped aerodromes with runways of 1100 m or more
- 5km of non-radar equipped aerodromes with runways of less than 1100 m

Similarly NERL has an interest in safeguarding CNS facilities. Figure 9.4.5 indicates areas where wind development is either likely to or has potential to interfere with NERL operational infrastructure.

Early consultation allows both aerodromes and en-route service providers to assess any impact that proposed developments may have on their CNS systems.

9.4.4.3 Baseline Description

Northern Ireland has three main airports: Belfast City, Belfast International and City of Derry. Of the 190 million passengers passing through UK airports in 2002, nearly 5.7 million used the main Northern Ireland airports (DfT 2003).

In comparison to much of the UK there are no areas in Northern Irish waters where the development of offshore wind is ‘likely to interfere’ with NERL CNS systems. There are, however, areas where offshore wind development has ‘potential to interfere’ with NERL operational infrastructure but these are limited to the North Coast and a narrow band between the entrance to Strangford Lough and the 12nm limit (Figure 9.4.5).

There are two locations within the study area where offshore wind developers would be required to undertake consultation with aerodrome licensees. City of Derry airport, a non-radar equipped aerodrome with a runway length of 1,100m or more, is located on the south bank of Lough Foyle and as such most of the Lough is within the 17km CAA consultation area. Belfast City airport, a larger airport, located on the east coast of the study area has its own surveillance facility. As a result there is a 30km consultation area around Belfast City airport which extends 10km offshore from approximately Larne in the north to Portavogie in the south, including the Lough's of Belfast, Strangford and Larne.

The waters surrounding the UK, including the study area, are within the range of Search and Rescue (SAR) helicopters (190 – 250nm), although there are no SAR bases in Northern Ireland.

9.4.4.4 Key Issues and Future Trends

In the past 25 year the UK air transport industry has experienced sustained growth with air travel demand at UK airports, if not constrained by airport capacity, forecast to increase from 241 million passengers per annum in 2007 to 465 million passengers per annum in 2030 (DfT 2009). The building of new airports or expansion at Northern Ireland's existing airports may influence the location of future offshore wind developments.

9.4.5 Military Activity

9.4.5.1 Data Sources

In order to identify and assess the military practise areas in the study area the following data sources have been used:

- UKHO Practice and Exercise Area (PEXA) charts. Available in both digital and paper formats this data provides information relating to military activity within the study area.

9.4.5.2 Background

Ministry of Defence (MoD) PEXA areas can belong to the Army, Navy or Air Force and are used to practice manoeuvres, test armaments and to conduct any other general exercises.

Although it is possible to ascertain some information on military activities from the PEXA charts and digital data, it was not possible to provide detailed information on the nature and extent of military activity throughout the study area. However, when developers undertake site selection studies, consultation with the MoD will need be undertaken to obtain more detailed site specific information.

Military practice areas in the study area are shown on Figure 9.4.6.

9.4.5.3 Baseline Description

Military activity occurs extensively throughout the study area with almost the entire coast utilised (Figure 9.4.6). Much of this is dominated by the Navy who use the PEXA areas for submarine, general surface fleet and aircraft exercises, there is no ammunition firing in these areas. There are no Air force training areas within the study area.

The UK low flying system (LFS) allows training within the whole of the UK airspace and surrounding seas, to 3nm, from the surface to 2,000 feet above the ground or mean sea level. Low flying is unlikely to impact upon offshore wind farms as no designated Tactical Training Areas (TTAs) are present over the sea, and any possible interference can be resolved through consultation, charting and lighting of developments (DTI 2002).

Air Surveillance and Control System (ASACS) are critical to air defence systems in the UK and as such the MoD submits holding objections to all wind energy proposals within 74km and in line of sight of air defence radars. There are no ASACS within 74km of the study area.

Two weapons ranges are located in the study area, the Magilligan and Ballykinler ranges which are controlled by the Army. Both Magilligan and Ballykinler ranges are Byelawed areas that are due to be reviewed by the Defence Estates as part of their review of all existing MoD byelaws.

Byelaws are a form of delegated legislation, used mostly by local authorities and government departments; they cover a defined geographical area, normally regulating certain activities in the interests of safety and security (MoD, 2009). In the two byelawed areas within the SEA study area certain civilian activities are restricted and so these areas would not be considered suitable for offshore renewable energy development.

The MoD is currently undertaking a review of the practise and exercise areas under byelaw and is also considering proposing new byelawed areas. No information is yet available on the location of proposed new byelawed sites.

9.4.5.4 Key Issues and Future Trends

Depending on the MoD's review of Byelawed areas the restrictions in place at the Magilligan and Ballykinler ranges may change. This should be taken into account in the EIA for any offshore renewable development.

9.4.6 Disposal Areas

9.4.6.1 Data Sources

- Harbour Dredging Spoil Disposal Sites: Data for Northern Ireland from CEFAS (2008)

9.4.6.2 Background

The deposit of substances or articles in the sea or under the sea-bed within Northern Ireland territorial waters or controlled waters is regulated by the NIEA, an agency of the DOE, under Part II of the Food and Environment Protection Act 1985 (FEPA).

The majority of sites receive chemically unmodified geological material derived from the adjacent coastline. Contaminated sediments which may be disposed of at sea (derived from routine dredging of existing harbours) are only licensed for disposal if contaminants are unlikely to cause environmental harm (EHS 2000).

Typically it can be assumed that there will be minimal interaction between marine renewable energy developments and disposal sites. Active disposal sites will almost certainly be avoided in site selection and it is also likely that out of use disposal sites may also be avoided due to the potential complexities (e.g. variable bathymetry, potential for disturbing contaminants) of installing in areas where materials have been previously been disposed.

9.4.6.3 Baseline Description

A number of statutory changes governing the types of waste that can be disposed of at sea have occurred over recent years. Since 1994, the dumping of most types of industrial waste has been prohibited and the disposal of sewage sludge was phased out at the end of 1998 under the Urban Waste Water Treatment Directive (91/271/EEC). Dredged material from port and navigation channel excavation and coastal engineering works now constitutes the majority of material that remains eligible for disposal at sea (EHS 2000).

Data detailing the location of all designated disposal sites in the study area that have been used in the last 10 years was provided to the SEA by CEFAS. These are shown in Figure 9.4.7. The frequency of use of the sites varies considerably. For example, some of the sites may have only been used once while others are used annually, and any one of the sites could be used in the future, irrespective of how frequently it has been used in the past (Pers. Comm. Peter Hayes, FRS). The majority of the sites shown in Figure 9.4.7 have been used for the disposal of silt, sand, gravel or rock, derived from new developments or extensions to small harbours. The practice of dumping sewage sludge is now prohibited, but the disposal of fish waste can still be licensed if the risk to risk to the environment and other users is considered to be within safe limits.

9.5 Material Assets

9.5.1 Cables and Pipelines

9.5.1.1 Data Source

In order to identify the location of cables and pipelines in the study area the following data sources have been used:

- UK Hydrographic Office (UKHO) digital charted data. This gives the locations of cables shown on Admiralty Charts.
- Kingfisher Cable Awareness Charts (KISCA). These charts give the locations of a number of national and international cable systems. Inclusion of cables on the charts is dependant on cable owners subscribing to KISCA and so some smaller cable systems are not included.
- UK Digital Energy Atlas Library (UKDEAL) data. This dataset details the location of oil and gas infrastructure around the UK including pipelines.

9.5.1.2 Background

The location of submarine cables and pipelines in the study area will be significant in terms of the siting of offshore renewable devices. Installation of devices will have to be away from active cables and pipelines.

Both submarine telecommunications and electricity interconnectors are located within the study area, as well as a number of pipelines.

Figure 9.5.1 accompanies this chapter and major cables systems located within the study area are detailed in Table 9.26.

9.5.1.3 Baseline Description

There are two major sub-sea electricity interconnectors in the study, both of which are operated by Northern Ireland Electricity (NIE). The Rathlin interconnector connects Rathlin Island to the main Northern Ireland electricity grid and the Moyle interconnector links Great Britain and Northern Ireland grids across the North Channel.

A number of telecommunications cables in the study area form an integral part of Northern Ireland's communications network, linking Northern Ireland with the UK and the Isle of Man. These communication links landfall on the east coast where crossing distances are shorter, in addition to these the Hibernia 'A' telecom cable, connecting Europe and the USA, passes in and out of the study area following the territorial limit. There are plans to connect Northern Ireland into the Hibernia 'A' system via a short section of cable from the north coast. This is known as Project Kelvin and is being pursued by the operator Hibernia Atlantic.

Table 9.26: Major Cable Systems in the SEA Study Area

Cable	Flow	Operator
Rathlin Interconnector	Power	NIE
Moyle Interconnector	Power	NIE
Scotland – N. Ireland 1	Telecommunications	BT
Scotland – N. Ireland 2	Telecommunications	BT
Manx – N. Ireland	Telecommunications	BT
Lanis 2	Telecommunications	C & W
Lanis 3	Telecommunications	C & W
Sirius North	Telecommunications	Virgin Media
Hibernia 'A'	Telecommunications	Hibernia Atlantic

There is only one major pipeline within the study area; this is the Scotland to Northern Ireland natural gas transmission Pipeline (SNIP) operated by Premier Transmission Ltd. The pipeline runs from Twynholm in Scotland to Ballylumford in Northern Ireland across the North Channel. There are two sub-sea gas pipelines crossing two of Northern Ireland's coastal Loughs, a 9km pipeline across Belfast Lough and a 3km pipeline across Larne Lough. In addition, a number of smaller local outfall pipes are located along the coast.

9.5.1.4 Key Issues and Future Trends

The international and national telecommunications industry is set to grow significantly as existing services are expanded, new services provided and consumer demand for internet access and use increases. There is a drive in Northern Ireland by DETI to provide international connectivity between Northern Ireland, North America and Europe. This may result in an increase in sub-sea cabling in the study area.

In addition future marine renewable energy development (wind, wave and tidal) both on and offshore in the UK and large wind farm developments in the Irish Sea will require significant upgrades to the electricity grid system. This may necessitate the development of High Voltage (HV) interconnector cables linking islands to the mainland or Northern Ireland to rest of the UK and will probably result in an increased number of sub-sea cables in the study area.

9.5.2 Aggregate Extraction

9.5.2.1 Data Sources

In order to describe aggregate extraction activity in the study area The Crown Estate were the key information source.

9.5.2.2 Background

The Crown Estate owns the (non-energy) mineral rights to the seabed extending to the edge of the UK continental shelf and issues consents for non-exclusive sampling and licences for commercial aggregate extraction. Before extraction can commence, the operator must first obtain consent from the government, in Northern Ireland this is administered by the Northern Ireland Environment Agency (NIEA).

9.5.2.3 Baseline Description

There is currently no licensed aggregate extraction in the study area and no prospective licence areas have been defined. However, to date there have been three areas that have been provisionally accepted for aggregate exploration by The Crown Estate following recent tender rounds. These areas have not been defined in terms of total extent but they are located adjacent to each other within 10nm from the coast of Kilkeel. Of these areas only two have applicants that wish to proceed to submit an application to the NIEA.

The next aggregates tender round to be undertaken by The Crown Estate is due to be held in 2011 (with any awards being made in 2012) and is likely to include Northern Irish waters.

9.5.2.4 Key Issues and Future Trends

The resource targeted by the marine aggregate industry is sand and gravel. This is a finite resource yet it is important for beach replenishment, coastal protection and construction. It is likely that as the population increases and coastal protection becomes crucial aggregate extraction will extend into those areas where resource is available and environmental sensitivities allow.

9.5.3 Renewable Energy Developments

9.5.3.1 Data Source

The following data sources have been used to inform this section:

- SeaGen website http://www.seageneration.co.uk/default.asp

9.5.3.2 Baseline Description

There is only one renewable energy installation currently in Northern Ireland's waters. The SeaGen horizontal axis 1.2MW tidal energy converter is currently operational in Strangford Narrows, and was the world's first commercial tidal generator.

Sea Generation Ltd is the project company which is a wholly owned subsidiary of Marine Current Turbines Ltd. SeaGen has been licensed for a maximum installed duration of 5 years.

9.5.4 Natural Gas and CO_2 storage

9.5.4.1 Data Source

The following data sources have been used to inform this section:

- DETI press release 12th May 2008

9.5.4.2 Baseline Description

Whilst there are no current proposals for storage of carbon dioxide in Northern Ireland waters, this is a use of the marine environment which could be implemented in the future. Carbon Capture and Storage (CCS) represents a possible future use of the subsea strata in NI waters. Whilst the UK is currently focussing attention on possible storage sites in the North Sea, should Northern Ireland require storage sites for its coal fired power stations it is likely that these would need to be sited in Northern Ireland's waters, close the source of the emission. At the time of writing, there is insufficient data to determine whether suitable geological conditions for carbon storage are present, although it is known that saline aquifer rock units are present.

The potential for natural gas storage using underground salt caverns in the vicinity of Lough Larne are the subject of ongoing studies.

9.6 Seascape

9.6.1.1 Data Source

The seascape assessment has been prepared with reference to a number of guidance documents including:

- DTI Guidance on Seascape and Visual Impact Assessment of Offshore Wind Farms[15]
- Scottish Marine Renewables SEA, 2007[16]
- UK Offshore Energy SEA 2009[17]
- Scott *et al*. Assessment of the Sensitivity and Capacity of the Scottish Seascape in relation to Offshore Wind Farms[18]
- Guide to Best Practice in Seascape Assessment (Hill *et al*., 2001)[19]
- Guidelines for Landscape and Visual Impact Assessment (GLVIA), published by the Landscape Institute and the Institute of Environmental Management and Assessment in 2002

9.6.1.2 Baseline Description

The main Seascape Character Types in Northern Ireland, protected/designated landscapes and associated experiential qualities is described in Table 9.27 below.

[15] Guidance on the Assessment of the Impact of Offshore Wind Farms. Seascape and Visual Impact Report. (DTI, November 2005)
[16] Scottish Marine Renewables Strategic Environmental Assessment 2007, Scottish Executive,
17 UK Offshore Energy Strategic Environmental Assessment 2009, DTI
18 Scott, K.E., Anderson, C. and Benson, J.F. (2005). An Assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms. Scottish Natural Heritage Commissioned Report No. 103 (ROAME No. F03AA06)
[19] Hill, M. *et al*. (2001) Guide to Best Practice in Seascape Assessment. Countryside Council for Wales

Table 9.27: Seascape Character Types, Designated Landscapes and Visual Amenity

Location	Description	Designated Landscapes	Experiential Qualities
Seascape Type 1 – Large Open or Partially Open Sea Lough with Raised Hinterland			
Lough Foyle Belfast Lough Carlingford Lough	▪ This seascape type comprises large scale sea loughs associated low-lying coastal plain, raised hinterland and headlands. ▪ Tidal mudflats are a common component of the seascape, with sands and mudflats evident at lough mouths. ▪ Settlement can vary, the hinterland can be comprised of low lying agricultural land with scattered rural settlement, elsewhere dense urban development is concentrated around head and mouth of the sea loughs, leading to visually prominent industrial infrastructure and linear development. ▪ Typically large ports and harbours are located at the lough head with associated urban or industrial development. ▪ Ferry terminals and busy shipping lanes are located at Lough Foyle and Belfast Lough.	▪ Lough Foyle and Carlingford Lough fall within the Derry Slopes and Mourne AONBs. ▪ Lough Foyle is also overlooked by EHSA areas.	▪ Large scale open views along windswept low lying shorelines are contained by basalt ridges or raised hinterland. ▪ Long smaller scale contained views from lough shores to the open sea are framed by headlands. ▪ Where there is an absence of urban development, truncated views along the lough to the open sea provide a high scenic quality.
Seascape Type 2 – Inner Sea Lough Enclosed by Narrow Mouth with Raised Hinterland			
Larne Lough Strangford Lough	▪ Inner loughs are more enclosed and sheltered in character than Seascape Type 1 above. ▪ The loughs are typically contained within a broad flat bottomed valley enclosed by distinct basalt ridges. ▪ Valley floor and shoreline are comprised of low lying coastal fringe and/or tidal mudflats and backed by raised hinterland and headlands. ▪ Flat estuarine landscapes with open farmland and estate woodlands situated on lough sides. ▪ Sheltered and rural character with pockets of visually dominant industrial development including Mageramorne quarry and Ballylumford power station situated at Larne Lough. ▪ Varying settlement patterns from scattered rural housing and farms in valleys to larger settlements at lough mouths and heads.	▪ This seascape type occurs within Strangford Lough AONB which is also Northern Ireland's only Marine Nature Reserve.	▪ Open contained views are experienced along the lough. The associated landmass increases the scale of these views. ▪ Views to the open sea are limited or obscured by the topography. ▪ Views and experience is primarily inward looking with associated qualities of shelter and tranquillity. ▪ There are some areas of high scenic quality.
Seascape Type 3 – Sounds at Mouths of Enclosed Sea Lough and Raised Hinterland			
Larne Lough Strangford Lough	▪ Key characteristics are sounds and narrow lough mouths backed by secondary rolling hinterland and steeply sloping shores. ▪ Associated shorelines are complex and indented with occasional small islands. ▪ Landscape is intimate in character containing attractive traditional coastal settlements comprising clusters of cottages, small scale harbours and scattered rural settlement. ▪ Dominant character of this seascape type is rural. ▪ Attractive headlands contain pockets of raised beaches with small bays at the outer lough mouth.	▪ Strangford Narrows falls within both the Strangford Lough AONB and Lecale Coast AONB. ▪ The narrows of Larne Lough fall partially within the Antrim Coast and Glens AONB area.	▪ Scenic landscape ▪ The sound diverts visual attention inland away from the outer coast and focuses attention on the adjacent shores or on the water itself. ▪ Sense of scale is reduced with the containment of views by the surrounding rising landmass. ▪ Sounds have a sense of tranquillity and calm and shelter.

Location	Description	Designated Landscapes	Experiential Qualities
Seascape Type 4 – Low Lying Coastal Plain			
Magilligan Lowlands Causeway Coast and Rathlin Island Ballycastle Glens Outer Ards Peninsula Ballyquintin and Lecale Coast Tyrella Coastal Dunes Kilkeel Coast	▪ Diverse and changeable – ranging from large to medium scale. ▪ Exceptionally flat and exposed. ▪ Coastal edges comprise either long sandy beaches or strands or sweeping rounded bays and curved sandy beaches. ▪ Occasional rocky and fragmented foreshores that slope gently up to coastal flats of the coastal strip. ▪ Low-lying coastal strip rises to a hinterland of rolling foothills, separated to the coast by agricultural land. ▪ The Magilligan Lowlands contain expansive and rugged sand dune systems, which provide a distinct separation between lowland hills and coastal strand. ▪ Patterns of settlement within this seascape type are generally rural and scattered. ▪ Development either follows a linear pattern dictated by low key transport lines or is localised and dispersed as appropriate to farming needs.	This seascape type is present in five of Northern Ireland's eight AONB areas: ▪ The Derry Slopes. ▪ Causeway Coast. ▪ Antrim Coast and Glens. ▪ Lecale Coast. ▪ Mourne.	▪ Wide, open, often expansive and long distance views extending far out to sea. ▪ From The Causeway Coast the distant peaks of Donegal can be seen while on a clear day it is just possible to view the southern west tip of Scotland. ▪ Enormous sense of scale with uninterrupted views. ▪ Isolated peninsulas e.g. Magilligan Strand can appear remote and wild. ▪ There are some areas of very high scenic quality such as Dundrum Bay.
Seascape Type 5 – Narrow Coastal Strip with Raised Hinterland			
Eastern Binevenagh Slopes Coleraine Farmland Moyle Glens Larne Glens Larne Coast Island Magee Dundrum Bay and Kingdom of Mourne Eastern Binevenagh Slopes	▪ Seascape is typified by the occurrence of a narrow, often inaccessible, coastal strip backed by raised beaches and headlands. ▪ In many places (such as Coleraine Farmland,) the coastal strip is divided from the rising hinterland by transportation corridors of minor roads and railway tracks. ▪ At the foot of the Mourne Mountains, the coastal edge is steep and rocky, rising to a narrow raised coastal shelf providing huge vistas of the bay and open sea. ▪ Often the coastline can be indented with steep hinterland, headlands and incised bays. ▪ The landscape is exposed and rugged with scattered rural settlements. ▪ Small linear developments follow road corridors are clustered adjacent to sheltered bays.	There are three AONB areas that include this Seascape type: ▪ The Derry Slopes ▪ Antrim Coast and Glens ▪ Mourne On the west shore of Lough Foyle there are EHSA areas of this seascape type.	▪ This seascape type is open and expansive with many elevated dramatic views to sea from both the raised hinterland and coastal shelf. ▪ The vast scale of the sea is in places heightened by the steeply rising hinterland and elevated viewpoints. ▪ There is a sense of exposure and a wildness which balanced by the influence of agriculture in the landscape providing areas of high scenic quality.

Location	Description	Designated Landscapes	Experiential Qualities
Seascape Type 6 - Complex Indented Coast, Small Bays and Offshore Islands			
Binevenagh; Eastern Binevenagh Slopes; Coleraine Farmland; Causeway Coast and Rathlin Island; Fair Head; Moyle Glens; Larne Glens; Larne Coast; Island Magee; Outer Ards Coast; Strangford Drumlins and Islands; Portaferry and North Leacale; Balyquintin and Leacale Coast and Newry Basin	▪ Seascape contains a varied, complex and incised coastline with steep, undulating hinterland, small bays and cliffs. ▪ The coastline along the Causeway Coast and Rathlin Island comprises a distinct, narrow, often rocky shelf with associated islands and rocky knolls. This is separated from the high plateaus beyond the coastline by high cliffs, sea blown arches and the rugged coastal massif. ▪ There are a number of small bays associated with headlands and raised beaches ▪ In some locations the hinterland consists of a drumlin landscape which rolls down to meet a deeply indented shoreline. ▪ At Ballyquintin, Moyle and Larne Glens large incised bays are formed at the mouth of large steep sided valleys. ▪ Traditional settlements and small towns are located in sheltered bays and inlets, with more rural settlement scattered over exposed uplands.	This seascape type is present in five of Northern Ireland's AONB areas: ▪ The Derry Slopes ▪ The Causeway Coast ▪ The Antrim Coast and Glens ▪ Strangford Lough ▪ Lecale Coast It also occurs within the Giants Causeway World Heritage Site and the Strangford Lough Marine Nature Reserve.	▪ Due to the complexity of the landform associated with this distinct seascape type, the experience and views continually change. ▪ Within indented inlets, contained views scaled by landmass give a sense of tranquillity and calm. ▪ This contrasts with the long, impressive and expansive views gained from the raised hinterland. ▪ The associated off shore islands create a rugged profile in a mass of sea when viewed from the shore. ▪ The raised headlands and hinterland are rugged and exposed. ▪ Within the drumlins and steep valleys, views can be enclosed with sea framed by an undulating landscape. The experience here is sheltered and more intimate. ▪ Typically this is a landscape of very high scenic quality.
Seascape Type 7 - Plateaus and High Cliffs			
Binevenagh; Eastern Binevenagh Slopes; Coleraine Farmland; Causeway Coast; Rathlin Island and Fair Head	▪ There is great vertical scale where often a high plateau landscape with basalt cliffs plunges abruptly to an incised coastal edge. ▪ Typically the plateau edge is raised with limited views from the rural hinterland out to the open sea. ▪ The narrow coastal edge is low, flat and in places jagged, comprising rocky mosaic, complete with rocky peninsulas and occasional small bays. ▪ The vast horizontal scale of sea and sky contrasts dramatically with the cliff faces, arches, basaltic columns and raised plateau. ▪ Black basalt cliffs contrast with chalk faces and white beaches dotted along the Causeway Coast. ▪ Settlement is largely rural scattered development, tourism and farmland.	This seascape is the setting of the unique geological features at Giant's Causeway designated a World Heritage Site (see Seascape Type 9). This seascape type occurs in three AONB areas: ▪ The Derry Slopes ▪ The Causeway Coast ▪ The Antrim Coast and Glens.	▪ The open expansive and elevated views to sea add to sense of wildness within this seascape type. ▪ The rugged and visually dramatic landscape is heightened by the interaction and interplay of weather and changing sea and sky. ▪ The combination of exposure to the elements and vastness of scale contribute to the dramatic character of the seascape. ▪ There are long, open, elevated views along the coast and out to the open sea including long views to Donegal and Scotland along the north coast. ▪ Typically this is a landscape of very high scenic quality.

Location	Description	Designated Landscapes	Experiential Qualities
Seascape Type 8 - Large Bay			
Dundrum Bay	▪ This is a distinct landscape comprising a very large long sweeping bay with sand dunes backed by flat agricultural land. ▪ The flat exposed coastal plateau rings the bay and rises steeply to the mountain landscape with plantation forestry to the south. ▪ The dramatic contrast between the flat plateau, great expanse of sea and sky with the steep volcanic mass of the Mourne Mountains creates a distinctive landscape. ▪ The north and east shoreline is rugged and exposed with scattered rural settlement. ▪ The town of Newcastle sits under the shelter of the Mountain to the south ▪ The traditional distinctive coloured house fronts form a linear edge visible across the bay.	Dundrum Bay is contained within two AONB areas: ▪ Lecale Coast ▪ Mourne AONB	▪ The scale of the landscape is vast with very long open views across the bay and out to the wide horizon of the open sea. ▪ The effects of scale, light, and water in long uninterrupted vistas are particularly important components of the landscape character within the bay area. ▪ The open and expansive long views from north shore are contained by the dramatic mass of the Mourne Mountains creating a foreshortening effect when looking south across the bay. ▪ Looking north towards the Lecale coast the flat open landscape forms a low linear strip on the horizon exaggerating the expanse of water and fading to the east into the wide horizon of the open sea. ▪ Typically this is a landscape of very high scenic quality.
Seascape Type 9 – The Giant's Causeway			
Causeway Coast	▪ This seascape contains the unique geological features at Giant's Causeway within a setting of steep cliffs and small rocky bays. ▪ This is an exposed, rugged and visually dramatic seascape. ▪ Steep cliffs tower above small sheltered bays and the dramatic rock formations of the causeway peninsula. ▪ The Giant's Causeway cannot be categorised within the eight other seascape types and is deemed to form its own unique seascape with a complex set of defining attributes shared nowhere else within the study area.	▪ The Giants Causeway is designated a World Heritage Site for its scenic, scientific and geological value and is within the Causeway Coast AONB.	▪ The special and unique geology, dramatic setting, long open views along the coast and expansive views to the open sea add to the special quality of this seascape type. ▪ This landscape is of exceptionally high scenic quality and attracts thousands of visitors every year.

The nine seascape types discussed above are illustrated on Figure 9.6.1. Further information on these seascape types and the associated landscape designations can be found in Appendix E.

Seascape Sensitivity

Table 9.28 below summarises the sensitivity to change of each of the eight seascape types in relation to each of the three different device characteristics prior to mitigation. Chapter 6: Assessment Method provides further detailed information of the various criteria considered when determining the sensitivity of the seascape types to the potential changes discussed in relation to:

- Offshore windfarms
- On surface linear devices (wave and tidal)
- On surface point structures (wave and tidal)

Table 9.28: Seascape Sensitivity

Seascape Type	Sensitivity to Change		
	Off Shore Wind	On Surface Linear Structure	On Surface Point Structure
1 – Large Open or Partially Open Sea Lough with Raised Hinterland	High	N/A	N/A
2 – Inner Sea Lough with Narrow Mouth and Raised Hinterland	N/A	N/A	N/A
3 – Sounds at Mouth of Enclosed Sea Lough with Raised Hinterland	N/A	N/A	High
4 – Low Lying Coastal Plain	Medium	Low	Medium-
5 - Narrow Coastal Strip with Raised Hinterland	High	Medium	Medium
6 – Complex Indented Coast, Small Bays and Off Shore Islands	High	Medium	High
7 – Plateaus and High Cliffs	High	Medium	Medium
8 – Large Bay	High	Medium	Medium
9 – Giant's Causeway	High	High	High

The levels of sensitivity presented above (low, medium and high) are based on the criteria presented in Chapter 6: Assessment Method.

Description of Levels of Sensitivity of Seascape Types to Offshore Wind Devices

The types of seascape that are least sensitive to offshore wind device characteristics are large scale, robust and open. The broad horizontal sea horizon of, for example, Seascape Type 4: Low Lying Coastal Plain has some capacity to absorb change, although there is potential for the low angle of vision to be sensitive to the introduction of a large scale vertical element. Hence this seascape type is judged to be of Medium Sensitivity to the device described.

Within Seascape Type 6: Complex Indented Coast with Small Bays and Off Shore Islands and Type 8 – Large Bay, the reduced scale of the sea horizon and enclosed view within the bay has potentially less ability to accommodate offshore wind devices. The elevated viewpoints of Seascape Type 7: Plateau and High Cliffs, Type 6 Narrow Coastal Strip with Raised Hinterland and Type 9 - Giant's Causeway, provide extensive elevated panoramic vistas which may increase the potential prominence and visibility of an offshore wind development. The sensitivity of these seascape types to offshore wind developments is therefore high.

Description of Levels of Sensitivity of Seascape Types to On Surface Linear Structure Devices

Generally, seascapes which are least sensitive to the On Surface Linear device characteristics are those with large scale character combined with open, expansive views of the sea. The On Surface Linear device could follow to a certain extent the natural movement of the sea, and be partially hidden by wave motion.

The sensitivity to the Surface Linear devices has been described as Low in Seascape Type 4: Low Lying Coastal Plain due to the large scale and low viewpoint. In Seascape Type 6: Complex Indented Coastline with Small Bays and Offshore Islands and in Seascape Type 8 Large Bay, topography and scale could potentially curtail views and limit perception of a surface linear device although there is a possibility that the linear form of array may conflict from the character of a complex coastal edge.

From the elevated viewpoints of Seascape Type 7: Plateau and High Cliffs and Seascape Type 5: Narrow Coastal Strip with Raised Hinterland, offshore On Surface devices may be evident from further afield. Coastal linear devices conversely may potentially be less noticeable where the raised viewpoint allows views over the devices to the open horizon. The sensitivity of Seascape Types 5, 6, 7 and 8 to On surface Linear device characteristics is therefore medium. Seascape Type 9 the Giants Causeway combines extensive and elevated panoramic views with vulnerable and unique seascape qualities resulting in a high sensitivity to on surface linear device characteristics.

Description of Levels of Sensitivity of Seascape Types to On Surface Point Structure Devices

Horizontal and large-scale seascapes with open views across sea have a greater potential capacity to accommodate On Point Surface Devices characteristics. However, depending on the scale and placement of these devices within the seascape, the introduction of new vertical elements within the sweeping vista could potentially affect the existing seascape character.

Therefore Landscape Types 4 – Low Lying Coastal Plain, 7 – Plateaus and High Cliffs, and 8 – Large Bay are of medium sensitivity. In Seascape Type 3 – Sounds at Mouth of Enclosed Sea Lough with Raised Hinterland and 6 – Complex Indented Coast, Small Bays and Off Shore Islands sensitivity prior to mitigation is high due to the reduced scale of the seascape, although there may be some potential for topography to curtail views and limit perceptions. The introduction of On Surface Point Structure device characteristics to the extensive and elevated panoramic views of Seascape Type 9 - Giant's Causeway could potentially create a noticeable focal point in the open sea, where none previously existed, therefore this vulnerable and unique seascape is of high sensitivity prior to mitigation.

9.7 Climate

9.7.1.1 Data Source

- Marine & Coastal Projections (UK Climate Projections report) – June 2009
- Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: 1990-2007 – AEA Technology – September 2009
- First Steps Towards Sustainability – A Sustainable Development Strategy for Northern Ireland. 2006.
- Digest of UK Energy Statistics 2009 – DECC
- Planning Monitoring and Review of Renewable Energy Projects – Quarterly Review Northern Ireland (Sept – Nov 2008) – BERR
- Guidelines to Defra / DECC's Greenhouse Gas Conversion Factors for Company Reporting
- Offshore wind – economies of scale, engineering resource and load factors – 2003 – Garrad Hassan for DTI

9.7.1.2 Background

Climate change has many facets which need to be considered. Firstly there is the anthropogenic contribution to climate change in the form of greenhouse gas emissions such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Secondly there are the changes to the climate itself and the physical environment, such as temperature, sea level, and extreme weather. Thirdly the vulnerability of a range of systems to these changes should be considered i.e. natural ecosystems and engineered infrastructure. And finally, there are the human responses to these vulnerabilities, which can include risk assessment and pre-emptive adaptation measures.

Efforts to minimise greenhouse gas emissions through, for example, energy efficiency and the supply of renewable energy are generally referred to as climate change mitigation. Understanding vulnerabilities to climate change and developing responses to these vulnerabilities is referred to as climate change adaptation.

9.7.1.3 Baseline Description

Although there are many sources of anthropogenic greenhouse gas emissions, the primary source around the world is the combustion of fossil fuels – particularly oil, coal and natural gas. The process of combustion converts the fossil carbon into gaseous carbon dioxide (CO_2): the CO_2 in the atmosphere traps some of the heat radiated from the surface of the earth, which creates a warming effect. Concentrations of CO_2 in the atmosphere have been increasing since the industrial revolution, but much more rapidly in recent decades. International efforts at global and EU levels, beginning with the Kyoto Protocol, have been underway for some time to stem the increase in CO_2 concentrations and limit global temperature increases to a potentially manageable limit of 2°C.

Within Europe, the EU Emissions Trading Scheme (EUETS) is in operation to limit emissions from large combustion plant (power generation and heavy industrial sectors). The EUETS is a cap and trade system where carbon allowances are allocated up to a fixed limit (the 'cap' which is reduced over time): this has created a carbon market, as emitters can sell excess allowances if they reduce their emissions sufficiently or buy additional allowances if required. Prices are set by the operation of the market. If the overall cap is exceeded, additional allowances must be acquired through flexible mechanisms under the Kyoto Protocol such as the Clean Development Mechanism (CDM) which funds carbon reductions in developing countries. Marine renewable can be part of a strategy for reducing the need for fossil fuel power generating plant in Northern Ireland.

Within the UK, the Climate Change Act 2008 provides an additional impetus towards decarbonising the economy. It requires carbon emissions to be reduced by 80% (from 1990 baseline) by the year 2050, with an interim target of a 34% reduction by 2020.

DETI has recently published, for consultation, its draft Strategic Energy Framework (SEF) for Northern Ireland 2009. This documents sets out the direction of travel on energy policy for the energy industry and consumers. The framework focuses on improving the competitiveness of the energy markets in Northern Ireland and improving the supply and reliability of the energy supply in Northern Ireland and securing the supply of energy for the future.

In terms of future – proofing electricity supplies, the SEF looks at renewable energy sources as providing more sustainable long term sources of energy and has set proposed targets for 40% of Northern Ireland's electricity to come from renewable sources, including offshore wind and marine, by 2020. Achieving this target would also assist Northern Ireland in delivering its contributions to the EU targets for reducing greenhouse gas emissions by 20% by 2020.

In addition to improving security of supply of electricity in Northern Ireland, it is also important to understand the potential implications of climate change in relation to the marine environment. Some of the key potential issues are summarised below:

- Relative sea level rise at Belfast of 11.1 – 18.6cm by 2050, and 19.6 – 32.3cm by 2080 compared to the base year of 1990. These are central estimates based on Low – High greenhouse gas emissions scenarios. The 5th and 95th percentile estimates suggest a much wider possible range of around 5cm to 60cm by 2080.
- The climate projections programme also modelled the changes in storm surges around the UK as a result of climate change. This suggests that there will be a small increase in the size of surge to be expected once in 50 years (over and above the projected rise in relative sea level). Over the course of the 21st Century, this increase is expected to amount to less than 0.3mm per year in the waters around Northern Ireland (to be added to the relative sea level rise). By 2095, the combined effect of sea level rise and storm surge increase could result in 50 year return storm surges of around 1.5m above present day astronomical high tide levels (central estimate).
- Climate change driven changes in waves have also been modelled based on a wind subset of Met Office climate modelling. In general these show a slight increase in seasonal mean and extreme waves to the SW of the UK and a decrease towards the North of the UK. In the waters around Northern Ireland, the projected trends suggest a decrease in wave height to the North and no significant change in the Irish Sea. These tentative projections are, however, based on maps with a very coarse grain, and considerable uncertainty is reported.
- Changes to hydrography and circulation have also been modelled, covering temperature, salinity, stratification and circulation. A seasonal mean sea surface temperature increase of 2.5 to 4℃ is projected for the Irish Sea by the end of the 21st Century.
- Changes to sea temperatures and salinity could also affect marine biodiversity and ecosystems. Of particular concern is the distribution and abundance of protected marine species and habitats and other keystone species, changes to which could affect the integrity of entire marine ecosystems. Various forms of plankton are considered to be particularly vulnerable to changes in sea temperatures and salinity, as are certain species of fish and benthic habitats and species.
- Changes in marine ecosystems could have wider knock on effects in terms of the industries and sectors that are dependent upon them for example commercial fisheries and aquaculture.

Section 3: Assessment Results

10 Generic Assessment

10.1 Introduction

This chapter provides a discussion of the potential generic effects associated with offshore wind, wave and tidal stream developments for installation, operational, maintenance, subsea cables and decommissioning. Most potential effects associated with decommissioning are similar to those that occur during the installation of devices and are therefore discussed in this chapter under the description of potential installation effects. Information on these main activities/development stages are discussed in Chapter 8: Technologies.

A detailed assessment of the potential effects of offshore wind, wave and tidal developments on sensitive receptors that are known to be present in certain parts of the study area is presented in Chapter 11 (Resource Zone Assessment).

This chapter does not include any mitigation measures. Information on proposed mitigation measures are discussed in Chapter 11 in relation to specific effects identified within each of the resource zones.

10.2 Potential Effects on Water and Soil (Sediment)

The main SEA topics in terms of Water and Soil (Sediment) include:

- Bathymetry
- Geology, geomorphology and sediment processes
- Seabed contamination and water quality

10.2.1 Bathymetry

No significant effects on seabed bathymetry are expected to result from the development of offshore wind or marine renewable energy, during either installation or operation of arrays of marine renewable energy devices.

However, the water depth/availability of the water column for navigation and other sea uses is likely to be affected by the installation of arrays of marine renewable energy devices. The impacts upon shipping and navigation are discussed in Section 10.5.5.

Potential effects on seabed morphology and coastal processes are discussed in Section 10.2.2.

10.2.2 Geology, Geomorphology and Sediment Processes

The potential for interaction of renewable devices offshore with the geological and broader geomorphological environment is generally low, being confined to small areas where devices are piled into, or moored on, the seabed, and the export of cables to shore.

Of greater concern is the potential interaction of marine renewable devices with the hydrodynamic regime, which may in turn affect the sediment dynamics and thus sediment movements and coastal processes.

Specific potential impacts on geology and the sedimentary environment are listed below. The effects are assessed purely in terms of the physical geological environment. The associated potential effects on marine wildlife (benthic ecology, fish and shellfish, reptiles, birds and marine mammals) are addressed in Section 10.3.

10.2.2.1 Installation Effects

Increase in suspended sediment: Increase in suspended sediment caused by release of sediment into the water column during installation / decommissioning of devices and their associated export cables. These effects will generally be limited in duration and extent. This is particularly true in the higher energy environments which are more associated with wave and tidal devices than offshore wind, and the dynamic nature of the marine environment, causing continual changes in suspended sediment load.

Change in seabed morphology caused by the piling of seabed fixed devices into the seabed, or physical disturbance during export cable installation (e.g. excavation of sediment and underlying bedrock) has the potential to affect sedimentary structures and bedforms, solid geology or geomorphological features.

Buried power export cables are generally installed within the top couple of metres of unconsolidated sediments or (partially) consolidated glacial drift material. The resulting burial material is mobile and may be subject to dynamic environment and erosion from currents.

Potential effects are likely to be most significant on coastal geological ASSI and GCR sites. There may also be potential effects on future offshore Marine Conservation Zones (MCZs) that are designated for geological features, although the precise locations of these sites are still to be determined as the designation of these sites is still under review.

Cable trenching activities or the installation of shoreline devices in areas designated as geological ASSIs, GCR and MCZ sites could have a significant adverse effect on the integrity of these areas. However, though cable routeing studies and site selection surveys these sites could be avoided, reducing any potential significant effects to negligible.

10.2.2.2 Operation Effects

Change in sediment processes: Modifications to sediment transport pathways in the immediate vicinity of operating devices, and sediment accretion or erosion (scour) of sediment at the site, could occur during the operation of marine devices. This effect could occur both as a result of the physical presence of devices on the seabed acting as a barrier or diversion to sediment transport during device operation (relevant for wind, wave and tidal), or as a result of localised hydrodynamic changes associated with wave or tidal energy removal by the operating device (relevant for wave and tidal devices only).

With regard to effects from the presence of devices, there is a direct relationship between the diameter of wind turbine towers (4-5m) and the extent of scouring (ABPmer, 2002). Estimations of the extent of scour indicate it to be between 6-10 times the tower diameter (24-50m). Variation in the extent of scouring is a consequence of differences in sediment characteristics and current regime.

Based on specialist advice from the Scottish Marine Renewables SEA, there is potential that the effects of energy extraction on sediment processes could occur up to 50 m from operating wave and tidal devices (Scottish Executive, 2007). This effect is therefore localised to the vicinity of the device array, but will be effective for the operational life of the device. Potential effects can be reduced through the utilisation of scour protection materials.

Changes in coastal processes: In order to assess the potential effects due to energy extraction, reference is made to a study that was undertaken as part of the Scottish Marine Renewables SEA, which looked at the effects that wave and tidal devices have on the energy associated with tidal currents and wave regimes. The aim of this study was to review the existing knowledge relevant to determining how any reductions in this energy could affect marine and coastal processes (Scottish Executive, 2007). The conclusions from this study informed the assessment of effects on seabed sediment and sediment transport from wave and tidal devices.

The main conclusions were that wave and tidal devices could potentially have significant adverse effects on coastal processes, particularly in areas with high levels of erosion, accretion and long-shore drift. However, it is important to note, that due to a number of variables e.g. the timescales over which these changes may occur (medium to very long-term); the extent of the change (slight to large), the distance from shore; the potential for effects to be reduced through careful site design; and the fact that these are only based on a limited number of previous studies; further research is needed to further increase understanding of this issue. It is likely that this information will only start to become readily available once commercial scale arrays are starting to be deployed as a number of the variables relate to the interactions between devices and arrays and coastal processes.

Based on current knowledge it is concluded that any potential significant effects of energy extraction on coastal processes could be prevented or minimised by avoiding siting devices where they could affect important sediment transport pathways. Modelling of coastal processes may be required as part of the site selection process to determine exactly which areas would be most sensitive to a possible reduction in energy from tidal flows or the wave regime.

The potential effects are summarised in Table 10.1.

Table 10.1: Summary of the Potential Effects on Geology, Geomorphology and Sediment Processes

Effect	Technology	Development Phase	Direct/ Indirect	Duration	Extent
Increase in suspended sediment	Wave / Wind / Tidal	CD CC	Direct	Temporary	Negligible
Change in seabed morphology	Wave / Wind / Tidal	CD CC	Direct	Long term (device life)	Within array area Cable route
Change in sediment processes	Wave / Wind / Tidal	OD	Direct	Long term (device life)	50m
Change in coastal processes	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Unknown and variable

CD = Construction/decommissioning impact – devices
CC = Construction/decommissioning impact - cables
OD = Operation impact – devices
OC = Operation impact – cables

10.2.3 *Seabed Contamination and Water Quality*

The following is a description of the potential effects that the installation and operation of wave, wind and tidal devices could have on water and sediment quality in the study area. It should be noted that, although the marine hydrodynamic environment is generally such that potential contaminants will tend to be dispersed, effectively diluting any potentially harmful inputs, there is still the potential for adverse effects to occur.

The potential effects of the installation and operation of devices, and the installation of cables on seabed and water quality are described below.

10.2.3.1 Installation Effects

Disturbance of natural sediments: Any seabed operation carried out on a sediment substrate is likely to temporarily re-suspend particulate material. At this SEA level it is not appropriate to quantify the potential effects for individual projects, because of the high number of variables involved in determining background and project related suspended sediment levels.

Sediments will be disturbed during the construction phase of offshore wind, wave and tidal arrays during pile driving and cable laying. They may also be disturbed during the removal of piled foundations during decommissioning. The coarser fraction of the sediment disturbed is likely to be initially re-deposited on the seabed close to the works, but will remain mobile. Any fine material released in a high energy area will disperse widely with eventual deposition over a large area. Where seabed operations impact low energy sites, fine sediments may be disturbed and large quantities of fine material could be released.

For wave and tidal devices, which will be placed in high energy environments; it is likely that readily disturbed sediments (e.g. unconsolidated silts and muds) will not be present at actual generator sites. Such sedimentary material that does exist at the turbine site is likely to be sand sized or greater, although consolidated clays, deposited under more favourable conditions and subsequently exposed, may be encountered. The increase in suspended sediment load is likely to be local for coarse material, but fine particles may remain in suspension and increase turbidity.

Release of additional sediment during construction: Production of extra sedimentary material on site (for example during drilling to insert piles into bedrock or in the course of trenching operations) is likely to have mainly localised impacts. Contamination to water and seabed sediments from this source is likely to be restricted to changes in particulate material distribution, but there is a possibility of dissolution of newly exposed particulate material through normal weathering reactions. It is unlikely that this will produce any significant change in water quality as only superficial bedrock is likely to be exposed.

Release of contaminants during construction: Various installation and decommissioning activities including grouting drilling or piling operations (installation and removal) and vessel movements may necessitate the release of toxic or otherwise hazardous materials, temporarily affecting the water quality of the local environment. The main route for contamination from this source is through the dissolved phase. Release of inert particulate material is discussed above.

Planned use and discharge of chemicals in construction operations will be subject to controls as part of consent requirements. Special conditions (e.g. that all spent or unused muds and cuttings must be transferred ashore for disposal) may be recommended.

It is impossible to predict the nature and quantity of such releases at this time due to a lack of detailed information on the variety of installation operations. Such impacts will have to be assessed on a case-by-case basis for specific developments.

Disturbance of contaminated sediments: The potential adverse effects of disturbing historically contaminated sediments during device and cable installation and removal depend on the nature (e.g. domestic or industrial waste, radionuclides, munitions) of the potential contamination source and local receptors. However, whilst impacts on water quality resulting from the disturbance of contaminants are most likely to be temporary, depending on the type and amount of material released, potential contaminants could be dispersed over a much wider area and persist within the environment beyond the lifetime of the project.

Accidental release of contaminants: There is a possibility that installation and decommissioning activities may lead to release of contaminants from vessels to water and sediments. These could include fuel and lubricating oils, cleaning fluids, paints, specialised chemicals and litter. Contamination from accidental spillages is likely to enter the environment either through the dissolved phase or as low solubility, slick forming, organics. Accidental contamination could also result from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays.

It is impossible to predict the nature and probability of accidental contaminant releases at this time, as installation methods will vary from development to development. Any use and discharge of chemicals in maintenance operations are likely to be subject to controls as part of consent requirements. Special conditions regarding storage and disposal may be recommended.

Should navigating vessels be involved in collisions with vessels involved in construction there is an additional effect associated with release of contaminants being carried by the vessel in question.

10.2.3.2 Operation Effects

During device operation the following impacts are possible:

Accidental release of contaminants: There is a possibility that routine maintenance operations may lead to release of contaminants to water and sediments. As noted above, these could include fuel and lubricating oils, cleaning fluids, paints, specialised chemicals and litter. Contamination from accidental spillages is likely to enter the environment either through the dissolved phase or as low solubility, slick forming organics. In the case of significant oil spills damage can be widespread and long lasting, affecting a wide range of ecosystems and amenities.

It is impossible to predict the nature and probability of accidental contaminant releases at this time, due to a lack of detailed information on device characteristics. Any use and discharge of chemicals in maintenance operations are likely to be subject to controls as part of consent requirements. Special conditions regarding storage and disposal may be recommended.

Accidental contamination could also result from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays.

Contamination – erosion of sacrificial anodes: Sacrificial anodes are designed to corrode, and thus dissolve, in preference to constructional iron and steel, prolonging the useful life of structures exposed to seawater. The technology is widely used in marine construction with no noted adverse effects. However, two of the most commonly used anode materials (Zinc and Aluminium) are potentially toxic to marine organisms and have EQS values of 10 μgl^{-1} and 40 μgl^{-1} respectively. These represent concentrations below which there is not predicted to be any significant environmental effect. In practice anode dissolution rates are sufficiently low that contaminant concentrations are unlikely to approach the EQS in any but the most restricted waters (see Section 5).

Contamination – leakage of hydraulic fluids: During the normal operation of some types of generation system it is possible that there will be minor leakages of hydraulic fluids. Contamination may be through the dissolved phase or in the form of slick forming low solubility liquids. Local water quality may be impacted by the leakage of hydraulic fluids and depending on the nature and quantity of material lost there is a risk of tainting of shellfish. However, it should be noted that developers will seek to avoid such impacts as it will increase the maintenance requirements for the devices. There is currently insufficient information on the uses of such substances and it is therefore not possible to fully quantify the effects.

Contamination – anti-fouling compounds: It is expected that use of antifouling coatings will be minimised as far as possible. In many applications non-toxic materials, which prevent settling of fouling organisms by mechanical means are now available. Assuming non-toxic materials are used no measurable impacts, on water or sediment quality from the use of anti-fouling paints, are predicted. Even if small quantities of toxic materials such as copper are used it is expected that the highly energetic environment in which devices are likely to be located will result in rapid dilution and dispersal.

Disturbance to contaminated sediment resulting from changes in sediment dynamics: As described above, localised changes in sediment dynamics could occur during wave, wind and tidal device operation, resulting in disturbance of natural and contaminated sediments. This impact, if it occurred during operation, is likely to be of a lesser magnitude than the disturbance of contaminated sediments during installation described above.

Table 10.2 below provides a summary of the potential effects on sediment and water quality. Biological receptors that will potentially be affected by changes in water quality are addressed in the relevant chapters of the report.

Table 10.2: Summary of Potential Effects on Water and Sediment Quality

Effect	Technology	Development Phase	Receptor	Direct/ Indirect	Duration	Extent
Disturbance of natural sediments during construction	Wave / Wind / Tidal	CC CD	Water quality	Direct	Temporary (during installation)	Coarser fraction of material likely to settle within 50m Fine material will spread widely, but with negligible effect
Release of additional sediments during construction	Wave / Wind / Tidal	CC CD	Water quality	Direct	Temporary (during installation)	Impossible to quantify but likely to be similar to natural sediment
Release of contaminants during construction	Wave / Wind / Tidal	CD OD	Water quality	Direct	Temporary (during installation)	Unquantifiable but likely to be negligible in practice
Disturbance of contaminated sediments	Wave / Wind / Tidal	CC CD	Water quality Shellfish waters Bathing waters	Direct	Temporary (during installation)	Not possible to quantify – unlikely to occur in practice
Accidental release of contaminants	Wave / Wind / Tidal	CD CC OD	Water quality Shellfish waters Bathing waters	Direct	Temporary (during installation)	Impossible to quantify, could be significant and widespread
Contamination – erosion of sacrificial anodes	Wave / Wind / Tidal	OD	Water quality	Direct	Long term (device life)	Negligible
Contamination – leakage of hydraulic fluids	Wave / Wind / Tidal	OD	Water quality Shellfish waters Bathing waters	Direct	Long term (device life)	Design dependant
Contamination of anti-fouling compounds	Wave / Wind / Tidal	OD	Water quality	Direct	Long term (device life)	Negligible
Changes in sediment dynamics	Wave / Wind / Tidal	OD	Water quality	Indirect	Long term (device life)	Dependant on individual site conditions
Disturbance of natural sediments (Operation)	Wave / Wind / Tidal	OD	Water quality	Indirect	Long term (device life)	Dependant on individual site conditions
Disturbance of contaminated sediments (operation)	Wave / Wind / Tidal	OD	Water quality	Indirect	Long term (device life)	Dependant on individual site conditions

CD = Construction/decommissioning effect – devices

CC = Construction/decommissioning effect - cables

OD = Operation effect – devices

OC = Operation effect – cables

10.3 Biodiversity, Flora and Fauna

The main SEA topics in terms of biodiversity, flora and fauna include:

- Protected sites and species
- Benthic and intertidal ecology
- Fish and shellfish
- Birds
- Marine mammals
- Marine reptiles

10.3.1 Protected Sites and Species

Potential effects on protected sites and species include the following:

- Effects on the structure and function of the features of the site
- Effects on site integrity
- Effects on site quality
- Effects on ecological coherence of the existing/proposed network of sites
- Effects on protected species

The more specific nature and significance of effects on protected sites and species will primarily be dependent on the interest features of the site in question, and potential key effects on these are assessed in the relevant sections (Benthic Ecology, Fish and Shellfish, Marine Birds, Marine Mammals and Marine Reptiles).

Where known, sensitivity of protected sites and species in the study area to the potential effects of offshore wind, wave and tidal devices are included in the Chapter 11.

10.3.2 Benthic Ecology

10.3.2.1 Installation Effects

During installation (and decommissiong) of wind, wave and tidal devices, and cables, benthic communities in the vicinity of installation operations would potentially be affected in the following ways:

Substratum loss and disturbance of species located within the installation area will occur as a result of cable trenching, installation of piles, gravity bases or clump weights, and deployment of anchors and jack-up rigs if used. Indirect effects (increased turbidity and smothering) on the surrounding area would also result from the re-distribution of sediment into the water column. These effects will be localised and temporary and are likely to be most significant for installation of export cables, and devices which require structures to be piled into the seabed. Devices which use gravity bases, anchors and clump weights will have a much smaller effect resulting from disturbance of the seabed and sediment suspension. The effects on benthic fauna will be limited to localised mortality or displacement, where objects come into contact with the sediment and smothering by resettled sediment occurs. Recruitment from adjacent unaffected areas should ensure rapid recovery of benthic species.

Smothering can occur within the immediate vicinity of the seabed disturbing works, as the coarser fraction of the sediment disturbed is likely to be re-deposited on the seabed within about 50 m of the works. This effect is only expected to be temporary, as material deposited will be re-suspended and distributed by natural hydrodynamic processes, and will only affect those species/habitats that are sensitive to smothering.

Increased suspended sediment and turbidity can occur as finer particles travel further from the disturbed area, swept by tidal currents, with potential effects on sessile filter feeders. It is not possible to quantify this effect because of the high number of variables involved in determining background and project related suspended sediment levels. It is likely that the small amounts of sediment released into the water column during turbine and cable installation will be rapidly dispersed into the surrounding environment, and will have a negligible effect on background suspended sediment and turbidity levels, and this is particularly likely for wave and tidal turbines which will generally be placed in high energy environments. The precise effect caused by individual developments would have to be assessed on a case by case basis at the consenting stage.

Contaminated sediments: Disturbance of contaminated sediments is also possible during cable and device installation and decommissioning, should seabed disturbing works be undertaken within an area of contaminated seabed, which may cause potential effects on nearby species that are sensitive to contamination.

10.3.2.2 Operation Effects

During device operation the following effects are possible:

Substratum loss due to the presence of piles, gravity bases, clump weights and anchors on the seabed, or scouring associated with structures piled into the seabed. The area of seabed lost is difficult to quantify at the strategic level, as it is dependent on many project specific factors.

Based on discussions with developers, typical array sizes are likely to be typically 2 km^2 for wave arrays (20 – 50 devices), 0.5 km^2 (5 – 20 devices) for tidal arrays, 1-2 km^2 and 50 km^2 for wind (5-250 turbines). Depending on design devices are expected to each occupy a seabed area of between approximately $12m^2$ (piles) and 40 m^2 (gravity bases).

Depending on design devices are expected to each occupy a seabed area of between approximately $12m^2$ (piles) and 40 m^2 (gravity bases). These numbers give an indication of the scale of effect per device/array, but it is not possible, given the wide range of device types and seabed attachments being considered in this SEA to make estimates of the actual area of seabed that would be lost.

Scouring of sediments will occur around the base of any fixed structures or foundations on the seabed such as monopiles (mainly relevant to wind and tidal devices), and clump weights and gravity bases (wave and tidal), which may have potential effects on the existing benthic environment. Over time, sediment conditions will stabilise with finer sediments being lost and the larger sediment fraction remaining allowing recolonisation by species that may have been absent before. Recolonisation may also lead to increased sediment consolidation and stability which would contribute to further recolonisation success. However, this in itself may increase friction levels with a resulting breakdown of consolidated sediment before equilibrium is reached and a new and changed benthic community becomes established. If scour protection is used the difference in faunal composition between before and after construction will be greater than without such protection.

Decrease in water flow resulting from extraction of tidal energy, will potentially effect on habitats and species which are sensitive to changes to tidal flows. The richness and variety of marine life in tidal rapids relies primarily on the strong water currents to carry food in, and waste materials and fine sediments away. Therefore, interruptions of tidal flows are likely to have implications for fauna and flora. Benthic habitats are also potentially affected by changes in sediment patterns as a result of reduction in tidal flows. Whether significant changes in community structure would occur and whether they would be considered deleterious would depend on the degree of change and the nature of the receiving environment. Based on limited existing projects and modelling studies, it is estimated that the extent of the potential effect on tidal energy can extend up to 0.5 km from tidal devices. Maerl beds, *Modiolus* beds, and some deep mud habitats may be highly sensitive to changes to tidal flows.

Decrease in wave exposure resulting from extraction of wave energy**.** Wave exposed habitats, and those consisting of mobile sediments, generally show reduced species diversity. These environments are likely to be resilient to the removal of wave energy. Based on limited existing projects and modelling studies, it is estimated that the extent of the potential effect on wave energy can extend up to 20 km from the wave device. Maerl beds and *Modiolus* beds are highly sensitive to decreases in wave energy.

Changes in suspended sediment levels and turbidity may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of potential effects on sediment processes of up to 50 m from devices (Bryden, 2006). Maerl beds are particularly sensitive to effects associated with changes to suspended sediment levels.

Whether changes to wave and tidal energy, and sedimentation patterns would cause significant changes in community structure, and whether they would be considered deleterious would depend on the degree of change and the nature of the receiving environment. Reduction of downstream water flow, if it occurs, is expected to be more significant in straits, tidal rapids and other constricted areas (such as Strangford Narrows).

There is also the potential for **leaching of toxic compounds** from sacrificial anodes, antifouling paints or hydraulic fluids (if present) from a device. A small number of both wave and tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. Most of the priority habitats likely to be present in the study area for which there is relevant sensitivity information are not particularly sensitive to heavy metal contamination that could result from use of copper based antifoulants or from sacrificial anodes. However, several of the benthic habitats under consideration are known to be sensitive to synthetic chemical contamination that could result from the leaching of hydraulic fluids used for some wave and tidal devices. *Modiolus* beds in particular, are identified as being highly sensitive to synthetic chemical contamination, with very low recoverability rates. The UKBAP for tidal rapids states that species inhabiting tidal rapids may be sensitive to water pollution.

The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small, and it is therefore considered that this potential effect will be of negligible significance. The potential for leakage of hydraulic fluids through accidental storm or collision damage could potentially present a significant adverse effect if it occurred, but it is considered that there is a very low likelihood of such a leakage occurring.

Potentially more significant still are the possible effects that could result from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays. This effect is impossible to quantify due the number of variables such as vessel cargo, risk of vessel collision, etc. It is not possible to make any realistic estimate of the geographical extent of this potential effect, due to the large numbers of variables involved (quantities leaked, metocean conditions, etc) and it is therefore not included in the significance mapping.

There is also potential for **colonisation of structures** such as turbine bases causing increased biodiversity and leading to increased food availability for fisheries. Whilst this therefore has potential to be a positive effect, species colonising underwater structures may lead to undesirable changes in community structure, giving rise to negative effects. On balance, colonisation of underwater structures is generally considered to be of neutral significance.

Electro-Magnetic Fields (EMF): Electric and magnetic fields are produced as a result of power transmission in the inter array cables and the export cable to shore. The devices themselves will also have an electrical signature, however this will be specific to the individual devices e.g. whether the power generator is in the water or on a platform and if there is a riser cable from a device on the seabed. A number of research reports have been undertaken by COWRIE into the likely field strengths and potential effects on marine species (CMACS 2003; CMAS 2005; CMACS 2006). A literature review of research into this area, undertaken for the Scottish Marine Renewables SEA (Scottish Executive, 2006) concluded that marine flora and macro-invertebrates are not sensitive to electric or magnetic fields and no effects from the installation or operation of tidal and wave devices are expected.

Table 10.3: Summary of Potential Effects on Benthic Ecology

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Substratum loss (construction)	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation area
Smothering	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	50m
Increased turbidity	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Increased suspended sediment	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Decrease in wave exposure	Wave / Tidal	OD	Direct	Long term (device life)	Up to 20km
Decrease in water flow	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Up to 500m
Substratum loss (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Within array area: wave - 4 km^2; tidal - 0.5 km^2
Changes in turbidity	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Changes in suspended sediment	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Disturbance of contaminated sediments	Wave / Wind / Tidal	CC CD	Indirect	Long term (device life)	Negligible
Contamination from anti-fouling paints and sacrificial anodes	Wave / Wind / Tidal	OD	Direct	Temporary (during installation)	Negligible
Accidental contamination (Hydraulic Fluids or vessel cargo/fuel)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect - cables
OD = Operation effect – devices
OC = Operation effect – cables

10.3.3 *Fish and Shellfish*

10.3.3.1 Installation Effects

Disturbance of mobile species can occur during installation and removal of turbines, devices and cables, as a result of the presence of the installation and decommissioning vessels and equipment (and associated noise) within the vicinity of operations. Should any piling be required for device installation, the noise generated by this activity is likely to have a greater effect as a result of disturbance than for developments where piling is not required. Whilst piling noise, and noise generated during the removal of piled devices, would only be produced over a temporary period, for the duration of construction activities, the effects may continue for longer, as fish may not immediately return to an area, particularly if they have been excluded for lengthy periods.

Timing of installation and decommissioning works is also a key factor, as the disturbance effect is likely to be greater during mating aggregations, as it may affect mating activity.

Smothering of fish spawning habitat or shellfish habitat could occur within the immediate vicinity of the seabed disturbing works, as the coarser fraction of the sediment disturbed is likely to be re-deposited on the seabed within about 50 m of the works. This effect is only expected to be temporary, as excess material deposited will be re-suspended and distributed by natural hydrodynamic processes. Based on sensitivity data available from MarLIN most finfish species within the study area are not sensitive to, and are therefore not affected by smothering. Those finfish that are sensitive generally have a low sensitivity. These include certain demersal species: lesser spotted dogfish, thornback ray, common skate, lemon sole and plaice.

The spawning areas of finfish species herring and sandeels are highly sensitive to smothering effects, and a smothering episode on a herring gravel bank, for example, could potentially affect an entire year class in the locality. Shellfish inhabiting the seabed are also generally more sensitive to the effects of smothering. *Nephrops* (Norway lobster), king and queen scallop, cockles and periwinkles are all highly sensitive. Whilst European lobster, edible crab, velvet crab, whelk and mussel have medium to low sensitivity.

Increased suspended sediment and turbidity can occur as finer particles travel further from the disturbed area, swept by tidal currents, with potential effects on filter feeders. King and queen scallop, cockle, mussel, herring and sprat all have a medium sensitivity to increased suspended sediment. All other fish and shellfish species, for which the sensitivity is known, have low or no sensitivity to this effect.

Increased turbidity can have effects on foraging, social and predator/prey interactions. It is not possible to quantify this effect because of the high number of variables involved in determining both background and project related suspended sediment levels and turbidity. It is likely that any sediment temporarily released into the water column during installation will be rapidly dispersed, and the small amounts of sediment released into the water column during turbine and cable installation will have a negligible effect on background suspended sediment and turbidity levels. This is particularly true for wave and tidal turbines which will generally be placed in high energy environment. Due to the strategic nature of this assessment the precise effects of individual developments will have to be assessed on a case by case basis at the consenting stage.

Contaminated sediments: Disturbance of contaminated sediments is also possible during piling and cable and device installation and removal, which may cause potentially detrimental effects on species that are sensitive to contamination. Potential sources of contamination and the associated implications for water quality are described in Section 10.2.3.

Marine noise: Marine fish can produce and hear marine noise which, whilst not fully understood, is thought to be associated with alarm calls and social behaviour. Studies have found that general noise such as is generated by shipping activity can cause an avoidance or attraction reaction in fish (Thomsen, 2006). Noise from wind farm, wave and tidal energy projects therefore has the potential to affect fish in the immediate vicinity of operations. An overview of the expected sources and effects of noise on the marine environment associated with wave and tidal turbines can be found in the Scottish marine renewables SEA (Scottish Executive, 2006) and for wind in a report for Collaborative Offshore Wind Research Into The Environment (COWRIE) (Thomson *et al*, 2006).

Key sources of noise during installation include shipping machinery, dredging and pile driving. Pile driving is anticipated to have the greatest potential effects on marine wildlife, as it generates very high sound pressure levels that are relatively broad-band (20 Hz - > 20 kHz). The removal of piled devices may also generate noise either from the cutting or excavation of piled foundations or from the use of explosives. Cod and herring will be able to perceive piling noise at large distances, perhaps up to 80 km from the sound source. Dab and salmon might detect pile-driving pulses also at considerable distances from the source. Behavioural effects, like avoidance and flight reactions, alarm response, and changes of shoaling behaviour are possible due to piling noise. Also physical effects, like internal or external injuries or deafness up to cases of mortality, may happen in the close vicinity to pile-driving or the use of explosives during decommissioning.

10.3.3.2 Operation Effects

Collision risk: The presence of wind turbines should not affect significantly on the movements of juvenile and adult fish. Turbines are relatively narrow in diameter (< 5 m) and widely spaced throughout the array.

However, collision risk is considered to be a key potential effect during wave and tidal device operation, and it is considered, bearing in mind the wide range of devices that may be deployed, that almost all species of marine finfish are at some risk of collision impacts. Whilst it is considered that pelagic fish will be the most likely to be affected by collisions with devices, demersal species make vertical migrations and could therefore also be potentially affected. A review of collision risk undertaken as part of the Scottish Marine Renewables SEA identified that certain parallels can be drawn between known collision risks and the responses of fish encountering existing hazards (shipping, fishing gear interactions, killer whale tail swipes). However, there is considerable lack of empirical knowledge on this risk, and it is important to bear in mind that turbine blades, either of the horizontal or vertical axis type present a threat quite unlike any that marine fish have previously experienced. Therefore, whilst an overview of the factors likely to influence collision risks posed by marine renewable devices is summarised in this section, it is not possible to fully quantify this risk based on the current state of knowledge.

The group of species at risk will vary depending on the type of device and its location within the water column. Demersal fish, spending all their time near the sea bed will not be affected by the moving parts of wave power generating devices that act at the surface. It is possible that they may benefit from the habitat structure provided by the foundations and or moorings for these devices. Some demersal species (Plaice or cod for example) may interact with turbines in mid water when they make excursions up the water column when using tidal stream transport during migration. Some devices, vertical axis turbines for example, may be placed in foundations on the sea bed in shallow water. Demersal species could be at particular risk from these devices.

Pelagic species of fish will be at some risk of interaction with all types of device. Their diurnal vertical migration behaviour forces them to occupy all depths in the water column at some time during the day.

In addition there are a number of other parameters that can be expected to affect the degree of collision risk:

- Size: Very small fish and larval fish with very low inertia experiencing viscous flow regime are more likely to follow the flow streamlines around moving parts and thus avoid collision. The collision risk increases with increasing fish size, and the greatest collision risk, as far as fish size is concerned, is therefore expected to apply to basking shark.
- Schooling behaviour: Schooling species may be at greater risk than those with a solitary habit. A school could be regarded as a large “super organism” rather than behaving as individual. Schools of fish move together in polarised formations and their predator escape behaviour is coordinated. Responses may lead to some individuals evading contact with turbine blades; whilst others could be directed into the path of a blade.
- Life stage: Juveniles are likely to be more at risk than adults because of reduced sensory and mobility abilities and/or experience.
- Season: Species at most risk will also vary with season, due to seasonal change in geographic distribution, migrations and spawning periods.
- Fixed submerged structures (such as vertical or horizontal support piles, ducts & nacelles) are likely to attract marine life in the manner of artificial reefs or fish aggregating devices (FADs).
- Mooring equipment such as anchor blocks and plinths are likely to function like other natural or artificial seabed structures and hence pose few novel risks for vertebrates in the water column.
- Collision risk is expected to be influenced by the nature of the environment where the turbines are located:

- Open water: Deployment of devices in the open sea will present the least risk unless the spacing between devices increases the risk of encounter (see above). However, water depth at the point of deployment will be critical and turbines need to be raised far enough off the bottom to reduce interaction with benthic fish.
- High flow environments: High flows can combine with swimming speeds to produce high approach velocities and consequently reduced avoidance or evasion response times. In high flow environments, fish may hold station in front of a device until they reach exhaustion and then passively be swept downstream towards it. This assertion is based on research undertaken into fishing methods, and why fish become swept into trawling nets (Wardle 1986, Walsh, 2003, Breen M. 2004, Jamieson, *et al* 2006).
- Sounds: Deployment within sounds increases risk of encounter and subsequent collisions.
- Loughs: Locating turbines in Lough entrances could prevent passage through the entrance into or out of a sea lough and therefore exclude fish from a lough or cause their retention within the lough. This effect would be of particular significance for migratory species such as salmonids and eels. Although it is unlikely that complete exclusion or retention will result, a reduction in numbers passing through could have a significant effect on the diversity of sea lough communities.
- Turbidity: Collision risk can be expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines themselves increase turbidity. This is because of the turbines' reduced visibility, and also because turbid waters are actively selected by many fish species, possibly as a refuge from predators.

Some initial modelling was undertaken as part of the Scottish Marine Renewables SEA to assess the potential encounter rate between a hypothetical array of 100 horizontal axis, 8 m radius turbines operating off the Scottish coast and existing populations of herring. The model incorporated a number of assumptions about the vertical distribution of herring, their swimming speeds and distribution. As escape (avoidance and evasion) behaviours by the fish to marine renewable devices are currently unknown it was also assumed that the fish were neither attracted to nor avoided the immediate area around the turbine. The model predicted that in a year of operation device encounters would occur for 2% of the Herring population between Cape Wrath and the Mull of Galloway.

However, this is a simplistic approach to quantifying collision risk, as marine fish are likely to show behavioural responses to the presence of marine renewable devices. Whilst the ability of fish to perceive their environment is well understood, their behavioural reactions to marine renewable devices are not. At long range they have the option to avoid the area of device placement (i.e. swim around) and at closer range they can evade the particular structures (i.e. dodge or swerve). The balance between avoidance and evasion responses will depend on a product of the distances that these animals will be able to perceive the devices and their subsequent behavioural reactions. Fish sense their environment using sight, hearing, and chemoreception. Their ability to detect devices will depend on the sensory capabilities of the species and the visibility and level of noise emitted by the device. The potential for animals to escape collisions with marine renewable devices will also depend on their body size, social behaviour (especially schooling), foraging tactics, curiosity, habitat use, and underwater agility.

Ecological effects resulting from fish interactions with devices can be expected to range between: no effects to the potential removal or injury of individuals, and, if rates are sufficiently high, declines in populations. If avoidance responses occur then habitat exclusion is possible while if structures provide foraging opportunities then this could cause positive effects.

Based on discussions with developers, typical array sizes are likely to be typically 2 km^2 for wave arrays (20 – 50 devices), 0.5 km^2 (5 – 20 devices) for tidal arrays, 1-2 km^2 and 50 km^2 for wind (5-250 turbines). Depending on design devices are expected to each occupy a seabed area of between approximately 12m^2 (piles) and 40 m^2 (gravity bases).

Hyrdraulic impacts: Fish can also potentially suffer injury or mortality through pressure changes occurring within the turbine as water is sucked through it. This effect is only relevant for shrouded tidal devices such as venturi devices, which use shrouding to constrict the flow, thus leading to a pressure low after the constriction. Possible impacts can result from shear, pressure flux or cavitation effects, which can cause damage to gills, eyes, gill bladder, decapitation, or general pulping of body tissues and internal haemorrhages. Significant impacts of this type have been observed for tidal barrage or fence projects, such as the La Rance (Dadswell and Rulifson, 1994). However tidal barrages and fences are not being considered within the Strategic Action Plan or this SEA.. Possible impacts associated with shrouded turbines can be addressed by using screens to prevent marine organisms from entering the device.

Habitat exclusion: The presence of wind, wave and tidal arrays could cause loss of habitat during device operation. Devices may exclude fish from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. Exclusion may limit other device interactions, such as collisions, but will also limit the available habitat, with associated effects on feeding and breeding success, stress on individuals and energy budgets. Based on discussions with developers, typical array sizes are likely to be 2 km^2 for wave and 0.5 km^2 for tidal arrays, and 50 km^2 for wind arrays.

Whilst it is considered that alternative feeding areas may be available to these species, the array will create a net loss of feeding area and removal of food resource, depending on the means of securing the device to the seabed. There may also be a knock-on effect on adjacent fish populations arising from increased competition for prey species in adjacent areas.

However the installation of marine turbines may also create new habitat that could potentially be colonised by benthic species and affect the availability of prey species in the vicinity of turbines.

Substratum loss: The presence of wind turbines, wave and tidal devices, gravity bases, clump weights and anchors on the seabed, or scouring associated with structures piled into the seabed, will cause loss of seabed habitat during device operation. The area of seabed lost is impossible to quantify at the strategic level, as it is dependent on many project specific factors.

Based on discussions with developers, it is estimated that a typical wave or tidal array is likely to comprise 20 – 50 wave devices, or 5 – 20 tidal devices each occupying a seabed area of between 12 m^2 and 40 m^2 depending on the mooring method involved. A very approximate estimate of the area of seabed lost for each array would therefore range between 0.24 – 2 km^2 for a wave array and 0.06 – 3 km^2 for a tidal array. A typical wind array would comprise 5 – 250 wind devices each occupying 12 m^2 which could affect approximately 0.06 – 0.8 km^2 of seabed.

This effect is only directly relevant for shellfish and benthic spawners such as sandeels and herring, although there could be a knock-on effect on other fish species by affecting their benthic food resources. In addition there is a potential effect from loose lying mooring cables, affecting the three dimensional structure of the seabed, which is important for juvenile fish and a range of demersal fish species.

Decrease in water flow resulting from extraction of tidal energy, will potentially affect habitats and species which are sensitive to changes to tidal flows and wave exposure. Based on limited existing projects and modelling studies, it is estimated that the extent of potential effect on tidal energy can extend up 0.5 km from tidal devices. This effect mainly applies to shellfish which range from low – medium sensitivity to changes to tidal flows. However, as herring spawn on gravel beds created by high water flow, herring spawning areas are also likely to be sensitive to this effect.

Decrease in wave exposure resulting from extraction of wave energy**.** Wave exposed habitats, particularly those facing the full force of the Atlantic swell and those consisting of mobile sediments, generally show reduced species diversity and are likely to be resilient to the removal of wave energy.

Based on limited existing projects and modelling studies, it is estimated that the extent of potential effects on wave energy can extend up to 20 km from the wave device. This primarily applies to shellfish which generally have a low to medium sensitivity to removal of wave energy. Cockles are highly sensitive to changes in wave exposure. In addition nearshore juveniles of Plaice, Cod and Saithe have a low to medium sensitivity to changes in wave exposure.

Changes in suspended sediment levels and turbidity may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of potential effects on sediment processes of up to 50 m from devices. King scallop, queen scallop, cockle, mussel, herring and sprat have a medium sensitivity to this potential effect. All other fish and shellfish species commonly found in the study area, for which the sensitivity is known, have low or no sensitivity to this.

Contamination: Leaching of toxic compounds from sacrificial anodes, antifouling paints or hydraulic fluids (if present) from the device is a potential effect during device operation. A small number of both wave and tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. For most of the finfish species likely to be present in the study area, sensitivity to this effect is not known. Shellfish species present in the study area have a generally low to very low sensitivity to heavy metal and synthetic chemical contamination that could result from use of copper based anti-foulants or from sacrificial anodes.

The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small. The potential for leakage of hydraulic fluids through accidental storm or collision damage could potentially present a significant effect if it occurred, but it is considered that there is a very low likelihood of such a leakage occurring. Potentially more significant still are the potential effect from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays. This effect is impossible to quantify due the number of variables such as vessel cargo, risk of vessel collision, etc.

Marine noise: Marine fish can produce and hear marine noise which, whilst not fully understood, is thought to be associated with alarm calls and social behaviour, and studies have found that general noise such as that generated by shipping activity can cause an avoidance or attraction reaction in fish. Noise from offshore wind, wave and tidal energy projects therefore has the potential to effect fish in the immediate vicinity of devices. There is a wide diversity in hearing structures among fishes, resulting in different auditory capabilities across species. Herring and Cod have been identified as being highly sensitive to marine noise.

A specialist study undertaken for the Scottish Marine Renewables SEA modelled the potential for permanent and temporary hearing damage to result from operating tidal devices. This study was based on the likely noise generated from a single type of device and therefore may not be applicable across all devices. It does, however, provide an indicative estimate of the levels of noise involved. The study concluded that, for the tidal device, if the most sensitive receptor were to spend 30 minutes within 16 m of tidal device it might suffer permanent hearing damage. The assessment also indicated that 8 hours within 934 m could result in temporary hearing damage. These findings were based on generic threshold curves that were used to determine potential effects for a range of species and sensitivities. However, evidence suggests that it is unlikely that an animal would choose to stay in close proximity to the source of a loud noise (Tougaard, *et al*. 2003).

Based on the available information, the noise produced during operation of wave devices is considered to be less than for tidal, and the risk of permanent hearing damage is considered negligible. For temporary hearing damage, the maximum predicted range for an exposure of 8 hours is only 6 metres, so the risk of an animal experiencing Temporary Threshold Shift (TTS) from a single 1 MW wave device of this type is insignificant. It should be noted, however, that this analysis did not include structural noise from the wave device, which is unknown.

During operation of offshore wind turbines the main source of underwater noise is transmitted into the water from the tower as structural noise. An overview of the expected sources and potential effects of noise on marine fish is provided in a report for COWRIE (Thomson et al, 2006). Their modelling concluded that species such as dab and salmon might detect operational noise of a wind turbine at relatively short distances of no more than 1 km. The zone of audibility for cod and herring will be larger, perhaps up to 4-5 km from the source. The level of behavioural response within this detection zone is not well understood. However, it is likely to occur only at very close ranges. Research conducted by Westerberg (1994, 2000) at the Svante wind farm in Sweden found that that European eels passing a single (220 kW) wind turbine at a distance of 0.5 km did not substantially change their swimming behaviour.

Wahlberg and Westerberg (2005) estimated the range to which fish can be scared away from a wind turbine to be only 4 m.

The construction of offshore wave, wind and tidal arrays and their maintenance during operation can also involve/require relatively high amount of ship-traffic for carrying parts and for the maintenance of construction platforms etc. These are likely to contribute to varying sound levels and frequency characteristics depending on ship size and speed.

Electro-Magnetic Fields (EMF): Wind farm development has led to considerable interest in electromagnetic effects from export and interturbine cables on marine species, especially elasmobranchs, but also other fish and marine mammals (Gill *et al.*, 2005). Magnetic fields are produced from AC or DC current passing through the conductor. Magnetic field strength generated during electricity cable operation is variable, and dependent on a number of factors including cable alignment and configuration. Electric fields can be produced in water passing through the magnetic field surrounding a cable. Electric fields can be almost completely blocked from emanating externally by the shielding effect of a cable's structure. The magnetic field from the Nysted wind park cable to shore was approximately 5 microtesla (µT), at 1 m above the cable; the natural magnetic field in Denmark is 45 µT (Tougaard *et al.,* 2006).The strength of both magnetic and electric fields decreases with distance from the source, and field strength at the seabed surface would therefore be dependent on the depth to which cables are buried.

Electric and magnetic fields are produced as a result of power transmission in the inter array cables and the export cable to shore. The devices themselves will also have an electrical signature, however this will be specific to the individual devices e.g. whether the power generator is in the water or on a platform and if there is a riser cable from a device on the seabed. These have the potential to affect migration and prey detection in certain electro-sensitive fish species such as elasmobranchs (sharks and rays). A number of research reports have been undertaken by COWRIE into the likely field strengths and potential effects on marine species (CMACS 2003; CMAS 2005; CMACS 2006). A literature review of research into this area, undertaken for the Scottish Marine Renewables SEA (Scottish Executive, 2006) concluded the following:

- Electrical and magnetic fields generated by the operation of offshore wind, wave and tidal devices are likely to be small and within the variation range of naturally occurring fields in the study area, but detectable to electro/magnetosensitve species. Burial of the cables will offer a protective barrier to electro/magnetosensitive species from the strongest magnetic and induced electric fields generated next to the cable.
- Marine teleost (bony) fishes do not react to electric field strengths of less than 6 V/m (several orders of magnitude greater than the estimated field strength from the inter array and export cables). No effects are expected.
- Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical export cable but the field would not cause an avoidance reaction. Furthermore, there is no evidence to indicate that existing cables have caused any significant effect on elasmobranch migration patterns.
- Atlantic salmon, eels and Sea Trout are believed to be sensitive to magnetic fields. There is currently no evidence from existing cables to suggest that navigation and migration in these species is unlikely to be affected by the magnetic field produced by the operation of wave and tidal devices.
- However, significance of potential effects cannot be quantified on the basis of current information.

Fishing exclusion areas: There is potential for positive effect on fish resources should the wave, tidal or wind array be excluded from fishing activities, as this could create spawning grounds and nursery areas that will be able to exist undisturbed by commercial fishing activity. Furthermore, with sensitive design wave and tidal installations could potentially form artificial reefs.

Barrier to movement: There is the potential that arrays of devices may form a barrier to the usual migration and transit patterns of marine finfish, either because of collision risk, aversive reactions to operation noise or perceptions of devices and associated infrastructure. This is particularly relevant in constrained areas (such as mouths of Loughs).

Table 10.4: Summary of Potential Effects on Fish and Shellfish

Effect	Technology	Development phase	Direct / indirect	Duration	Extent
Disturbance	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation area
Smothering	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	50 m
Increased turbidity	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Increased suspended sediment	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Marine Noise (Construction)	Wave / Wind / Tidal	CD CC OD	Direct	Temporary (during installation)	80 km
Collision risk	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Study area
Substratum loss	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Within array area Wave: 0.24 – 2 km^2 Tidal: 0.36 – 2 km^2
Decrease in wave exposure	Wave / Wind / Tidal	OD	Direct	Long term (device life)	20 km
Decrease in water flow	Wave / Wind / Tidal	OD	Direct	Long term (device life)	500 m
Changes in turbidity	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Changes in suspended sediment	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Disturbance of contaminated sediments	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Contamination from anti-fouling paints and sacrificial anodes	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Negligible
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify
EMF	Wave / Wind / Tidal	OC	Direct	Long term (device life)	Within array area
Marine noise (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Up to 80 km
Fishing exclusion areas (positive effect)	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Impossible to quantify
Barrier to movement	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect - cables
OD = Operation effect – devices
OC = Operation effect – cables

10.3.4 Birds

10.3.4.1 Introduction

Marine bird species can potentially be affected in a number of ways, as outlined below. It should be noted that this report identifies generic effects, and, where possible, assigns strategic effect significance based on the available high level data. The species groups of most conservation concern offshore are seabirds, waterbirds (notably waders and wildfowl) and migrating passerines. Any proposed marine renewable energy development would need to examine the potential effects specific to that development, which may require use of more detailed data sources, further data collection and detailed modelling studies.

10.3.4.2 Installation Effects

Food availability: Construction and decommissioning could potentially damage the benthos and disrupt sediments locally, both of which may lead to changes in the invertebrate fauna and fish stocks. This could reduce food availability for birds, at least in the short term (BirdLife International, 2003).

Collision risk: There is the risk of marine birds colliding with construction machinery and vessels present during the project installation and decommissioning phases. Existing evidence from collisions with shipping activity indicates that whilst birds are generally more manoeuvrable than marine mammals they may also be at risk of collision with vessels, especially at night. Collision can typically occur in two situations – flying birds colliding with the surface structures of ships or ships colliding with birds rafting on the surface. Risk is likely to be low for all species and very low for cormorants since they spend the night on land (Daunt *et al*. 2006a). However, no empirical data are available. There are also no data on strike rates when birds are foraging underwater. Vessels involved in installation of both wave and tidal devices and export cables are likely to be either stationary or travelling considerably slower than commercial shipping vessels whilst involved in construction activities, and therefore the collision risk during construction is likely to be lower than that posed by commercial shipping activity.

Physical disturbance: Physical disturbance to birds in the immediate vicinity of construction and decommissioning activities could potentially have a temporary effect during array and export cable construction and removal. Noise is a key factor in causing the disturbance effect, but the physical presence of the installation/decommissioning vessels themselves can also cause a disturbance effect due to physical and visual intrusion. Birds likely response to disturbance effects would be to avoid the immediate area during construction and decommissioing, which has implications of foraging and breeding success, stress on individuals and energy budgets. This has been looked at for shore birds, and it is recognised that disturbance may have long term effects if breeding is disrupted, or if birds feeding is disrupted with fitness affected. However, there is no quantified data to from which to determine estimated magnitude of effect.

Marine noise: Marine noise during installation and decommissioning could potentially affect marine birds whilst underwater, causing them to become disorientated and affecting their foraging success. Physiological effects could result in temporary or permanent hearing damage. Key sources of noise during installation are shipping machinery, dredging and pile driving. Pile driving is anticipated to have the greatest potential effects on marine wildlife, as it generates very high sound pressure levels that are relatively broad-band (20 Hz - > 20 kHz). The use of explosives to remove piled foundations during decommissioning also has the potential to generate very high sound pressure levels. Effects on surface feeding birds are likely to take the form of disturbance effects (as described above).

Increased turbidity (reduced visibility): This can occur during seabed disturbing installation activities, as fine particles travel further from the disturbed area, swept by tidal currents. Increased turbidity can have effects on foraging, and predator/prey interactions. The magnitude of this effect will depend on the high number of variables involved in determining both background and project caused suspended sediment levels and turbidity. However, given that the wave and tidal turbines will be placed in high energy environments, it is likely that the small amounts of sediment released into the water column during turbine and cable installation will be rapidly dispersed into the surrounding environment, and will have a negligible effect on background suspended sediment and turbidity levels.

This conclusion will of course have to be re-assessed on a case-by-case basis for specific developments. Marine birds are thought to have a high sensitivity to reductions in visibility.

Disturbance of contaminated sediments is also possible during cable and device installation and removal which may cause potential detrimental effects on species that are sensitive to contamination. Areas of potential contamination risk and the associated implications for water quality are assessed in Section 10.2.3.

10.3.4.3 Operation Effects

Collision risk: Bird collision risk with offshore wind turbines is predominately limited to the operational phase and is influenced by a range of factors including species sensitivity, weather and visibility conditions, the location of bird populations adjacent to the wind farm, bird flight behaviour (height above sea level etc) and migration routes and flight routes to feeding areas that could potentially occur within the array. Collision risk is expected to be greater closer inshore as this will increase the proximity to flight paths by birds moving between feeding areas (e.g. scoters), feeding and roosting (e.g. waders and wildfowl) or breeding and feeding areas (e.g. seabird colonies), and larger-scale movements along the coast or migration landfall or departure. Further offshore, any large concentrations of birds are most likely to be present in response to food availability e.g. at tidal upwellings which concentrate plankton and shoals of fish, around fishing vessels, and when birds are rafting during feather moult.

A study at Nysted offshore wind farm (160 MW, 72 turbines) investigating whether long-lived geese and ducks can detect and avoid a large offshore wind farm demonstrated that the percentage of flocks entering the wind farm area decreased significantly (by a factor 4.5) from pre-construction to initial operation. At night, migrating flocks were more prone to enter the wind farm but counteracted the higher risk of collision in the dark by increasing their distance from individual turbines and flying in the corridors between turbines. Overall, less than 1% of the ducks and geese migrated close enough to the wind turbines to be considered to be at any risk of collision.

A combination of visual and radar studies in Germany (Hüppop *et al* 2003, cited in Bird Life International, 2003) showed that considerable migration over the sea occurs at heights occupied by wind turbines, especially during low visibility (fog, rain, darkness) when birds fly at lower altitude.

Low-flying flocks of eiders were rarely seen to pass within 500m of the wind turbines during daytime, and avoidance behaviour was observed, with some birds altering direction 3-4kms before reaching the Utgrunden wind farm to fly around it (Pettersson 2002 cited in Birdlife International, 2003). No collisions were observed during this study, but it was difficult to judge whether this means collisions have not occurred on the basis of visual observations and limited radar tracking. Whilst the available evidence suggests that birds will in many cases change their behaviour to avoid collision with offshore windfarms, residual risks remain, particularly in areas with large numbers of migrating birds passing through, possible changes to route and altitude in response to the prevailing weather conditions. Avoidance behaviour also becomes more difficult in a scenario of multiple wind farms.

Collision risk is also considered to be a key potential effect during wave and tidal device operation, and it is considered that, bearing in mind the wide range of devices that may be deployed, all species of birds using the study area are at some risk of collision with devices. However, there is considerable lack of empirical knowledge on this risk, and it is important to bear in mind that turbine blades (tidal energy devices), either of the horizontal or vertical axis type present an underwater threat quite unlike anything that marine birds have previously experienced. Therefore, whilst an overview of the factors likely to influence collision risks posed by marine renewable devices is summarised in this section, it is not possible to quantify this risk based on the current state of knowledge. It is also worth noting that wave devices and venturi tidal devices that do not have rotating blades are considered to pose a lower collision risk than horizontal and vertical axis tidal turbines.

Mooring equipment such as anchor blocks and plinths are likely to function like other natural or artificial seabed structures and hence pose few novel risks for vertebrates in the water column. Cables, chains and power lines extending up through the water will have smaller cross-sectional area than vertical support structures and so produce reduced flow disruption and fewer sensory cues to approaching diving birds. Instead of being swept around these structures, mammals are more likely to become entangled in them.

Marine birds have means of escaping moving or stationary hazards. The response of marine birds to a wave or tidal scheme will depend on whether it is detected above or below the surface and how close the object is before the animal detects it, and whether it is interpreted as a hazard that needs to be avoided.

Above the surface: If schemes are visible from above the surface, birds in flight will probably operate broadly similar avoidance tactics to those employed when encountering other natural and man-made obstructions i.e. by taking alternative flight routes and avoiding obstructions to a greater degree at night (Desholm & Kahlert 2005).

Below the surface: Similar avoidance tactics are likely to be employed by diving birds when they detect a stationary or moving object as flying birds when detecting obstructions. More drastic avoidance behaviours are likely to be required if an object is only detected very late, especially if the bird is in the path of a turbine blade. Birds have a moderately fast burst speed, which, although considerably slower than the speed of the outer edge of blades (Fraenkel 2006), would enable escape under many situations where the bird manages to move out of the path of the blades.

Collision risk is also expected to be influenced by the nature of the environment where the turbines are located, proximity to protected areas/SPAs, foraging behaviour and encounter rates.

Open waters: The above concerns are likely to be of general relevance to schemes placed in open waters, which will potentially be equally visible from all directions (device orientation notwithstanding) both above and below the water surface to marine birds. However, marine birds do not fly evenly and in all directions across open water, and are aggregated in relation to oceanographic conditions and prey availability (Daunt, *et al*, 2006b). Thus, detailed data on the use made of the area by birds, including travelling and underwater foraging trajectories, would be required to further understand this issue.

Sounds and channels: Device location and orientation are likely to be particularly important where topography restricts options for bird avoidance behaviours e.g. sounds and channels. This is true both for birds in flight and underwater. In such cases, detailed data are required on how birds use the area. Sounds are used for both activities by marine birds (Daunt 2006c). For birds in flight, in the majority of cases, heading will be longitudinal to the sound, so a parallel design is likely to be preferable to a series design for schemes that protrude above the sea surface. It is less clear which design is likely to increase collision risk among underwater foraging birds. All other things being equal, devices placed in series are more likely to have an effect on marine birds in sounds and channels since topography will be more likely to restrict avoidance options, especially in cases where the array spans the width of the sound or channel.

Sea lough entrances: Sea lough entrances are likely to be regions of high tidal currents, so are likely to be important areas for foraging (Daunt 2006c). The relative risk of parallel and series placement is unclear for foraging birds, but as with sounds the added component of topography may result in a greater risk associated with a series placement, in particular if it spans the width of the sea lough entrance.

Flow characteristics: Most species are attracted to areas of high flow because of good foraging opportunities (Daunt *et al*. 2006b). Risk of collision will be increased if renewable schemes alter the flow characteristics, especially if such changes create new foraging opportunities for marine birds, since this may affect the manoeuvrability and underwater swimming agility of the birds. However, no empirical data exist. Risk will be higher among diving than surface feeding species. However, overall risk associated with change in flow characteristics is likely to be linked to the extent to which birds feed at night.

Water depth: Collision risk will depend on the extent to which species and devices are distributed through the water column. Thus, diving species will be at greater risk of collision with subsurface rotating turbines and mooring cables than surface feeding species, which would be at a lower risk of interaction, and therefore potential effect, with floating devices, and above surface structures as these do not use rotating blades.

Empirical data exist on the depth usage of a range of species including European shags, northern gannets, northern fulmars, common guillemots, razorbills and Atlantic puffins (Wanless *et al.* 1988; Harris *et al*. 1990; Wanless *et al*. 1991; Garthe *et al*. 2000; Garthe & Furness 2001; Daunt *et al*. 2003; Daunt *et al*. 2005; Daunt *et al*. 2006b). In general, depth distribution depends on maximum foraging depth, with shallow divers spending most time near the sea surface and progressively less time at depth, whereas deep divers, which are principally benthic feeders, showing a bimodal depth distribution with peaks of time spent at the sea surface and at deep depths and less time spent at intermediate depths.

Water quality: Collision risk can be expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines increase turbidity, because of their reduced visibility. Birds vision can be affected by small levels of turbidity (Strod *et al*. 2004). However, no data exist on collision risk in relation to turbidity. Diving species will be more at risk of collision in turbid waters than surface feeding species, and night-time feeders more at risk than daytime foragers.

Ecological effects resulting from bird interactions with devices can be expected to range from: no effects to the potential removal or injury of individuals, and, if rates are sufficiently high, to declines in populations as a result of adverse effects on foraging and breeding success, stress on individuals and energy budgets. A bad injury or break to an appendage that is critical to forging could be expected to result in the death of the bird in question. However, there is no quantified data from which to determine estimated magnitude of effect.

Airborne noise: Airborne noise is only an issue for offshore windfarms. It is produced from the movement of the blades through the air, and the consequent transmission of power and momentum in the nacelle. This can result in avoidance of the operating turbines by birds, which is discussed in more detail under "collision risk".

Marine noise: As for construction noise, noise produced during operation of wave, wind and tidal devices could also potentially disrupt prey location and underwater navigation in marine birds, or even result in temporary or permanent hearing damage. Whilst the noise levels likely to be generated during wave, wind and tidal device operation are currently not known operation noise is expected to be considerably less in magnitude than construction noise. The potential noise sources during device operation include: rotating machinery, flexing joints, structural noise, moving air, moving water, moorings, electrical noise, and instrumentation noise.

Habitat exclusion: The presence of wind, wave and tidal arrays will cause loss of habitat during device operation. Devices may exclude birds from a suitable foraging habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. Exclusion may limit other device interactions, such as collisions, but will also limit the available habitat, with associated effects on foraging and breeding success, stress on individuals and energy budgets. Based on discussions with developers, typical array sizes are likely to be 2 km^2 for wave and 0.5 km^2 for tidal arrays, and 50 km^2 for wind arrays.

Evidence from wind farm projects indicates that many species, most notably diver and sea-duck have been displaced some 2 – 4 km from wind farm areas, and this wider displacement effect is thought to be due to the birds perceptual reaction to turbines or maintenance vessels.

Whilst it is considered that alternative foraging areas may be available to these species, the array will create a net loss of foraging area and removal of food resource, depending on the means of securing the device to the seabed. There may also be a knock-on effect on adjacent bird populations arising from increased competition for prey species in adjacent areas.

However the installation of marine turbines may also create new habitat that could potentially be colonised by benthic species and affect the availability of prey species in the vicinity of turbines.

Changes in suspended sediment levels and turbidity may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of potential effects on sediment processes of up to 50 m from devices.

Contamination: Leaching of toxic compounds from sacrificial anodes, antifouling paints or hydraulic fluids (if present) from the device is a potential effect during device operation. A small number of both wave and tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small.

Marine birds are particularly sensitive to contamination by oil based compounds which may be included in the hydraulic fluids used by some devices. The oil damages the plumage causing it to lose its waterproofing (Wernham *et al.* 1997). Furthermore, considerable physiological damage occurs as a result of marine birds ingesting oil. The susceptibility of species is dependent on their distributions and general behaviour, in particular the proportion of time spent on the sea surface in relation to time spent flying and on land. Devices which use hydraulic systems will normally be designed such that at least two seal or containment failures are required before a leaking fluid reaches the sea. It is not possible to be definitive for every device listed in this document as a number of them are still at concept stage and this aspect is a matter for detailed design. However, the industry's design guidelines (Carbon Trust, 2005), if followed, would lead a developer to minimise risks of hydraulic fluid leakage. Potentially more significant still are potential effects from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays. This effect is impossible to quantify due the number of variables such as vessel cargo, risk of vessel collision, etc.

It is not possible to make any realistic estimate of the geographical extent of this effect, due to the large numbers of variables involved (quantities leaked, metocean conditions, etc).

Creation of resting and breeding habitat: Wind turbines and wave and tidal devices with surface structures, may offer roosting or nesting sites for birds. Man-made objects are frequently used as perching posts by a range of species, notably gulls, terns, gannets and cormorants. They may also provide breeding locations to these same species (Craik, 2004).

Foraging opportunities: Turbine bases and marine renewable devices, with associated seabed moorings and vertical structures, will potentially function as artificial reefs or fish aggregating devices. In changing the habitat they therefore have the potential to also change the distribution of marine seabirds. Their structures may offer enhanced opportunities for foraging for some species. The action of moving parts may scatter schooling prey or injure fish or squid and thus draw in opportunistic foragers. However, there is the potential for increased bird collision risk if birds are attracted into an array by greater food abundance, for example terns and gannets whose plunge-diving feeding behaviour may bring them into the rotor swept area of wave or tidal turbines. Furthermore, fisheries refuges may attract fishing vessels into the area.

Table 10.5: Summary of Potential Effects of Marine Birds

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Collision risk (construction)	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Construction area (unknown)
Physical disturbance	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Construction area (unknown)
Marine noise (construction)	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Unknown
Increased suspended sediment and turbidity (reduced visibility)	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Disturbance of contaminated sediments	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Collision risk (operation)	Wave / Wind / Tidal	OD	Direct	Temporary (during installation)	Within array area: wave - 2 km^2; tidal - 0.5 km^2
Marine noise (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Unknown
Habitat exclusion	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Within array area: wave - 2 km^2; tidal - 0.5 km^2
Increased turbidity (reduced visibility)	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Contamination from anti-fouling paints and sacrificial anodes	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Negligible
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify
Creation of resting and breeding habitat	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify
Foraging opportunities	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Impossible to quantify
Increased predation	Wave / Wind / Tidal	OD	Indirect	Long term (device life, and beyond)	Impossible to quantify

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect - cables
OD = Operation effect – devices
OC = Operation effect – cables

10.3.5 *Marine Mammals and Reptiles*

10.3.5.1 Introduction

Marine mammal and reptile species can potentially be affected in a number of ways, as outlined below. It should be noted that this report identifies generic effects, and where possible, assigns strategic effect significance based on the available high level data. Any proposed marine renewable energy development would need to examine the potential effects specific to that development which may require use of more detailed data sources, further data collection and detailed modelling studies. With regard to the potential effects on otters, these animals are known to stay within the 10 m contour, in waters that are shallower than those that will generally be exploited for wave, wind and tidal energy development. The only potential effects on otters therefore are expected as a result of shoreline wave devices and cable installation.

10.3.5.2 Installation Effects

Collision risk: There is the risk of seals, cetaceans and turtles colliding with machinery and vessels present during the project installation and decommissioning phase. Shipping collision is a recognised cause of marine mammal mortality worldwide, the key factor influencing the injury or mortality caused by collisions being ship size and ship speed. Ships travelling at 14 knots (~7 $m.s^{-1}$) or faster are most likely to cause lethal or serious injuries. Vessels involved in installation or removal of wave, wind and tidal devices and export cables are likely to be either stationary or travelling considerably slower than this whilst involved in construction/decommissioning activities, and therefore the collision risk during construction and decommissioning is likely to be lower than that posed by commercial shipping activity.

Physical disturbance of seals hauled out on land can occur during the installation and removal of devices and cables, as a result of the presence of installation and decommissioning vessels and equipment, and the noise they produce in the vicinity of operations. Noise is a key factor in causing disturbance effects (as described below), but the physical presence of the installation and decommissioning vessels themselves can also cause a disturbance effect. In general, ships more than 1,500 m away from hauled out grey or common seals are unlikely to evoke any reactions from seals, between 900 and 1,500 m seals could be expected to detect the presence of vessels and at closer than 900 m a flight reaction could be expected (Brasseur & Reijnders, 1994).

This would be most significant for breeding and moulting seals, hauled out on the coast and on intertidal banks. Breeding seals exhibiting flight reactions could temporarily abandon their young, causing a more significant disturbance effect during the breeding season**.** Moulting seals spend more time out of the water, and if they are scared into the water they may lose condition as a result of additional energetic costs. Physical disturbance of otters could also occur should disturbing works occur close to the coastal areas where they are present. As for seals, disturbance effects would be greatest during the primary breeding seasons for otters of spring and late autumn.

Marine noise: Acoustic disturbance of seal and cetacean species both in the water, and seals using haulout sites, can occur during the installation and removal of wind, wave and tidal devices and cables. Should any piling be required for device installation, the noise generated by this activity is likely to have a greater disturbance effect than for developments where piling is not required. The use of explosives to remove piled devices is also likely to generate high sound pressure levels which could lead to high levels of disturbance. Marine noise generated by cutting and excavation activities during decommissioning could also cause disturbance to seal and cetacean species. Whilst piling noise (and noise generated from the removal of piled devices) would only be produced over a temporary period, for the duration of construction and decommissioning activities, the effects may continue for longer, as mammals may not immediately return to an area, particularly if they have been excluded for lengthy periods. This is particularly relevant in constrained areas (such as mouths of sea loughs) where loud noise sources may prevent transit, effectively trapping individuals.

The key sources of device construction noise related to site preparation and device installation include: Shipping and machinery; dredging, and pile driving or drilling. In addition, cable burial requires the use of trenching or jetting machinery in soft sediments, rock cutting machinery in hard sea-beds, or rock or concrete mattress laying may be used to protect cables in areas where they cannot be buried. Noise emitted during pile driving is understood to have the greatest potential effects on marine wildlife (Thomsen *et al*, 2006). An overview of the expected sources and effects of noise on the marine environment is provided in the Scottish Marine Renewables SEA.

Recent research work has suggested that detection of sound or pressure changes may play an important role in assisting seals to sense their environment and to hunt efficiently. Initial research reported in the Strangford Lough MCT ES (Royal Haskoning, 2005), suggests that seals may rely upon a form of passive sonar through which they sense the environment and form sound "maps" of their seabed surroundings, whilst relying on vision and vibrissae for "close work" associated with hunting.

Acoustic disturbance in the marine environment is an important cause of behavioural disturbance in cetaceans because they use acoustics to navigate, locate prey and maintain social contact. Noise produced during marine construction could potentially interfere with these signals through masking of communication calls, or disruption of foraging clues. This effect should be considered in the context of the many other sources of both natural and anthropogenic noise in the marine environment which could also cause masking effects.

Seals and cetaceans could both be generally expected to be able to hear piling noise up to a distance of 80 km, and behavioural responses could be expected up to 20 km (Thomsen *et al*, 2006 and Tougaard *et al,* 2009).In addition, physiological effects on both seals and cetaceans could include temporary or permanent hearing damage or discomfort. Permanent hearing damage may be a concern at a distance of 400 m from any pile driving activities for common seal, and 1.8 km for harbour porpoise (Thomsen *et al*, 2006). However, these figures are likely to vary, depending on site characteristics (e.g. shielding affects of islands and affect of water depth). There is also a risk of injury of death associated with exposure to loud noise sources such as close proximity to piling operations. Some protections under the Habitats Directive and Habitats (NI) Regulations, operate on the level of the individual marine mammal rather than at the population level, and pile driving activities without observing appropriate mitigation could be interpreted as "reckless or deliberate disturbance".

Effects of piling installation noise on harbour porpoise was assessed for the Strangford Lough MCT Seagen project (COWRIE, 2008). Comparison of the measured background noise data with the hearing sensitivity of the harbour porpoise has indicated that this region is a noisy environment for marine animals that are sensitive to high frequency noise. The data for the drilling noise indicated that these species are unlikely to be able to hear noise from the piling operation over the high levels of perceived background noise, highlighting the importance of considering the spectral perception of underwater noise by marine animals when estimating its effect.

The data indicated that the noise does not exceed the 90 dBht level, at which strong and sustained avoidance is expected, at any measured range. The 50 dBht level, at which a mild and brief reaction is expected in a minority of individuals, extends to a maximum range of 115 m. The MCT data indicated that, when taking into account the existing background noise, marine mammals considered are unlikely to be disturbed by the drilling noise unless they are in the close vicinity of the piling activities.

Increased turbidity (reduced visibility) can occur during seabed disturbing installation and decommissioning activities, as fine particles travel further from the disturbed area, swept by tidal currents. Increased turbidity can have effects on foraging, social and predator/prey interactions. The magnitude of this effect will depend on the high number of variables involved in determining both background and project caused suspended sediment levels and turbidity. However, it is likely the small amounts of sediment released into the water column during turbine and cable installation and removal will be rapidly dispersed and will have a negligible effect on background suspended sediment and turbidity levels, this is particularly true for the wave and tidal turbines which will be placed in high energy environments.

This conclusion will of course have to be re-assessed on a case-by-case basis for specific developments. Grey and common seals have been identified as having a high sensitivity to reductions in visibility, whilst the cetaceans in the study area have a moderate sensitivity to this effect.

Disturbance of contaminated sediments is also possible during cable and device installation and removal which may cause potential detrimental effects on species that are sensitive to contamination. Areas of potential contamination risk and the associated implications for water quality are assessed in Section 10.2.2.

10.3.5.3 Operation Effects

Collision risk is considered to be a key potential effect during wave and tidal device operation, and it is considered that, bearing in mind the wide range of devices that may be deployed, all species of marine mammals are at some risk of collision effects. Whilst a distinction can be drawn between species that forage in the water column, or at the seabed, they all breathe at the surface and so regularly transit the water column.

Certain parallels can be drawn between known collision risks and response of mammals encountering existing hazards (shipping, fishing gear interactions, killer whale tail swipes), and a review of this information was undertaken as part of the Scottish Renewable SEA. However, there is considerable lack of empirical knowledge on this risk, and it is important to bear in mind that turbine blades, either of the horizontal or vertical axis type, present a threat quite unlike anything that marine mammals have previously experienced. Therefore, whilst an overview of the factors likely to influence collision risks posed by marine renewable devices is summarised in this section, it is not possible to quantify this risk based on the current state of knowledge.

Mooring equipment such as anchor blocks and plinths are likely to function like other natural or artificial seabed structures and hence pose few novel risks for vertebrates in the water column. Cables, chains and power lines extending up through the water will have smaller cross-sectional area than vertical support structures and so produce reduced flow disruption and fewer sensory cues to approaching mammals. Instead of being swept around these structures, mammals are more likely to become wrapped around or entangled in them.

Being highly mobile underwater, marine mammals have the capacity to both avoid and evade marine renewable devices. This is as long as they have the ability to detect the objects, perceive them as a threat and then take appropriate action at long or short range. However there are several factors that compromise this ideal scenario.

- ***Detection failure***: The broad acoustic, visual and hydrographic signatures of marine renewable devices are at present poorly understood. Other than the visual appearance of devices, the need for efficient energy conversion will encourage the development of devices that produce as little extraneous energy signatures as possible. This is in direct contrast to any warning stimuli required by the animals at risk. There is therefore a key conflict between the stimulus output from the devices and perceptual acuity of the animals at risk. The distances that animals perceive, and hence can take avoiding/evasive action will therefore depend on this ratio. Environmental circumstances such as darkness, turbid water, background noise from rough weather or ship noise may all effect perception distances and hence escape options.

- ***Diving constraints***: Marine mammals are accomplished divers and typically dive close to aerobic dive limitations. This means that animals do not have unlimited time and manoeuvrability underwater and may have few options other than upwards at the end of a dive. In addition to this, buoyancy varies among marine mammals from negative to neutral to positively buoyant. Irrepressible positive buoyancy is a particular problem for whales when surfacing from depth and therefore constrains manoeuvring options.

- ***Group effects:*** whales and dolphins travelling or feeding together may be at greater risk than those with a solitary habit. A group could be regarded as a large “super organism” rather than behaving as individuals. Responses may lead to some individuals evading contact with turbine blades; whilst others could be directed into the path of a blade.

- ***Attraction***: It is quite possible that marine renewable devices will not be perceived as a threat but instead attract marine mammals as a result of devices acting as Fish Aggregating Devices (FADs) or artificial reefs. It is also possible that species such as seals and small delphinids will be attracted to renewable devices should they injure or disorientate their prey. Certain more "curious" species, such as common and grey seals may actually be attracted to devices, whilst other more timid species (such as harbour porpoise) may tend to be more wary of devices. The age of individuals may also be relevant, as juveniles may also be more likely to investigate novel features. It is therefore likely that the more timid species or individuals that have had previous negative interactions with devices will show the strongest avoidance reactions.

- ***Confusion***: We do not yet know how marine mammals will respond to perceiving a marine renewable device, especially one with moving parts. It is quite possible that they will simply swim around it but it is also possible that they will respond in an inappropriate way. This is particularly likely for devices with gaps that move relative to the animal's trajectory such as ducted / shrouded turbines. In arrays, an escape response from one device may put the animal into a collision path with another.

- ***Distraction***: Marine mammals undertake a variety of activities underwater from simple transits, social interactions to complex foraging tactics. It is likely that during some of these occasions the animals' awareness of objects in the water column will be compromised. A particular example is the range detection problem encountered by echolocating cetaceans. When acoustically locked onto prey they reduce the interpulse intervals of their echolocation clicks such that they become acoustically blind to objects at greater distance than their intended prey. Therefore cetaceans feeding around submerged devices run an enhanced risk of close encounters without active acoustic detection.

- ***Illogical behaviour***: It is commonly believed that marine mammals have a high capacity for intelligent behaviour and as such would act logically when faced with a threat. However, there are many examples where this is not the case. The reticence of dolphins to leap the head line of tuna nets is a prime and ecologically significant example.

- ***Disease and life stage:*** It is likely that most collisions will involve young, old, diseased or disorientated individuals. As long as marine renewable devices do not significantly attract marine mammals for enhanced foraging opportunities, juveniles are likely to be more at risk than adults because of reduced sensory and mobility abilities and/or experience, whilst old, ill or disorientated individuals will have reduced abilities to detect the threat or escape from it once perceived.

- ***Size:*** Smaller mammals (such as grey and common seals) are more likely to follow the flow streamlines around moving parts and thus avoid collision. The collision risk increases with increasing size.

- ***Season:*** Collision risk will also vary with season, due to seasonal change in migrations and pupping periods. Some species, such as the baleen whales and warm water dolphins typically increase in abundance during the summer and autumn, whilst most other species are resident and show only local changes in distribution.

Collision risk is also expected to be influenced by the nature of the environment where the turbines are located:

- ***Open water:*** Deployment of devices in the open sea will present the least risk unless the spacing between devices increases the risk of encounter. The effects of devices on marine mammal habitat exclusion are likely to be localized to the area of placement.

- ***High flow environments*: ** High flows can combine with swimming speeds to produce high approach velocities with consequently reduced avoidance or evasion response times. Many marine mammals (particularly harbour porpoises and bottlenose dolphins) are attracted to areas of high flow to forage.

- ***Sounds*:** Sounds between land masses are often used by marine mammals as transit corridors, and because they present good opportunities for foraging, as fish also use them for transit. Deployment within sounds increases risk of encounter and subsequent collisions.

- ***Loughs*:** Interactions between marine mammals and devices placed at the mouths of sea loughs are likely to be similar to those for sounds, but will only have an effect on local rather than transiting species.

- ***Water quality***: Collision risk can be expected to be greater for turbines deployed in regions of moderate to high turbidity, or if the turbines increase turbidity, because of their reduced visibility.

Some initial modelling was undertaken for the Scottish Marine Renewables SEA to assess the potential encounter rate with a hypothetical scenario involving 100 horizontal axis 8 m radius turbines operating off the Scottish coast and existing populations of harbour porpoise.

The model incorporated a number of assumptions about the vertical distribution of porpoises, their swimming speeds and distribution. As escape (avoidance and evasion) behaviours by porpoises to marine renewable devices are currently unknown it was also assumed that the animals were neither attracted to nor avoided the immediate area around the turbine. The model predicted that in a year of operation device encounters would occur for 3.6% of the harbour porpoise population between Cape Wrath, the Mull of Galloway.

Whilst collision risk therefore presents a potential effect of major significance on cetaceans, it should be borne in mind that this is a simplistic approach to quantifying collision risk, as marine mammals are likely to show behavioural responses to the presence of marine renewable devices. Whilst the ability of marine mammals to perceive their environment is well understood, their behavioural reactions to marine renewable devices are not. At long range they have the option to avoid the area of device placement (i.e. swim around) and at closer range they can evade the particular structures (i.e. dodge or swerve).

The balance between avoidance and evasion responses will depend on the distances that these animals will be able to perceive the devices, and their subsequent behavioural reactions. Their ability to detect devices will depend on the sensory capabilities of the species, and the visibility and level of noise emitted by the device. The potential for animals to escape collisions with marine renewable devices will also depend on their body size, social behaviour, foraging tactics, curiosity, habitat use, and underwater agility.

Ecological effects resulting from mammal interactions with devices can be expected to range from: no effects, to the potential removal or injury of individuals, and, if rates are sufficiently high, to the decline in population numbers**.**

Marine noise: As for construction noise, noise produced during operation of wind, wave and tidal devices could also potentially disrupt prey location, navigation and social interaction behaviour in marine mammals, or result in temporary or permanent hearing damage. Whilst the noise levels likely to be generated during wave and tidal device operation are currently not known, operation noise is considered to be considerably less in magnitude than construction noise. The potential noise sources during device operation include: rotating machinery, flexing joints, structural noise, moving air, moving water, moorings, electrical noise, and instrumentation noise.

Operational noise of wind turbine of 1.5 MW should have only minor influence as the detection radii for harbour porpoises and seals is rather small. However, since operational noise of larger turbines cannot be assessed reliably yet, these results are preliminary. It is very likely that larger turbines are noisier resulting in much larger zones of noise influence. At 100 m distance turbine noise would be audible to both harbour porpoises and common seals. At 1,000 m the signal to noise ratio is too low for detection in harbour porpoises. In common seals, detection might be possible at distances greater than 1,000 m in the 125 – 160 Hz range.

A specialist study undertaken for the Scottish Renewable SEA modelled the potential for permanent and temporary hearing damage to result from operating devices. This study was based on the likely noise generated from a single type of tidal and wave device and therefore may not be applicable across all wave and tidal devices, or wind devices. It does, however, provide an indicative estimate of the levels of noise involved. The study concluded that, for the tidal device, if the most sensitive receptor were to spend 30 minutes within 16 m of tidal device it might suffer permanent hearing damage. The assessment also indicated that 8 hours within 934 m could result in temporary hearing damage. These findings were based on generic threshold curves that were used to determine potential effects on a range of species and sensitivities. However, evidence suggests that it is unlikely that an animal would choose to stay in close proximity to the source of a loud noise (Tougaard, *et al*. 2003).

Based on the available information, the underwater noise produced during operation of wave and wind devices is considered to be less than for tidal, and the risk of permanent hearing damage is considered unlikely – however it should be noted that the current information on wave devices relates to measurement of a single device on a single day. For temporary hearing damage the maximum predicted range for an exposure of 8 hours is only 6 metres, so the risk of an animal experiencing Temporary Threshold Shifts (TTS) from a single 1 MW wave device of this type is insignificant. It should be noted, however, that this analysis did not include structural noise from the wave device, which is unknown.

Marine life may exhibit avoidance reactions to underwater noise at levels much lower than the permanent and temporary hearing damage thresholds described above. It should therefore be noted that arrays of devices may appear as impenetrable barriers to an animal, perhaps separating them from feeding grounds, even though there may be plenty of room between devices for the animal to pass without experiencing damaging noise levels. In addition noise produced during operating devices has the potential for “masking effects” disrupting prey location, navigation and social interaction.

Barrier to movement: There is the potential that device arrays may form a barrier to the usual migration and transit patterns of marine mammals, either because of collision risk, aversive reactions to operation noise or perceptions of devices and associated infrastructure. This is particularly relevant in constrained areas (such as mouths of sea loughs) where loud noise sources may prevent transit, effectively trapping individuals.

Habitat exclusion*:* The presence of wave, wind and tidal arrays will cause loss of habitat during device operation. Devices may exclude mammals from a suitable habitat (both marine foraging habitats and, in the case of seals, terrestrial breeding habitats) by providing a physical or perceptual barrier or producing noise that results in avoidance behaviour. Cetaceans may also be excluded from areas used as nursery or breeding areas, migration/travelling routes and socialising areas. Exclusion may limit other device interactions, such as collisions, but will also limit the available habitat.

Based on discussions with developers, typical array sizes are likely to be 2 km^2 for wave and 0.5 km^2 for tidal arrays, and 50 km^2 for wind arrays.

Decrease in water flow resulting from extraction of tidal energy will potentially affect species which are sensitive to changes in tidal flows. Seals have been shown to use their vibrissae to sense small-scale hydrodynamic vibrations and flow vortices in the water column. They are thought to use this sense to track the wake of prey organisms swimming through the water column. Its use for navigation or detecting larger objects is unknown. The existence of a similar sense in cetaceans is unknown.

Changes in suspended sediment levels and turbidity may be caused by changes to sedimentation patterns resulting from extraction of tide and wave energy. Depending on the specific environmental parameters at a given location this may result in increases or decreases of both sediment suspension and deposition. High confidence estimates, based on expert knowledge can be given for the extent of effects on sediment processes of up to 50 m from devices. Grey and common seals have been identified as having a high sensitivity to reductions in visibility, whilst the cetaceans in the study area have a moderate sensitivity to this effect. However, many seals live in areas of almost persistent turbidity e.g. the southern North Sea, The Wash, Thames Estuary etc. It is therefore unlikely that increased turbidity would be a significant issue, although the effects for a Northern Irish seal encountering suddenly or persistently turbid water is not known.

Contamination: Leaching of toxic compounds from sacrificial anodes, antifouling paints or leakage of hydraulic fluids (if present) from the device is a potential effect during device operation. A small number of both wave and tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. Seals and cetaceans in the study area generally have a low sensitivity to contamination, although the sensitivity rises to medium around seal breeding sites. However, as top predators seals and cetaceans are more susceptible to various substances building up to higher levels in their bodies.

The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small, and it is therefore considered that this potential effect will be of negligible significance. It is not possible to make any realistic estimate of the geographical extent of this effect due to the large numbers of variables involved (quantities leaked, metocean conditions, etc).

Accidental leakage of hydraulic fluids may be more significant, should they occur through storm damage, device malfunction or collision with navigating vessels. Devices which use hydraulic systems will normally be designed such that at least two seal or containment failures are required before a leaking fluid reaches the sea. It is not possible to be definitive for every device listed in this document as a number of them are still at concept stage and this aspect is a matter for detailed design. However, the industry's design guidelines (Carbon Trust, 2005), if followed, would lead a developer to minimise risks of hydraulic fluid leakage. Potentially more significant still are the potential effects from leakage of cargoes or fuel carried by a vessel involved in a collision with renewable device arrays. This impact is impossible to quantify due the number of variables such as vessel cargo, risk of vessel collision, etc.

Electro-Magnetic Fields (EMF): Electric and magnetic fields are produced as a result of power transmission in the inter array cables and the export cable to shore. The devices themselves will also have an electrical signature, however this will be specific to the individual devices e.g. whether the power generator is in the water or on a platform and if there is a riser cable from a device on the seabed. A number of research reports have been undertaken by COWRIE into the likely field strengths and potential effects on marine species (CMACS 2003; CMAS 2005; CMACS 2006).

A literature review of research into this area, undertaken for the Scottish Marine Renewables SEA (Scottish Executive, 2006) concluded that there is no evidence that magnetic fields from existing cables have influenced migration of cetaceans. However, matrices of cables within arrays may produce a more concentrated EMF effect than individual export cables.

The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains a complicated, understudied and unproven field of science (Basslink, 2001), with only circumstantial evidence. Cetaceans cross cables constantly, for example, migration of the harbour porpoise in and out of the Baltic Sea necessitates several crossings over operating subsea HVDC cables in the Skagerrak and western Baltic Sea without any apparent effect on its migration pattern (Basslink, 2001). There is no apparent evidence that existing electricity cables have influenced migration of cetaceans, but further study is thought warranted (Gill *et al.*, 2005).

There is no evidence that seals are sensitive to electromagnetic fields.

Haulout sites: If surface structures have horizontal surfaces near water level then there is potential that seals will use them as haulout sites. Whilst this could be viewed as a positive effect, increasing the area available for seals to haul out, there may be risks of injury associated with getting onto/off the structures and any contact with exposed moving or articulated parts.

Increased Foraging Opportunities: Wave, wind and tidal devices, with associated seabed moorings and vertical structures, will potentially function as artificial reefs or fish aggregating devices. In changing the habitat they therefore have the potential to also change the distribution of marine mammals. Their structures may offer enhanced opportunities for foraging for some species. This could occur because, in tidal flows these structures will produce eddies and areas of slack water which predators could use to shelter when ambushing prey. Otherwise the action of moving parts may scatter schooling prey or injure fish or squid and thus draw in opportunistic foragers such as seals and small cetaceans. There is, however, no guarantee that animals will be able to take advantage of this, as it will depend on their feeding techniques, prey choice and adaptability. Therefore, whether these opportunities would enhance the foraging prospects for such species for the better or attract them into otherwise dangerous situations is not yet clear.

Table 10.6: Summary of Potential Effects on Marine Mammals and Reptiles

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Collision Risk (construction)	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Array size (2 km^2 – wave; 0.5 km^2 - Tidal – 50 km^2 - wind)
Physical Disturbance	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	900m from seal colonies
Marine Noise (construction)	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	At least 20km for porpoises (may vary between species)
Increased suspended sediment and turbidity	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Disturbance of contaminated sediments	Wave / Wind / Tidal	CC CD	Indirect	Temporary (during installation)	Negligible
Collision Risk (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Array size (2 km^2 – wave; 0.5 km^2 - Tidal – 50 km^2 - wind)
Marine Noise (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Unknown (development specific)
Habitat exclusion	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Array size (2 km^2 – wave; 0.5 km^2 - Tidal – 50 km^2 - wind)
Decrease in water flow	Wave / Wind / Tidal	OD	Direct	Long term (device life)	500m
Increased turbidity (reduced visibility)	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Contamination from anti-fouling paints and sacrificial anodes	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Negligible
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify
EMF	Wave / Wind / Tidal	OC	Direct	Long term (device life)	Negligible
Haulout	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Increased foraging opportunities	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Impossible to quantify
Barrier to movement	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect - cables
OD = Operation effect – devices
OC = Operation effect – cables

10.3.6 *Bats*

10.3.6.1 Introduction

As discussed in Chapter 9, the information on the potential effects of offshore renewable energy developments (mainly offshore wind farms) on bats is very limited. Based on current research it has been identified that potential effects are most likely to occur on where bats are on migratory routes (EUROBAT 2006). Any potential effects are also to be associated with the operational offshore windfarms as discussed below.

10.3.6.2 Installation effects

There is very little information available in relation to potential installation effects associated with offshore renewable energy developments, mainly offshore wind farms. Further research is required to gain a greater understanding of potential effects. This is likely to be required at a national and also international level rather than as a specific part of this SEA, although the SEA can assist the development or request for further research by highlighting significant data gaps and the need for a greater understanding of the potential effects on bats during the installation of offshore wind turbines.

10.3.6.3 Operational Effects

Collision Risk: Based on available information the main potential effect of offshore wind farms has been identified as risk of collision with moving turbines although the evidence of this is very limited. Thermal images of windfarms in America appeared to indicate that bats are attracted to both static and moving blades (Arnett EB-technical editor 2005). Studies in Europe have also bats foraging close to moving turbines (Bach L (2002), Ahlen I (203) and Endl, P, Engelhart U, Seiche K, Teufert S, Trapp H (2005). There appears to be concern that this attraction of bats to turbines is causing fatalities (http://www.windaction.org/news/18851).

Another possible explanation regarding collusion risk with offshore wind farms is that bats do not use their echolocation when flying over large bodies of water and that they rely on sight only (http://www.windaction.org/news/18851). However, migrating bats are known to stop on ships at sea to rest and therefore may also see offshore wind turbines as possible resting platforms (http://www.windaction.org/news/18851) increasing the risk of potential collision with moving blades.

Barotrauma: Barotrauma has been identified as a possible cause of bat fatality associated with wind farms. Barotrauma is caused by rapid air pressure reductions near moving turbines. This reduction in air pressure has been linked to possible internal tissue damage and an expansion of the lungs. Research into fatalities of bats associated with wind farms identified that in some cases a large proportion of the bats did not exhibit any external injuries that would be consistent with collision impacts but had internal haemorrhaging and the majority of the bats that did have external injuries also had internal haemorrhaging (Baerwalda, E F, D'Amoursa G H, Kluga B J, and Barclaya R. M. R (2008)).

10.4 Cultural Heritage including Archaeological Heritage

10.4.1 Archaeology and Wrecks

The potential for damaging an archaeological site is, in part, related to the ease of finding (and hence avoiding) it. Recent, metal built, wrecks (including aircraft if intact) are likely to be reasonably detectable. Older, wooden, vessels are likely to be fragmentary, sites often consisting only of scattered, mainly metal and ceramic or stone artefacts, possibly buried. Pre-historic landscapes and remains of prehistoric settlement sites are likely to consist of scattered artefacts or structures (often semi-natural) buried beneath considerable layers of sediment. In the latter case recognition is likely to be a major problem.

The following is a description of the potential effects that the installation and operation of wind, wave and tidal devices could have on archaeological sites if directly affected.

10.4.1.1 Installation Effects

During installation of devices and cables, archaeological sites in the vicinity of installation operations could be affected in the following ways:

Seabed attachment: There is a potential significant adverse effects resulting from the destruction of sites and artefacts, both surface and buried within the seabed footprint of device construction.

Displacement of sediments: While most sedimentary material is unlikely to cause damage to any but the most fragile artefacts, there is a risk of damage when large fragments are displaced. Displaced sedimentary material might bury a site delaying or preventing discovery.

Cable laying operations: There is a potential for negative effects from cabling laying due to damaging to sites and destroying artefacts along the line of trenches.

Exploratory operations: There is possibility of damaging artefacts. Cores should be inspected for presence of archaeological material. Archaeological assessment of survey data collected as part of wave, wind and tidal energy projects could also provide data that could provide archaeological evidence from the marine environment that could contribute to the archaeological record for the area.

10.4.1.2 Operational Effects

No significant effects to archaeological sites are anticipated during routine operation of wind, wave and tidal energy extraction systems, although scouring could lead to the exposure of sites leading to possible enhanced degradation. There is also the possibility of deeper burial of a site if there is an increase in local sedimentation rates, covered under sediment displacement.

Table 10.7: Summary of Potential Effects on Archaeological Sites

Effect	Technology	Development phase	Direct / Indirect	Duration	Extent
Seabed attachment	Wave / Wind / Tidal	CD	Direct	Permanent	Within disturbed area
Scouring and exposure of sites	Wave / Wind / Tidal	OD	Indirect	Temporary to Permanent	Within developed area
Displacement of sediments	Wave / Wind / Tidal	CD CC	Indirect	Temporary to Permanent	Within sedimented area

Effect	Technology	Development phase	Direct / Indirect	Duration	Extent
Cable laying operations	Wave / Wind / Tidal	CC	Direct	Permanent	Cable trench
Exploratory operations	Wave / Wind / Tidal	CD CC	Direct	Permanent	Extent of work

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect - cables
OD = Operation effect – devices
OC = Operation effect – cables

10.5 Population and Human Health

10.5.1 Commercial Fisheries

The key difference between effects on commercial fisheries and mariculture is that fin and shell fish farms are static installations and therefore the species exploited cannot temporarily relocate or adapt to take into account effects from installation. This factor is taken into account in the identification of effects below that are specific to commercial fishing activities and the operation of shell and fin fish farms.

The key effects identified relating to commercial fisheries include direct disturbance of grounds and displacement of fishing vessels. A detailed description of ecological effects relating to fish and shellfish species is presented in Section 8.3.3**.**

10.5.1.1 Installation Effects

Temporary displacement from traditional fishing grounds: The UK Energy Act 2004 provides for safety zones around renewable energy installations. Although this Act does include provisions for Northern Ireland, the Northern Ireland territorial waters were not included in the definition of geographical coverage leaving a gap in the practical application of this legislation. In terms of the provisions of the Energy Act 2004, and additional provisions included in the Energy Act 2008, the SAP sets out proposals for DETI to work with DECC to develop a legislative regime for Northern Ireland that is consistent with the rest of the UK. This would include the application of safety zones and statutory decommissioning regimes in Northern Ireland waters. The introduction of safety zones during construction and installation of developments could therefore result in fishing vessels being temporarily displaced into different fishing grounds, effectively concentrating fishing effort into a smaller geographical area.

Direct disturbance of fishing grounds: Installation and removal of wave, wind and tidal devices, and associated cables will potentially cause a direct disturbance to commercially targeted fish species in the immediate vicinity of operations. The nature of potential effect on commercial fish and shellfish is described in Section 8.3.3, and includes possible noise disturbance, increased suspended sediment, smothering and removal of seabed habitat used by demersal species, species which spawn on the seabed and shellfish.

Disturbance of contaminated sediments is also possible during cable and device installation and removal, which may cause potential detrimental effects on fin and shellfish species that are sensitive to contamination. Potential sources of contamination and the associated implications for water quality are assessed in Section 10.2.3.

Smothering, increased suspended sediment and turbidity, and installation noise effects on fish and shellfish species are described in Section 10.3.3.

10.5.1.2 Operation Effects

Permanent displacement from fishing grounds during array and cables operation: As noted above, DETI proposes to work with DECC to establish an appropriate legislative regime for Northern Ireland waters which is consistent with regime applied to the rest of the UK under the UK Energy Act.

The UK Energy Act (2004) provides for safety zones around offshore renewable energy installations installation/device during installation and operation. Following public consultation, new regulations – 'The Electricity (Offshore Generating Stations) (Safety Zones) (Applications Procedures and Control of Access) Regulations 2007 (SI No 2007/1948) - were introduced in August 2007 clarifying these requirements. The regulations refer to standard dimensions of 500 metres (the maximum permissible under international law) during construction, major maintenance, possible extension and decommissioning, and 50 metres during the operational phase of an installation's life which will normally apply. However all applications will be assessed on a case by case basis taking into account site specific conditions, and it is envisaged that certain types of fishing may activity excluded, and certain types allowed.

The footprints of a wind, wave or tidal device array have been estimated to be 50 km^2, 2 km^2 and 0.5 km^2 respectively, and certain types of commercial fishing activities may therefore be permanently excluded from a 50 m buffer around the array area.

The actual magnitude of this effect will be dependent on the availability of alternative grounds for fishermen to exploit, and also any potential positive effect fisheries exclusion may have on fish stocks.

Although fishing over cables is not prohibited - snagging a cable represents a safety hazard for the fishing vessel and damaging a cable is an offence under the United Nations Law of the Sea. Therefore it could be assumed that the area in which the cables are installed will not be attractive for mobile, invasive fishing methods (i.e. beam trawls, bottom otter trawls) once the cable has been installed. Therefore it is predicted that vessels operating such gear will be displaced due to the installation of power cables over a swathe of approximately 300 m for each device array (an array may have up to three export cables, each separated by 100 m).

Increased pressure upon fishing grounds: Displacement of fishing effort on a long term basis could have an indirect effect upon fish stocks and competition between fishing vessels and other sectors, depending on the scale of displacement and availability of fishing grounds. If fishing effort were to be concentrated in small areas stocks could become depleted and competition between vessels and/or sectors may mean that the viability of certain fisheries in certain areas is compromised. This effect would be particularly acute for inshore waters and communities dependent on fishing.

Effects on the fish resource in the study area could also affect the exploitable species available to fishermen, and the following effects on fish species are discussed in detail in Section 10.3.3:

- Substratum loss due to the presence of gravity bases, clump weights and anchors on the seabed, or scouring associated with structures piled into the seabed
- Decrease in water flow; decrease in wave exposure
- Changes in suspended sediment levels and turbidity
- Electric and magnetic fields
- Contamination and marine noise effects

10.5.2 Mariculture

This section focuses on additional effects that are specific to mariculture, which are not covered in Section 10.3.3.

10.5.2.1 Installation Effects

Direct disturbance: Disturbance of mobile species can occur during installation and removal of devices and cables, as a result of the presence of the installation and decommissioning vessels and equipment (and associated noise) in the vicinity of operations. The key disturbing factor for marine fish farms is the noise produced during installation and decommissioning operations, and this is addressed under “marine noise” below.

Disturbance of contaminated sediments: Disturbance of contaminated sediments is also possible during cable and device installation and removal, which may cause potential negative effects on species that are sensitive to contamination. Areas of potential contamination risk and the associated implications for water quality are assessed in Section 8.2.3. The potential effect on market confidence in non sensitive, high value species also needs to be considered here, as even in circumstances where there are no significant effects on farmed species, should consumers perceive that farmed fish and shellfish are being affected by contamination as a result of marine wave, wind and tidal development this could have implications for the fish farming industry in Northern Ireland as a whole.

Marine noise: Marine fish can produce and hear marine noise which, whilst not fully understood, is thought to be associated with alarm calls and social behaviour. Noise emissions from installation activities have particular potential significance for mariculture as the fish are unable to employ avoidance reactions.

Pile driving is anticipated to have the greatest potential effects on marine wildlife, as it generates very high sound pressure levels that are relatively broad-band (20 Hz - > 20 kHz). There is also potential that the use of explosives to remove piled foundations could generate very high sound pressure levels. Physiological effects of noise are also possible at very close proximity to the noise source; however this has not been quantified due to lack of data. Should noise producing activities be undertaken in close proximity to fish farms, there is a potential for physiological effects, as farmed fish may not be able to move away from the source of the noise. Experience from marine aquaculture suggests that under stress females can become “egg bound”, resulting in eggs not being released at the anticipated time, and can ultimately result in eggs being reabsorbed or the fish dying. Mariculturalists tend to keep broodstock in quiet areas, and avoid unnecessary loud noises (RPS Energy, 2006).

Atlantic salmon are thought to have poor hearing ability, as their swim bladder is disconnected from their skull/hearing system. However, cod have been identified as being highly sensitive to marine noise, and may be able to detect pile driving pulses at distances of up to 80 km in some situations.

Smothering and increased suspended sediment and turbidity effects are described in detail in Section 10.3.3.

10.5.2.2 Operation Effects

Substratum loss due to the presence of gravity bases, clump weights and anchors on the seabed, or scouring associated with structures piled into the seabed. The area of seabed lost is impossible to quantify at the strategic level, as it is dependent on many project specific factors. The footprints of a typical wave, tidal or wind device array have been estimated to be 2 km^2 and 0.5 km^2, or 50 km^2 respectively.

EMF: Electricity cables produce small electric and magnetic fields, which have the potential to affect migration and prey detection in certain electro-sensitive fish species such as elasmobranchs (sharks and rays).

Marine noise: As for construction noise, noise produced during operation of devices could also potentially cause fish to become “stressed”, or maybe result in temporary or permanent hearing damage in particularly close proximity. Noise emissions from operation of devices have particular potential significance for mariculture as the fish are unable to employ avoidance reactions.

However, the marine environment is noisy with ambient noise arising from wave action, natural sediment movements, action of wind and rain on the sea surface and noise from wildlife. This ambient noise combines with man made noise produced from sources such as shipping, and fishing sonar to produce background noise which varies with different locations due to the influences of the existing seabed geology and bathymetry. Noise generated during wave, wind and tidal array operation will contribute to existing background noise.

A specialist study for the Scottish Marine Renewables SEA modelled the potential for permanent and temporary hearing damage to result from operating devices. This study was based on the likely noise generated from a single type of tidal and wave device, and therefore may not be applicable across all devices, it does, however, provide an indicative estimate of the levels of noise involved.

The study concluded that, for the tidal device, if the most sensitive receptor were to spend 30 minutes within 16 m of tidal device it might suffer permanent hearing damage. The assessment also indicated that eight hours within 934 m could result in temporary hearing damage. These findings were based on generic threshold curves that were used to determine the potential effects on a range of species and sensitivities.

Whilst evidence suggests that it is unlikely that an animal would choose to stay in close proximity to the source of a loud noise (Tougaard, *et al*. 2003), this option may not be available to caged fish in fish farms. The exposure period of 8 hours that was assessed in this study should also be considered against the production cycles for marine fish farms – typically less than 1 year for farmed trout, around 1.5 years for farmed salmon, and 2-5 years for farmed halibut and cod.

Based on the available information, the noise produced during operation of wind and wave devices is considered to be less than for tidal, and the risk of permanent hearing damage is considered negligible. For temporary hearing damage, the maximum predicted range for an exposure to an operating wave device of 8 hours is only 6 metres, so the risk of an animal experiencing a Temporary Threshold Shift (TTS) from a single 1 MW wave device of this type is insignificant. It should be noted, however, that this analysis did not include structural noise from the wave device, which is unknown. At a distance of 1km from a 2MW wind turbine, the operational noise merges with the ambient noise (see Section 10.3.3.2).

10.5.2.3 Summary of Potential Effects

The siting and location of both devices and cables could result in some fishing vessels being permanently displaced into different fishing grounds, effectively concentrating fishing effort into a smaller geographical area and increasing journey times to grounds and use of fuel. A summary of the potential effects identified for commercial fisheries and mariculture is given below in Tables 10.8 and 10.9.

Table 10.8: Summary of Potential Effects on Commercial Fisheries

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Direct disturbance of fishing grounds	Wave / Wind / Tidal	CC,CD	Direct	Temporary (during installation	Cable device and installation area
Temporary displacement from traditional fishing grounds	Wave / Wind / Tidal	CC,CD	Direct	Temporary (during installation	Cable device and installation area
Long term displacement from traditional fishing grounds	Wave / Wind / Tidal	OC,OD	Direct	Long term	Array size (2 km^2 – wave; 0.5 km^2 - Tidal – 50 km^2 - wind) and potentially cable swathe

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Increased pressure upon fishing grounds	Wave / Wind / Tidal	OC, OD	Indirect	Long term	Depends on scale of development in relation to fishing grounds

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect - cables
OD = Operation effect – devices
OC = Operation effect – cables

Table 10.9: Summary of Potential Effects on Mariculture

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Smothering	Wave / Wind / Tidal	CC,CD	Direct	Temporary (during installation	50m
Increased turbidity	Wave / Wind / Tidal	CC,CD	Indirect	Temporary (during installation	Negligible
Increased suspended sediment	Wave / Wind / Tidal	CC,CD	Indirect	Temporary (during installation	Negligible
Marine noise (construction)	Wave / Wind / Tidal	CC,CD	Direct	Short term (installation)	80km (maximum)
Marine Noise (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	1km (tidal device based on 8 hours exposure) Negligible (wave device)
Substratum loss	Wave / Wind / Tidal	OD	Direct	Long term (device life)	20km
Decrease in wave exposure	Wave / Wind / Tidal	OD	Direct	Long term (device life)	500m
Decrease in water flow	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Negligible
Changes in turbidity	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Changes in suspended sediment	Wave / Wind / Tidal	OD	Indirect	Long term (device life)	Negligible
Disturbances of contaminated sediment	Wave / Wind / Tidal	CC,CD	Indirect	Temporary (during installation	Negligible
Contamination from anti-fouling paints and sacrificial anodes	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Negligible
Accidental contamination (hydraulic fluids)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Impossible to quantify

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect - cables
OD = Operation effect – devices
OC = Operation effect – cables

10.5.3 *Shipping and Navigation*

Effects on shipping and navigation can be categorised as effects on safety, and effects on issues related to economics such as journey times and distances, and trade. In terms of safety it is important to note that there are various rules, regulations and guidelines that relate to safety of navigation with regards to any offshore development that are in place to help prevent casualties and collisions. Below is an overview of the potential effects that could occur. It is important to recognise that all offshore activities are subject to various rules and regulations that aim to mitigate the chance of such effects occurring.

It should also be noted that this report identifies generic effects, and where possible, assigns strategic effect significance based on the available high level data. Any proposed wave, wind or tidal energy development would need to examine the potential effects that are specific to that development, which would require use of more detailed data sources, further data collection and detailed navigation risk studies.

10.5.3.1 Installation Effects

Increased journey times and distances: During installation and decommissioning there will be exclusion or avoidance zones in operation around development sites and associated installation activities for the purposes of safety. The UK Energy Act 2004[20] provides for the establishment of safety zones round offshore renewable energy installations. The proposal under consultation was that a 500 m safety zone should be employed around construction activities. The introduction of installation vessels and equipment into the study area may require vessels to move around the construction activities potentially increasing journey times and distances. The extent to which journey time or distances are affected will be highly variable depending on the location of the development. Increased journey distances will, of course, lead to increased fuel use with the associated indirect increase in costs incurred by the shipping operator, and increased carbon emissions. The scale of the effect will be dependent on the type of shipping activity – for example a five mile increase in journey will be less of an effect if the journey is 500 miles, than if the journey is only 20 miles.

Displacement of shipping density: The safety zones that will be in place during construction and decommissioning activities will affect shipping density in already constrained areas as vessels will be forced to move around the installation area. In unconstrained areas (e.g. the open waters off the north coast of Northern Ireland there will be no measurable effect on shipping density.

Reduced trade opportunities: Temporary reduced access to ports and harbours may occur during construction and decommissioning activities and this would have an effect on trade and supplies.

Reduced visibility: The presence of installation vessels, barges, jack-up rigs and other construction equipment has the potential to obstruct the view of other vessels, navigation features such as lights and buoys and the coastline. This could cause a hazard to shipping in areas where visibility is particularly important for navigation or areas where the topography already constrains visibility.

Collision: The presence of slow moving or stationary installation and decommissioning vessels and equipment is likely to affect the probability of close quarter encounters and collisions with both vessels moving under power and drifting vessels.

The presence of construction activities also has the potential to cause small and recreational vessels to modify their routes to use areas transited by larger vessels, which potentially increases the risk of encounter or collision.

[20] Although the UK Energy Act 2004 does include provisions for Northern Ireland, the Northern Ireland territorial waters were not included in the definition of geographical coverage leaving a gap in the practical application of this legislation. In terms of the provisions of the Energy Act 2004, and additional provisions included in the Energy Act 2008, the SAP set out proposals for DETI to work with DECC to develop a legislative regime for Northern Ireland that is consistent with the rest of the UK. This would include the application of safety zones and statutory decommissioning regimes in Northern Ireland waters.

In the unlikely event of a collision occurring there is a risk of extensive and serious environmental effects associated with the spillage of oil and hazardous cargos.

Search and rescue: Search and rescue exercises and operations could take place throughout the study area. The planning of such activities would need to be adapted to take into account the presence of installation equipment.

10.5.3.2 Operational Effects

The effects of the operation of offshore wind and marine renewable energy devices upon shipping and navigation are very similar to the installation effects. The key difference is the scale (installation footprint versus development footprint) of the effect and duration of effects (temporary during installation versus long term during device life).

Increased journey times and distances: Vessels will be required to move around marine renewable energy developments and associated safety or avoidance areas potentially increasing journey times and distances. The extent to which journey time or distances are affected will be highly variable depending on the location and size of the development and the type of journey being disrupted. Increased journey distances will potentially lead to increased fuel use with the associated indirect increase in costs incurred by the shipping operator, and increased carbon emissions.

The footprints of wind, wave or tidal device arrays have been estimated to be 50km^2, 2 km^2 and 0.5 km^2 respectively. The UK Energy Act (2004)[20] also provides for a 50 m safety zone around each installation/device following construction. In certain cases an official “area to be avoided” agreed by the IMO may also be required to ensure navigational safety. There is a possibility that bottom mounted tidal devices that have sufficient clearance above them will not present an obstruction to shipping. However, risks associated with the placement of, and continued navigation over, such devices will have to be assessed on an individual project basis but as an example, tidal devices with approximately 50 m clearance could be tolerable in certain locations. Maintenance visits would still be required to service such devices and these would require vessels to move around them.

Displacement of shipping density: The presence of renewable energy developments will affect shipping density in already constrained areas as vessels will be forced to move around the device area. In unconstrained areas (e.g. the open waters off the north Northern Ireland coast) there will be no measurable effect on shipping density).

Reduced trade/supply opportunities: Long term reduced access to ports and harbours could have a long term effect on trade opportunities and access to supplies.

Reduced visibility: The presence of devices has the potential to obstruct the view of other vessels, navigation features such as lights and buoys and the coastline. This could cause a hazard to other shipping in areas where visibility is particularly important for navigation or areas where the topography already constrains visibility.

Collision: The presence of stationary wave, wind and tidal device arrays is likely to increase the probability of collisions with both vessels moving under power and drifting vessels.

There is also a very small risk that moored devices could break free of the moorings under extreme weather conditions. It should be noted that although this is a credible risk due to the nature of extreme weather events, the industry will always seek to ensure the risk is as low as reasonably manageable and insurers will also require that risks are minimised and mitigated as far as possible.

In the event of a collision occurring there is a risk of extensive and serious environmental effects associated with the spillage of oil and hazardous cargos.

Search and rescue: Search and rescue exercises and operations could take place throughout the study area. The planning of such activities would need to be adapted to take into account the presence of arrays of devices.

Compass deviation: There is potential for magnetic interference with ships compasses from the cables associated with renewable energy developments. However, Medium Voltage AC (132kV or lower) three-phase transmission cables are typically used for renewables projects and the time varying magnetic fields from each phase tend to cancel each other out. In the case of HVDC cables the (static) magnetic field can have an effect on a nearby compass but this reduces dramatically with distance from the cable. Depth of burial and water depth therefore will affect the levels of magnetic compass deviation at the sea surface.

The orientation of the cable also influences the effect of the magnetic field emitted due to the magnetic field of the earth – a cable running from east to west will have less effect than one that runs north to south. Due to the way the magnetic field decreases with distance from the cable, compass deviation is only likely to be an issue in very shallow and intertidal areas which are typically areas of low activity for shipping.

Radar, communications and positioning systems: There is potential for offshore wind farms to have adverse effects on the use of radar for navigational safety and marine communications due to the height to which the turbines protrude above the surface of the water. Wave and tidal array are less likely to have a negative effect on radars as the devices generally do not protrude above the surface of the water to heights of the offshore wind turbines.

A study was undertaken by MCA into potential for interference with marine radar, communications and positioning systems for the North Hoyle windfarm project (MCA and Qinetiq, 2004). The study concluded that only significant cause for concern was the effect of wind farm structures on shipborne and shorebased radar systems. It was determined that the large vertical extent of the wind turbine generators returned radar responses strong enough to produce interfering side lobe, multiple and reflected echoes. While reducing receiver amplification (gain) would enable individual turbines to be clearly identified from the side lobes - and hence limit the potential of collisions with them – its effect would also be to reduce the amplitude of other received signals such that small vessels, buoys, etc., might not be detectable within or close to the wind farm. Bearing discrimination was also reduced by the magnitude of the response and hence the cross range size of displayed echoes. If on passage close to a wind farm boundary or within the wind farm itself, this could in some circumstances affect a vessel's ability to fully comply with the International Regulations for the Prevention of Collisions at Sea and might also affect the performance of its automatic radar plotting aid (ARPA). With respect to the multiple and reflected echoes produced when wind farm structures lie between the observing radar and a relatively high sided vessel, gain reduction will have similar effects to those described above. If, as in the trial undertaken, a shore or platform based radar is intended to detect and track traffic in port approaches, Vessel Traffic Systems or in the proximity of offshore oil or gas installations, the effects could be significant.

MCA guidance note MGN371 assess level of risk associated with offshore wind farm distances from main shipping routes, based on impacts on vessel communications and positioning systems:

- Up to 0.45 nm (800 m) – very high risk
- 0.5 nm (926 m) – 0.8 nm (1481 m) – high risk
- 1 nm (1852 m) – 1 nm (3704 m) – medium risk
- 2 nm (3704 m) – 5 nm (9260 m) (provided it is not near a TSS) – Low risk
- 5 nm (9260m) or greater – very low risk

Site specific traffic intensity studies and consultation with MCA and relevant ports authorities will need to be undertaken for specific developments to determine the level of shipping collision risk of specific development sites, and acceptable proximity on a case by case basis.

Table 10.10: Summary of Potential Effects - Shipping and Navigation

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Increased journey times and distances (construction)	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	500 m around installation activities

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Displacement of shipping density (Construction)	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	Focussed around device arrays if located in areas of high shipping density
Reduced trade/supply (construction)	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	Focussed around device arrays if located in vicinity of entrances to ports and harbours
Reduced visibility (construction)	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	Focussed around device arrays where visibility is key to navigation
Collision (construction)	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	Installation area
Search and rescue	Wave / Wind / Tidal	CC, CD	Direct	Temporary (during installation)	Focussed around device arrays
Increased journey times and distances (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	50 m around device array
Displacement of shipping density (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Focussed around device arrays if located in areas of high shipping density
Reduced trade/supply (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Focussed around device arrays if located in vicinity of entrances to ports and harbours
Reduced visibility (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Focussed around device arrays where visibility is key to navigation
Collision (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Unknown (development specific)
Search and rescue	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Focussed around device arrays
Compass deviation (operation)	Wave / Wind / Tidal	OC	Direct	Long term (device life)	Cable routes
Radar, communications and positioning systems (operation)	Wave / Wind / Tidal	OD	Direct	Long term (device life)	50 m around device array (depends on proximity of shipping routes)

10.5.4 *Recreation and Tourism*

The marine environment, landscape and resources play an important role in many tourism and recreation activities in Northern Ireland. Therefore, any impact on the coastal or marine environment through the installation, operation or maintenance of marine renewable energy devices could potentially have an effect on the tourism industry and recreation. The potential effects are discussed below.

10.5.4.1 Installation Effects

Noise: Noise generated during the installation and removal of the marine devices will potentially have direct and indirect effects on recreation and tourism, although the effects will only be short term. The main sources of construction and decommissioning noise include:

- Presence of vessels
- Piling
- Movement of machinery/device components
- Installation of machinery/device components
- Cable trenching
- Excavation and cutting noise or noise from use of explosives to remove piled foundations
- Installation of onshore grid connection

The main direct effect of installation and decommissioning noise is related to general disturbance that will be experienced by visitors to key coastal attractions/locations e.g. beaches and coastal paths, and participants in key coastal and marine recreational activities e.g. golf, sailing, swimming and water sports. Installation and decommissioning noise may have adverse effects on the breeding, feeding and migratory patterns of marine wildlife and seabirds, leading to their displacement or avoidance of areas. This could potentially have an indirect effect on the marine wildlife watching industry and bird watchers. The effect of noise on marine wildlife is discussed in more detail in Section 10.3.

Transportation: There will be a requirement, as part of the installation and decommissioning process, for the transportation of the various components of the marine devices. This will include the movement of device components from the point of production to a port or coastal location for transfer onto deployment vessels. The main effects associated with the transportation of large pieces of machinery include congestion caused by large, slow moving vehicles, increased noise, vibration, air pollution and general environmental disturbance. Due to the predicted size of the marine devices, most will require deployment from harbours that can accommodate vessels with sufficient loading capacity for device deployment. In most cases, access routes to these harbours have been designed to accommodate the movement of large vehicles. There is also potential that the marine vessels could disrupt recreational sailing routes, fishing activities and other water sports.

Landscape, Seascape and Visual Amenity: The effects on landscape, seascape and visual amenity are discussed in Section 10.6.2. The landscape, seascape and views around the Northern Ireland coastline are intrinsic to the area's ability to attract tourists and visitors. Installation and decommissioning activities may temporarily affect the general attractiveness of certain areas which could potentially affect visitor's perceptions and enjoyment of an area.

Access Restrictions: In the interests of efficiency and safety, installation and decommissioning activities may involve some restriction of public access to areas where construction is underway. Depending on location, this may affect sailing activities, diving, open water swimming, water sports and wildlife watching.

Water Quality: The effects of the deployment of marine devices on water quality are discussed in Section 10.2. In terms of the installation and removal of devices there are a number of potential sources of water pollution including:

- Release of contaminated materials during piling, drilling or grouting
- Vessel fuels – spillage
- Leakage of device lubricants, hydraulic oils
- Antifoulants

Any water pollution arising from the installation of devices could potentially affect bathing water quality and local beaches.

10.5.4.2 Operation Effects

Noise and Vibration: In terms of the operation of the marine devices, the majority of the effects of noise will be on the marine environment, although shoreline devices generate noise which could potentially affect land based receptors.

As with installation noise, operational noise may have an adverse effect on the breeding, feeding and migratory patterns of marine wildlife and seabirds, leading to their displacement or avoidance of areas. This will potentially have an indirect effect on the marine wildlife watching industry and bird watchers. The effect of noise on marine wildlife is discussed in more detail in Section 10.3.

Landscape, seascape and visual amenity: The effects on landscape, seascape and visual amenity are discussed in 10.6.2. The landscape, seascape and views around the Northern Ireland coastline are intrinsic to the area's ability to attract tourists and visitors. The presence of marine devices in certain locations may affect people's perceptions and enjoyment of an area.

Safety and collision risk: The effect of marine devices in terms of safety and collision risk is discussed in 10.5.3 in relation to shipping and navigation, Section 10.3.5 with respect to marine mammals and10.3.4 with respect to Birds. Submerged, partially submerged and sub-aerial devices all present a potential hazard to other users of the marine environment as collisions could cause damage to vessels and danger to the health and safety of people in the area. Increased risk of collision with structures at sea could act as a deterrent to recreational sailors or water sports enthusiasts.

Access restrictions: In order to avoid potential collisions, areas in which devices are located may require access restrictions to be imposed. Such restrictions may have a negative effect should they prevent access to specific sites or areas of coastline which are of special interest. There is also potential for wave, wind and tidal energy projects to cause cruising routes to become 'squeezed' into commercial navigation routes and effects on sailing and racing areas (RYA's Position on Offshore Energy Developments, December 2005).

Disturbance to wildlife: As mentioned previously in terms of noise and vibration, the operation of marine devices may lead to the disturbance and potential displacement of marine wildlife or seabirds. Other factors potentially affecting marine mammals and birds include: habitat loss; disturbance, disruption or loss of food sources and feeding areas; physical severance or obstruction of migratory routes; population pressures if certain species are forced into smaller areas or predator habitats. The displacement of marine wildlife or birds could have negative effects on marine wildlife watching operators and bird watchers. The effects of marine devices on birds and marine mammals are discussed in detail in Sections 10.3.4 and 10.3.5.

Energy extraction: The potential implication of energy extraction on recreation and tourism are associated with how energy extraction affects coastal processes and how these effect local beaches. Potential effects on coastal processes and geomorphology are described in Section 10.3. Concerns have been raised by the surfing community in general that extraction of wave resources could potentially affect wave energy at the coast, with the associated effects on surfing. The area of greatest wave energy potential in Northern Ireland is offshore of Lough Foyle, which is also offshore of the most popular surfing areas between Magilligan point and Ballycastle. However, the percentage of wave energy extracted by the offshore wave devices is negligible in comparison with the wave energy lost by increased bottom friction in the shallowing water as the waves approach the shore, and exploitation of offshore wave energy is not expected to have a negative effect on recreational surfing.

Creation of tourist attractions: There is potential that the marine devices themselves could have positive effect on recreation and tourism by becoming key tourist attractions. With increased awareness of climate change and the opportunities for gaining first hand experience of the evolution of new technologies, the attraction of marine devices which are accessible (and visible) could be potentially high in the short-term. Interest is likely to decrease as wave, tidal and wind power become more commonplace.

10.5.4.3 Summary of Potential Effects on Recreation and Tourism

Table 10.11 below provides a summary of the potential key effects on recreation and tourism activities. A distinction is made between direct and indirect effects e.g. direct effects on facilities or resources and indirect effects on the environment which in turn effects people's responses to tourism and recreation e.g. if noise effects birds this may impact on bird watching.

Table 10.11: Summary of Potential Environmental Effects – Recreation and Tourism

Effect	Technology	Direct/ Indirect	Duration	Extent
Installation Effects				
Noise Generation	Wave / Wind / Tidal	Indirect	Short term	Unknown
Transportation	Wave / Wind / Tidal	Direct	Temporary	Array area, access routes (marine and land)
Effect on Seascape	Wave / Wind / Tidal	Indirect	Temporary	Effects possible up to 5 to 15 km from shore depending on the device type and seascape character.
Safety and Collision Risk	Wave / Wind / Tidal	Direct	Temporary	Array area
Access Restrictions	Wave / Wind / Tidal	Direct	Temporary	Zone around array area. Section of coastline
Reductions in Water Quality	Wave / Wind / Tidal	Indirect	Temporary – Permanent	Unknown
Operation Effects				
Generation of Noise	Wave / Wind / Tidal	Indirect	Permanent	Unknown
Effect on Seascape	Wave / Wind / Tidal	Indirect	Permanent	Effects possible up to 5 to 15 km from shore depending on the device type and seascape character.
Safety and Collision Risk	Wave / Wind / Tidal	Direct	Permanent	Array area
Access Restrictions	Wave / Wind / Tidal	Direct	Permanent	Zone around array area
Disturbance to Wildlife	Wave / Wind / Tidal	Indirect	Permanent	Unknown
Energy Extraction	Wave / Wind / Tidal	Indirect	Permanent	Unknown
Creation of Tourist Attraction (positive effect)	Wave / Wind / Tidal	Direct	Permanent	Unknown

10.5.5 *Interference with Military and Aviation Radar*

10.5.5.1 Installation Effects

There are no expected effects on radar from the installation of windfarms.

10.5.5.2 Operation Effects

Aviation operations may be affected by wind farm development in two ways; the physical obstruction caused by the turbines and the effect that the turbine structure and rotating blades may have on communications, navigation and surveillance (CNS) systems (including radar and meteorological radar) and other equipment, referred to as technical sites (DTI 2002).

The performance of **civil radar** may be degraded by the electromagnetic signal generated by turbine motion. Resulting effects include false radar responses and the masking of objects in the sky in the lee of wind farms. Turbine density, individual turbine size, construction material and blade shape are factors which may influence the degree to which radar is effected (DfT 2008b). Certain civilian and military aerodromes and technical sites are officially safeguarded to ensure that their operation is not compromised by developments such as wind farms. NERL has made available map data indicating the likelihood of interference from wind turbines on its radar network for a range of blade tip heights (20 to 140m).

Air defence radar systems: The main effects that wind turbines can have on air defence operations are upon the ability of the surveillance and command and control systems to detect and identify aircraft approaching, over-flying or leaving the UK and thence to produce a Recognised Air Picture (RAP). The system for achieving this task is known as the Air Surveillance and Control System (ASACS); the ASACS has three main elements; ground-based radars, airborne radars and command and control systems. Wind turbines can affect air defence systems in the same way as civilian radar systems (see above). At present, Ministry of Defence (MOD) policy is to not accept any application within 74km of an air defence radar site unless developers can prove that it will have no effect on the radar concerned. None of the 74 km exclusion areas associated with ASACS overlap with the study area.

10.5.6 *Military Activities/Practice Areas*

10.5.6.1 Installation Effects

Temporary disruption to military exercises and activities during installation of devices and arrays. When installation is underway there will be safety areas around activities which may cause military vessels to have to modify their routes and activities around the installation area. It is also possible that other activities such as firing practice could be disrupted during installation activities.

10.5.6.2 Operation Effects

Long term disruption to military exercises and activities during operation of device arrays. It is not expected that cables from the array to the shore will have any noticeable long term effect on military activities. However, if a device array is located close to or within a practice or exercise area this could potentially have a long term effect on military activities, depending on how these activities are distributed within the exercise area. Operating devices could cause vessels involved in military exercises to use alternate locations within the area, or cause longer journey times due to the need to avoid operating devices.

10.5.6.3 Summary of Potential Effects

A summary of the potential effects identified for military activities/practice areas is given below.

Table 10.12: Summary of Potential Effects - Military Activities/Practice Areas

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Disruption to activities during installation	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation areas
Disruption to activities during operation	Wave / Wind / Tidal	OD	Direct	Long term (device life)	Array size (2 km^2 – wave; 0.5 km^2 - Tidal – 50 km^2 - wind) and potentially cable swathe

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect - cables
OD = Operation effect – devices
OC = Operation effect – cables

10.5.7 Disposal Areas

Consultation with device developers has indicated that they would seek to avoid developing (arrays or cables) close to (e.g. within 500 m) a disposal site. With this in mind the key potential effects identified are as follows:

10.5.7.1 Installation Effects

Temporary disruption to vessels transiting to and from disposal sites during installation and removal of device arrays and cables located in close proximity to disposal sites. If such an effect occurs, the potential significance of restricting access to the sea disposal sites will be major for ports and harbours both during installation, operation and decommissioning due to the significant financial costs that would be incurred by the port or harbour authority if the distance to the disposal site was increased.

Direct disturbance of previously disposed material where device arrays are located in close proximity to disposal sites. The effects of disturbing contaminated sediments are discussed in Section 10.2.2 Strictly speaking, this is not a direct affect on the activities associated with the disposal site, but it is relevant in terms of potential effects on marine wildlife located in the vicinity of any disturbed sediment. These **effects** are discussed in Section 10.3.3.

10.5.7.2 Operation Effects

Long term disruption (in terms of increased journey lengths and times) to vessels transiting to and from disposal sites due to the existence of a device array. Developers have indicated that they would seek to avoid disposal sites by a distance of approximately 500 m.

A summary of the potential effects identified for disposal sites is given below.

Table 10.13: Summary of Potential Effects - Disposal Areas

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Disruption to access during installation	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation area
Direct disturbance of contents of disposal sites	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Dependent of area of overlap between disposal site and array
Disruption to access during operation	Wave / Wind / Tidal	OC OD	Direct	Long term (device life)	Array size (2 km^2 – wave; 0.5 km^2 – tidal; 10km^2 - wind) and potentially cable swathe

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect - cables
OD = Operation effect – devices
OC = Operation effect – cables

10.6 Material Assets

10.6.1 Cables and Pipelines

Potential effects upon pipelines and cables can be summarised as follows:

- Direct damage caused by physical interaction with the cable by anchors, device foundations or cable installation. This would be most likely to occur during installation of development but may also occur during maintenance of devices or cables.
- Reduced access to existing pipelines and cables for maintenance and repair activities during construction of device array and cables, and operation of devices and cables.

The avoidance of cables and pipelines is important for a number of reasons. All power cables and most telecommunications cables carry power. Damage to telecommunications cables can lead to extensive disruption of international communications, whilst damage to power cables will interrupt electricity supply. Pipelines may contain flammable oil or gas under pressure and damage to pipelines could result in a hazard to the environment or a hazard from fire or explosion (UKHO, 2006).

In reality the installation of marine renewables devices is unlikely to have any adverse effects on cables or pipelines because the location of existing infrastructure will be considered during the site selection for any development. Additionally, where the cables associated with marine renewable energy developments cross existing pipelines and cables, legally binding crossing agreements will be developed. Such agreements seek to ensure the integrity of the new and crossed infrastructure and facilitate ongoing safe access to each cable or pipeline for maintenance and repair activities.

Positional accuracy in installing devices may vary slightly according the method employed for fixing the device to the seabed.

The zone of within which cables and pipelines could be adversely affected by development has been determined as being a 500 m zone either side of the centreline of the infrastructure. This zone has been determined based on International Cable Protection Committee (ICPC) guidelines that suggest wind farm developments should avoid cables by 500 m for safety reasons. However, it is recognised that the distance of avoidance required may be less than 500 m in certain circumstances.

In common with the method applied throughout the SEA, potential effects have been determined based on no mitigation (i.e. no avoidance of existing pipelines and cables, and no use of crossing agreements). However, it should be noted that it is standard practice to avoid existing infrastructure or to cross it in accordance with crossing agreements and therefore the effects noted without mitigation are very unlikely to occur in reality.

Table 10.14: Summary of Potential Effects - Cables and Pipelines

Effect	Technology	Development phase	Direct/Indirect	Duration	Extent
Direct damage	Wave / Wind / Tidal	CC CD OD OC	Direct	Temporary (during installation or maintenance activities)	Up to 500m from cable and device area
Reduced access	Wave / Wind / Tidal	CC CD OD OC	Direct	Temporary (during installation or maintenance activities) – permanent if development is sited too close to pipelines or cables	Up to 500m from cable and device area

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect – cables
OD = Operation effect – devices
OC = Operation effect – cables

10.6.2 Aggregate Extraction

Whilst there are currently no licensed aggregate extraction areas in Northern Ireland waters, there is some interest in potential licensing of future sites. Installation of renewable energy arrays will not be permitted within any sites licensed for aggregate extraction at the time of determination of the renewable array licence. With this in mind the key potential effects identified are as follows:

10.6.2.1 Installation Effects

Temporary disruption to vessels transiting to and from extraction areas during installation of device arrays and cables located in close proximity to these sites.

10.6.2.2 Operation Effects

Long term disruption (in terms of increased journey lengths and times) to vessels transiting to and from extraction sites due to the existence of a device array. Developers have indicated that they would seek to avoid etraction sites by a distance of approximately 500 m.

Sterilisation of unlicensed mineral resources: Areas licensed for marine renewable energy development will not be available for subsequent exploitation for aggregate resources during the operational life of the array.

A summary of the potential effects identified for disposal sites is given below.

Table 10.15: Summary of Potential Effects – Aggregate Extraction

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Disruption to access during installation	Wave / Wind / Tidal	CC CD	Direct	Temporary (during installation)	Cable and device installation area
Disruption to access during operation	Wave / Wind / Tidal	OC OD	Direct	Long term (device life)	Array size (2 km^2 – wave; 0.5 km^2 – tidal; 10km^2 - wind) and potentially cable swathe

Effect	Technology	Development Phase	Direct/Indirect	Duration	Extent
Sterilisation of unlicensed aggregate resource areas	Wave / Wind / Tidal	OC OD	Direct	Long term (device life)	Array size (2 km^2 – wave; 0.5 km^2 – tidal; 10km^2 - wind) and potentially cable swathe

CD = Construction/decommissioning effect – devices
CC = Construction/decommissioning effect - cables
OD = Operation effect – devices
OC = Operation effect – cables

10.7 Seascape

10.7.1 Introduction

This part of the SEA considers the generic effects that wind, wave and tidal developments could have on the seascape resource of the study area. Seascape can be defined as *'the coastal landscape and adjoining areas of open water, including views from land to sea, from sea to land and along the coastline'.*

There are a number of ways in which offshore renewable energy developments could affect the seascape resource, as detailed below.

- The scale and form of the offshore windfarm or array could prove inappropriate and intrusive in the context of the existing seascape;
- The offshore windfarms or arrays could introduce activity, features and forms out of keeping with the seascape;
- The offshore windfarms or arrays could involve the loss or fragmentation of important and distinctive seascape components, features and characteristics; and
- The introduction of an offshore windfarm or array in a nationally designated seascape could affect the integrity of a national resource.

The extent to which the offshore wind farm or device array would affect the seascape varies depending on the various stages of the development and the capacity of the existing seascape to absorb these components. The construction and decommissioning phases of the development would involve temporary and relatively short periods of change and as a result the potential effects on the seascape are not considered to be significant. However, the operational phases of a development are likely to have more permanent and potentially significant effects on seascape. It should be noted that whilst submerged devices are not likely to result in potential significant effects the buoys and lighting associated with these device arrays have been assessed as there is the potential for them to affect the seascape.

10.7.2 Operational Effects

The potential effects of operational offshore wind, wave and tidal developments on seascape are dependent on a range of factors including the seascape character type, the sensitivity of the seascape character type, the presence of protected landscapes and the magnitude of the development e.g. the prominence or visibility of an offshore wind farm or wave or tidal array within a seascape type. The prominence and visibility of an offshore wind farm or wave or tidal array is influenced by a number of factors including the distance from shore, size of the development, height above water of the individual devices and the alignment and configuration of a development/array.

Seascape character types are defined by the different seascape components/elements that are contained within it. Variations in these components/elements lead to the creation of different seascape character types. In total nine seascape character types have been identified within the Northern Ireland. These are discussed in Chapter 9 (baseline). Each of the nine seascape character types comprises common elements/features. Each of the components varies in their sensitivity to offshore wind farms and wave and tidal devices.

In terms of generic effects, these are discussed below in relation to the effects of offshore wind, wave and tidal developments on the key components of different seascape. Specific effects of developments within the individual resource zones on the nine seascape character types that have been identified in the Northern Ireland SEA study area are discussed in Chapter 11: Resource Zone Assessment.

10.7.2.1 Potential Operational Effects on Seascape Components/Elements

The different seascape components and associated varying levels of sensitivity are discussed in Table 10.16 below (this is also shown in the Seascape Assessment Method, Chapter 6).

Table 10.16: Seascape Components and Relative Sensitivities

Criterion	Increase Sensitivity	Decrease Sensitivity
Scale	Small scale, enclosed Views extend out past enclosing land mass across sea to horizon Elevated views from coastal edge Absence of scaling elements	Large scale, open
Coastal Topography/ form /pattern	Intricate, complex, rugged Important focal points – Mountains, headlands, offshore islands	Flat, horizontal, simple, lack of natural focal points
Settlement/infrastructure	Traditional coastal and rural, scattered settlements Lack of visually prominent infrastructure.	Larger scale, urban mass and linear settlements Visually prominent infrastructure and busy navigational routes
Scenic quality	Seascape of high scenic quality with distinctive visual qualities, and inherent natural characteristics or traditional landscape patterns intact, or in good state of repair, or well looked after.	Degraded set of landscape features contributing to create a less intact visual quality within the landscape. Visually prominent industrialisation of landscape present.
Exposure	Sheltered, calm coastal areas	Exposed, dramatic seascapes
Protected Areas	Areas protected by specific designations that include protection of landscape character or scenic quality such as WHS, AONB, MNR, EHSA	No designations relating to the area that include protection of landscape character or scenic quality

The potential effects of offshore wind, wave and tidal developments on the different seascape components listed in Table 10.16 above are discussed below.

Scale: the scale of the seascape takes into consideration whether the emphasis is horizontal or vertical, linear, open, large or small. Where, for example, there are low coastal sand and flats with uninterrupted seaboard views, the seascape is deemed to be large scale. The interplay of sky/sea/horizon all contribute to a large sense of scale. Sensitivity to devices will generally increase with small scale enclosed seascapes and decrease with large open scale areas. Large scale seascapes may still be sensitive to exceptionally large devices, such as off shore wind turbines.

Coastal topography/form/pattern: Where seascape form is relatively, flat and simple such as low lying agricultural coastal land, low lying linear devices could relate to this characteristic. However, the introduction of large point structures or turbines could intrude into the broadly horizontal plane of the same seascape. In the case of off shore wind turbines, the scale of the vertical element to be introduced into the seascape is potentially large and will affect the horizon to a far greater extent than the smaller point structures. Where the seascape form is more complex and intricate, the straight linear lines of device arrays may conflict with the inherent pattern, forms and focal points.

Topography of associated land form, even when distant, will also inform the sensitivity of seascape to change, especially when in the case of offshore wind, the landmass is prominent within the setting. Where the accessible coastal edge, or immediate hinterland, provides elevated views the distance at which effects would be considered low or negligible (e.g. distances that offshore wind farms or wave and tidal areas would no longer be visible), would increase creating a higher level of sensitivity.

In general the zone of intervisibility increases proportionally in relation to the elevation of the viewpoint. For example, the theoretical maximum viewable distance of a wind turbine from Seascape Type 4 – Low Lying Coastal Plain (such as Tyrella beach, Dundrum Bay) will be 49-50 km but from Seascape Type 7– Plateaus and High Cliffs (such as the Causeway Coast) the viewable distance might be 52-62 km. Conversely characteristics of coastal devices may be less noticeable where the elevation of the viewpoint allows uninterrupted views over the device to the open sea horizon.

Settlement/infrastructure: Device arrays are more likely to relate to linear developments, urban forms and areas where larger scale infrastructure exists than to small clustered, nucleated villages or scattered settlement where scale and character contrasts are greater. It should be noted that settlement and infrastructure is only considered in relation to the seascape and not the importance of visibility and views from them. Often where there is little settlement there will be little in the way of associated infrastructure. For off shore wind, only settlement of a prominent industrial scale and/or associated with high density urban environments will relate to the turbines.

Scenic quality: The scenic quality of a landscape relates to its inherent distinctive visual qualities, and to the condition and completeness of inherent natural characteristics or traditional landscape patterns. In the context of seascape this can often be related to the drama, sense of wildness or tranquillity that is associated with the area. For example, where the hinterland of a coastline has a defined geometric geography, evolved over time due to intense farming, a coloured patchwork of field patterns may be highlighted uniquely against the backdrop of a wide open sea.

Along the Causeway Coast there is a scenic quality which has a recognised value and attracts visitors from all over the world. Often designations highlight the landscape quality, recognising the visual, functional and ecological perspectives. Absence of a designation will not render a seascape void of scenic quality. However, where the scenic quality of a seascape is deemed to be evident, it has been deemed sensitive to device characteristics. The extent to which an area is sensitive is in part related to the intactness and state of repair of individual features which contribute to the quality of any one place. It should be noted that when making a judgement on the scenic quality of a particular seascape type the desk-based study has not identified individual developments such as oil rigs, fish farms or land based wind farms.

Exposure: Exposure to the elements is linked to the scale of the seascape but is also affected by topography. The mouths of open sea loughs can feel as exposed as a seascape dominated by cliffs and basalt escarpments. As waves crashing against rocks can seem dramatic and heighten the sense of wildness of the sea, so a distinction has been made on whether an area is calm, sheltered (higher sensitivity) or exposed, wild (lower sensitivity) and what effect the elements could have on each of the device characteristics.

Devices will respond to exposure in different ways. For the purposes of this study an assumption has been made that seascapes which are exposed will be more sensitive to on surface point devices than on surface linear structures. The latter share a motion with the movement of waves that lessens the impact of the sensitivity as there is a sense of the natural in its movement. The former, standing vertical above the waves will become a (series of) fixed points of contrast for the waves to crash against, accentuating the force of nature. In the case of off shore wind turbines the support column of the devices will remain prominent above the horizon and in addition the rotating blades will from a perpetual focal point within the seascape.

Protected Areas: For the purposes of the seascape assessment, landscape value has been addressed by reference to national, regional and local landscape designations. Absence of such a designation, however, does not infer a lack of quality or importance. Factors such as accessibility and local scarcity can render areas of nationally unremarkable quality, highly valuable as a local resource. The presence of an AONB, MNR or EHSA designation does not automatically preclude potential development but there may be potential for some device characteristics to conflict with the landscape objectives of a designation. The World Heritage Site (WHS) is an area of special sensitivity that has the lowest capacity to accommodate change.

10.8 Climatic Factors

10.8.1 Introduction

In terms of assessing the potential effects of offshore wind and marine renewable energy in terms of climate factors three main areas have been identified:

1. Gas and carbon storage sites
2. Changes in the marine environment that can affect the operation of marine devices directly (i.e. marine renewable energy devices are vulnerable to climate change in various ways)
3. Changes in the environment that can affect how devices interact, and therefore potentially affect particular environmental receptors.
4. The amount of carbon saving or offsetting of developing renewable energy sources

These potential effects are discussed below.

10.8.2 Installation Effects

Gas and carbon storage: There is potential that the installation (and subsequent operation) of offshore renewable energy developments could sterilise potential areas for future gas and carbon storage. At present, although no specific sites have been identified in Northern Ireland waters any future projects would have to identify, through consultation and other sources of data whether there could be potential for the sites to be in a location for future gas and carbon storage.

Carbon footprint of marine renewable energy construction activities: Any generating plant (including renewable energy developments) holds embodied CO_2 – that is, CO_2 emissions associated with the manufacture of the plant, including raw material extraction and transport. However, the overall effects of the development on climate in terms of carbon emissions (positive and adverse) are considered to be low compared to the emissions relating to the overall operation of a plant. Further detail on the emissions associated with operational offshore renewable energy developments, and their effects on climate are discussed below.

10.8.3 Operational Effects

Effects on marine devices: Examples of the direct impact on the devices might include changes in output (e.g. wave devices affected by changes in mean wave height) and durability associated, for instance, with frequency of extreme storms.

Effects of climate change on the environmental effects of devices: Examples of indirect impact of climate change include the possibility that changing sea temperatures will significantly alter the ecological profile of the area, and the interaction between the renewable energy devices and this new ecology is thus a consideration.

Carbon Savings: It is often desirable to quantify the consequent reduction in greenhouse gas emissions to the atmosphere resulting from a given energy strategy or project. The idea behind this is that the electricity generated by offshore renewable energy developments offsets the electricity that would otherwise have been generated by another technology. This allows the contribution of the strategy or individual projects towards targets for decarbonisation of the economy to be quantified. It does not, however, quantify the reduced impact on climate change as national progress on carbon emissions is only significant in the context of a concerted global movement in the same direction.

Assessing the reduction in greenhouse gas emissions caused by a strategy or project is not a straightforward process, as the results depend on a number of assumptions discussed below.

Load Factor: The installed capacity of a generating device, or group of devices, refers to its maximum output. However, there are significant periods during which it will generate below this level, or even not at all, during periods when wave/tidal conditions are well below their peak, or during maintenance downtime.

The load factor is the average power output, over a period of one year, expressed as a percentage of the installed capacity. There are a range of influences on the load factor, including local meteorological conditions (for wind and wave devices); the nature of the tidal currents; the design of the equipment; and the reliability of the equipment. Given that a number of the technologies/devices are still at the earlier stages in their development, a proportion of this information is uncertain.

A report for the DTI in 2003 suggested load factors of 33% to 38% at for offshore wind at average speeds of 8.5 to 9.5m/s, allowing for 20% losses (downtime, wake losses, etc.). An approximate figure of 40% is often used in discussions of load factor for marine devices (wave and tidal). However, as technologies develop and new devices emerge that are more effective, efficient and reliable is it likely that these load factors will increase.

Displaced Capacity: Identifying the tonnage of CO_2 emissions displaced for each MWh generated is a complex process. This is mainly due to the challenges in determining which (non-renewable energy) power generators have been displaced as different power generators all have very different rates of CO_2 emission.

For example, it might be argued that if a coal fired power station were reaching the end of its life as offshore wind and marine renewable energy developments begin to establish themselves then the offshore renewable energy sources are replacing the coal fired generator, which has a high emissions factor (tonnes of CO_2 emitted per MWh generated). However, if the coal fired power station closed because it had reached the end of its operating life, then potentially the capacity displaced by the offshore wind and marine renewable energy developments is that capacity which would otherwise have been constructed to replace the coal fired station. This could in some cases by a more carbon efficient Combined Cycle Gas Turbine (CCGT) station or a carbon efficient fossil fuel power station fitted with carbon capture and storage.

Due to the complexities associated with determining displaced capacity and load factors it has become accepted practice to use the same emissions factor across the UK which is based on 5-year rolling average emissions from electrical generation (including losses) across the entire grid. The current value which is published in DEFRA guidance is 0.544 tonnes CO_2/MWh.

This figure has increased over the last few years (owing to improvements in the business case for coal use relative to gas). However, over the medium to long term this value should show a sharp decline as fossil fuel capacity is replaced by renewable energy capacity.

11 Resource Zone Assessment

11.1 Introduction

The following chapter presents the results from the assessment of the resource zones identified in Chapter 8.

The main focus of this part of the assessment (Part 2) is to assess in greater detail (although still at a strategic level) the potential effects that the development of offshore wind and marine renewable energy developments would have on the marine and coastal environment and other marine users in the key areas of resource and developer interest within Northern Ireland waters.

This part of the assessment is concerned with identifying the likely interactions and potential effects that could occur as a result of developing certain types of offshore renewable energy in particular locations. It does not take into account the likely size or configuration of individual developments, as these aspects of offshore wind and marine renewable energy development are examined as part of the cumulative assessment (Part 3) the results of which are presented in Chapter 12.

The results from this assessment are presented in Tables 11.6 to 11.13 and are based on the following information:

- Device characteristics (offshore wind and marine renewables) discussed in Chapter 7;
- Resource zones based on key areas of natural resource and areas of developer interest as discussed in Chapter 8;
- Baseline characteristics for each of the SEA topics discussed in Chapter 9; and
- Generic environmental effects discussed in Chapter 10.

11.1.1 Resource Zones and the Wider NI SEA Study Area

The aim of this part of the assessment is to provide information in relation to the key resource zones to inform the cumulative assessment in Chapter 12. Ultimately the aim of the resource zone assessment and cumulative assessment is to provide information that will assist DETI in establishing targets that reflect the extent to which offshore wind, and marine renewable energy developments, taking into account likely environmental effects will contribute towards meeting the proposed target of 40% of Northern Ireland's electricity demand to be met from renewable energy sources by 2020.

Where possible, the resource zones have been extended beyond the current known operating parameters (Chapter 8) to include areas of resource that could be exploited in the future. This aims to maximise the areas covered by the more detailed (although strategic) resource zone assessment.

However, it is recognised that there may be a requirement for future developments to be sited in locations outside the resource zones discussed in this assessment. Where this is the case, reference should be made to Chapter 10: Generic Assessment which identifies the full range of potential effects that could occur from offshore wind, wave or tidal developments at any location within the entire NI study area. Therefore, although the resource zone assessment focuses on specific areas within the NI study area, **the SEA does not preclude any development (demonstration or commercial) occurring outside these 'resource zones'**.

11.1.2 Presentation of the Assessment Results

There are a number of different variables that have been taken into account in this part of the assessment. These include the key information listed above (e.g. device characteristics, baseline data and resource zones), the individual SEA topics listed in Chapter 1 and possible mitigation measures that can be implemented to avoid, reduce or offset adverse effects.

To illustrate how the different variables have been taken into account in the assessment of the different resource zones the results have been presented in a series of assessment tables. Each of the tables (11.6 to 11.13) includes the following information:

- SEA topics where potential strategic environmental effects could occur.
- Type of the potential effect.
- Phase of the development during which potential effects are likely to occur e.g. installation, operation, maintenance and decommissioning.
- Device characteristics that are likely to give rise to potential effects.
- Device type (wind, wave or tidal).
- Assessment of potential effect (effect without mitigation).
- Summary of key environmental sensitivities (from baseline data) and description of potential effects.
- Description of possible project level mitigation that could be implemented to reduce, avoid or offset potential adverse effects.
- Assessment of likely (residual) effect (effect with mitigation).

11.1.2.1 <u>Assessment Criteria</u>

To assist with reviewing the results presented in Tables 11.6 to 11.13 the assessment criteria presented in Chapter 6: Assessment Method is reproduced below.

Table 11.1: Assessment Criteria for Resource Zone Assessment

Potential Effect	Assessment Criteria
Significant Adverse	The precise measure for **significant adverse effect** varies across the different SEA topics. This is reflected in the results presented in Chapters 11 and 13. However, in general, the key factors influencing the potential for a significant adverse effect to occur generally include: ▪ Permanent, long term or irreversible change in baseline conditions e.g. reduction in quality of baseline environment or effect on baseline features (receptors). ▪ Direct and indirect effect on baseline features of international or European importance e.g. habitats, species and sites designated under the EU Habitats or Birds Directives, where habitats and species are known to be sensitive to interactions from marine devices/offshore wind developments. ▪ Direct and indirect effects on baseline features of national importance (e.g. habitats or species of national value/importance) where habitats and species are known to be sensitive to interactions from marine devices/offshore wind developments. ▪ Direct, long term or permanent exclusion from, or disruption to, recognised shipping/navigation channels or fishing grounds of international, European or national importance. It should be noted that each SEA topic, and the baseline environment/features (receptors) associated with that topic, have been considered on a case by case basis. The criteria listed above are generic and has been subject to modification during the assessment to reflect specific characteristics of the baseline environment within Northern Ireland waters. However, any modifications will be reflective of the main principles of an assessment of **significant adverse effect** listed above.

Potential Effect	Assessment Criteria
Negative	As above, the measure of **negative effect** varies across the different SEA topics. However, in general, the key factors influencing the potential for a negative effect to occur include: ▪ Temporary, short term or reversible change in baseline conditions e.g. reduction in quality of baseline environment or effect on baseline features (receptors). ▪ Direct effect on baseline features that are not designated under international, European or national legislation but which are known to be sensitive to interaction with marine devices/offshore wind developments. ▪ Indirect, temporary or short term, disruption to, or exclusion from, main (international, European and national) shipping and navigation channels and fishing grounds. ▪ Direct, long term or permanent disruption to, or exclusion from, local shipping and navigation routes and fishing areas.
Negligible (positive or negative)	Negligible effects are identified where there is likely to be change in baseline, or effect on a baseline feature (receptor), but the level of change/effect will be indiscernible/very slight. Negligible effects may be positive or negative.
Neutral	Neutral effects are identified where the potential effect on the baseline features (receptor) are both positive and negative, thus balancing the overall effect on an SEA topic.
No Effect	The development of marine renewable energy/offshore wind developments in Northern Ireland waters will have no effect (e.g. cause no change in baseline conditions).
Positive	The development of marine renewable energy/offshore wind will have a positive effect on the baseline environment/features.
Unknown	Where there is insufficient information available to accurately determine the level and type of potential effect these have be classed as 'unknown' effects. Unknown effects are likely to occur where there is: ▪ A lack of baseline data. ▪ Limited knowledge of how marine renewable energy devices/offshore wind developments interact with particular baseline features/ characteristics. ▪ A lack of knowledge as to whether certain baseline features (receptors) are sensitive to interactions from marine renewable energy devices/offshore wind developments.

11.1.3 *Mitigation Measures*

The mitigation measures suggested in Tables 11.6 to 11.13 reflect standard good practice in terms of marine development (e.g. standard controls to be implemented during the installation and maintenance of devices based on examples from other marine sectors) and also take into account specific site selection criteria (e.g. avoidance of potential effects though the siting of commercial arrays outside, or away from, designated/protected sites and sensitivity receptors). The mitigation measures that have been suggested are specific to potential effects, receptors and device types.

11.1.4 *Overview of Resource Zones*

In total eight resource zones have been identified as part of this SEA. Details of the criteria and information used to inform the selection of these resources zones is presented in Chapter 8. A summary of the selected resource zones is provided in Table 11.2 below and illustrated in Figure 11.1.

Table 11.2: Resource Zone Areas

Technology	Resource Zone	Location
Wind	Wind Resource Zone 1	North Coast
Wave	Wave Resource Zone 1	North Coast
Tidal	Tidal Resource Zone 1	North Coast
Tidal	Tidal Resource Zone 2	Rathlin Island and Torr Head
Tidal	Tidal Resource Zone 3	Maiden Islands
Tidal	Tidal Resource Zone 4	Copeland Islands
Tidal	Tidal Resource Zone 5	Strangford Narrows
Wind	Wind Resource Zone 2	East Coast

11.2 Key Findings from the Resource Zone Assessment

The following section provides an overview of the key findings from the assessment of each of the resource zones listed above. This overview focuses specifically on the potential significant adverse, negative and positive effects identified in Tables 11.6 to 11.13 and the associated residual effects that may occur should mitigation be implemented appropriately.

The summary includes:

- An overview of the potential effects that could occur within the different resource zones. The focus is on the type of effect. Specific details relating to each of the resource zones are discussed in the assessment tables.
- An overview of the key sensitive receptors identified in each of the individual resource zones.

11.2.1 Summary of Key Findings from the Resource Zone Assessment

The following provides a summary of the key findings from the resource zone assessment.

Water, Soil and Sediment

- **Geology, geomorphology and sediment processes – scouring:** There is potential that the presence of structures on the seabed, in particular piled foundations could lead to localised scouring of the seabed, in particular where the sediment comprises sand and gravel. Potential significant adverse effects could be reduced by through careful site selection informed by hydrodynamic modelling at the project stage. *Likely residual effects will be negative to negligible.*
- **Geology, geomorphology and sediment processes – changes in coastal processes:** Significant adverse effects on coastal process resulting from the extraction of energy from the existing wave and tidal regime could be reduced or avoided through careful site selection and modelling. *Likely residual effects will be negative to negligible.*
- **Accidental contamination** from devices and vessels as a result of storm damage or failure or collision – there is a risk that this could occur in all zones for all types of development (offshore wind, wave and tidal). Should this occur it would have significant adverse effects on water quality, birds, marine mammals, marine reptiles, benthic ecology and fish and shellfish. However, the likelihood of this occurring is low and the risks of contamination from devices can be reduce through appropriate designs and integration of mechanisms to protect against contamination should a device get damaged or failure occur. *The likely residual effects are negligible.*

Biodiversity, Flora and Fauna

- **Benthic ecology –substratum loss:** All three technologies could potentially have significant adverse effects on benthic habitats and species due to substratum loss resulting from the attachment of devices to the seabed. These effects are likely to be greatest for piled devices and gravity bases. With increased information on species and habitat distributions and appropriate siting of devices to avoid sensitive habitats and species the *likely residual effects would be negative/negligible*.
- **Benthic ecology, marine mammals, seabirds and fish - habitat exclusion:** All three technologies could lead to habitat exclusion through occupying areas of the seabed, surface and water column. The overall effect of this is unknown but is likely to be more significant in areas used for breeding (marine mammals), feeding (marine mammals, fish and seabirds) and spawning (fish). *Likely residual effects are unknown*.
- **Marine mammals, marine reptiles, seabirds and fish - collision risk from operational wave and tidal devices:** the potential effects of collision with operational devices on marine mammals, marine reptiles, fish and seabirds (diving and pursuit) are unknown. However, it is likely that these effects will be more significant for tidal devices than wave devices which generally have lower rates of motion and less moving parts. With increased information on species distributions and their interactions with tidal devices and appropriate siting of devices the *likely residual effects are unknown/negative*.
- **Seabirds - collision risk from operational offshore wind farms:** Operational offshore wind farms could potentially have a significant adverse effect on birds in flight, in particular on key migratory routes. This is discussed below in relation to specific wind resource zones. The potential effects of marine mammals, marine reptiles, fish and seabirds colliding with offshore wind turbine foundation structures is likely to be negligible and the level of harm would be low given there are no moving parts. *Likely residual effects for birds are negative and other species are negligible.*
- **Marine mammals, marine reptiles, fish and seabirds - noise from the installation of piled devices:** In terms of the installation of devices the most significant source of noise is from the piling of offshore wind and tidal turbine foundations. Noise from piling activities can have significant adverse effects on marine mammals, marine reptiles, fish and possibility seabirds (diving and pursuit feeders). Although potential effects can be reduced by avoiding breeding and spawning seasons and well as Marine Mammal Observers, exclusion zones, passive noise monitoring, pingers or bubble curtains the *likely residual effects are still likely to be negative to significant adverse.*
- **Marine mammals, marine reptiles and fish - noise from the operation of tidal devices:** In terms of the three technologies, tidal devices currently have the greatest potential to generate underwater noise from the frequent and regular movement of submerged turbines (wave moving parts tend to be at or above the surface, wind moving parts are all above surface). Noise from operational tidal devices could affect fish, marine mammals and seabirds (diving and pursuit). However, the *level of likely residual effect is unknown.*
- **Marine mammals, marine reptiles and fish - barriers to movement:** There is still uncertainty over the potential effects of commercial arrays (all device types) on marine mammals, marine reptiles and fish (particularly migratory species e.g. salmon) in terms of creating barriers to movement. Barriers to movement are more likely to occur in constrained areas e.g. Lough mouths, inter-island channels and around headlands. These tend to coincide with areas of tidal resource. The potential causes of barriers to movement include noise from arrays/devices, a perceived risk of harm and presence of physical barriers, which are more likely be caused by tidal developments although large wave arrays may create physical barriers. Therefore, although the precise effects in terms of barriers to movement are unknown, the *likely residual effect from tidal arrays could be significant adverse*.

Biodiversity, Flora and Fauna

- **Fish – hydraulic impacts from shrouded devices** – there is potential that the pressure differentials created by shrouded devices could lead to internal injury or mortality of fish. Although the precise nature of the effects are still unknown, there is potential for adverse effects to be avoided by using screens to prevent fish entering the devices and avoiding migratory routes and spawning and nursery areas. Through the implementation of this mitigation there should be *no residual effects*.
- **EMF impacts** – whilst there is no evidence that operating power cables have caused a change to behaviour and migration for marine fish and mammal species, there is evidence that some species of fish can detect electric fields, and circumstantial evidence that cetaceans can detect magnetic fields. Given that most of the existing anecdotal evidence demonstrating lack of an avoidance reaction is based on operating interconnectors, and the effect of interturbine cable arrays could cause a more concentrated effect, the scientific community believes that more research is needed to quantify this potential effect. *Likely residual effects are therefore unknown*.

Cultural Heritage including Archaeological Heritage

- **Marine and coastal archaeology and wrecks** – there is potential that device installation and cabling activities could have a significant adverse effect on archaeological sites and features (marine and coastal). However with site investigations and appropriate siting of devices and routing of cables, the *likely residual effects could be negligible*.

Population and Human Health

- **Commercial fisheries- direct disturbance of commercial fishing grounds:** The physical presence of devices or noise generated by piling activities and the operation of devices could potentially have a significant adverse effect on fishing grounds. However, through appropriate siting of devices the *likely residual effects could be negative to negligible*.
- **Commercial fisheries - long term displacement from fishing grounds:** The presence of an array in certain locations could lead to the displacement of fishermen from key fishing grounds. Although, through the appropriate siting of arrays potential adverse effects could be reduced the significance of the effect depends on the importance of the fishing ground and whether displacement would lead to increased pressure on stocks in other areas. Therefore *likely residual effects could potentially range from significant adverse to negligible*
- **Commercial fisheries - recovery of fish stocks:** The exclusion of commercial fishing activities from certain areas could have *positive residual effects on fish stocks*.
- **Mariculture –** shellfish and fin fish farming areas generally only overlap with a few of the resource zones identified, and in most cases the potential for significant adverse effects relates to the installation of onshore connection cables (substratum loss or disturbance and smothering) rather than actual offshore wind, wave or tidal developments. Through the avoidance of shellfish and fin fish farming areas for cabling activities *likely residual effects on mariculture could be negligible*.
- **Shipping and navigation -** reduced navigational safety and collision risk: The presence of arrays in navigational and shipping channel can affect navigational safety and increase the risk of collision either directly or by displacing vessels into areas where there is a higher intensity of vessels movements. The significance of these effects depends on the type of development and the intensity of vessel movements in certain locations. In terms of the device types the level of displacement is likely to be greater for wind and wave developments as these tend to occupy larger areas than tidal developments which have much higher energy densities and therefore occupy smaller areas. Wind and wave devices also occupy entire water column (wind) or sea surface (wave) where as tidal devices could potentially be fully submerged at depths which would allow shipping and tidal developments to co-exist. Likely residual effects in areas of high vessel movements are could be *significant adverse and negative in areas of low to moderate vessel intensity*.

Population and Human Health

- **Recreation and tourism:** There are a number of marine and coastal recreational activities that occur across the study area, and could therefore be affected or disrupted by commercial offshore renewable energy developments either directly (disruption to or exclusion from recreational sailing areas) or in directly through effects on visual amenity and seascape quality. However, the *likely residual significance of these effects depends on the sensitivity and importance of tourist and recreational activities that occur within that area*.
- **Radar interference:** Potential effects from radar interference are only likely to be generated by offshore wind farm developments as wave and tidal devices generally do not protrude more than a few meters above the water surface. *Within identified as 'Potential to Interfere' NERL areas likely residual effects from offshore wind farms are likely to be negative*.
- **Military practice areas –** Although these overlap with all of the resource zones information on the nature and frequency of the activities that occur in these practice areas was not available for this SEA. *Therefore the potential effects range from significant adverse to negligible.*

Material Assets

- **Cables and pipelines –** A number of cables and pipelines pass through the different resource zones. Although direct damage to a cable or pipeline would have significant adverse effects as telecommunications or gas and electricity supplies could be severely disrupted, there are recognised guidelines (ICPC), protocols (e.g. crossing agreements) and buffer zones (usually 500m) that would have to be adhered to by developers. Application of these guidelines, protocols and buffer zones would avoid or significantly reduce the risk of adverse effects occurring. *Likely residual effects will be negligible to no effect.*
- **Aggregate extraction areas** – as with cables and pipelines any significant adverse effects on these areas would be avoided or significantly reduce through exclusion zones and good practice. *Likely residual effects will be negligible to no effect.*

Landscape/seascape

- **Seascape –** offshore wind farms are likely to have more significant effects on seascape and visual amenity than wave and tidal devices as a larger proportion of the development is visible above the water surface. Large sections of the Northern Ireland coastline are designated as Areas of Outstanding Natural Beauty (AONBs) for their high, and often dramatic, scenic value. The north Antrim Coast is considered to be very high seascape value, particularly around the Causeway Coast and Giant's Causeway World Heritage Site. *Likely residual effects on seascape vary from significant to negligible*.

Climatic Factors

- **Climate –**The development of offshore renewable energy will have a *positive effect on the wider marine environment* in terms of combating potential adverse effects that are attributed to climate change offsetting carbon emissions from other sources of electricity e.g. coal or gas powered power stations.
- **Gas and Carbon Storage** - although the viability and practicalities of storing gas and carbon offshore are still being investigated there is potential that, in the future appropriate sites could be located within Northern Territorial waters. At present no specific areas of gas or carbon storage have been identified within the main resource zones (possible sites in Larne Lough are outside the main study area for this SEA). However, there is potential that the presence of piled devices (offshore wind, wave or tidal) could sterilise potential future areas of search for gas and carbon storage. Given that there are no identified areas within the study area the *potential residual effects are unknown.*

11.2.2 *Summary of Key Sensitive Receptors Associated with Each of the Resource Zones*

Table 11.3: Key Sensitive Receptors

Resource Zone	Key Sensitive Receptors
Wind Resource Zone 1: North Coast **Wave Resource Zone 1: North Coast** **Tidal Resource Zone 1: North Coast**	▪ Two active harbour dredging disposal sites ▪ PAIH for rocky reef and sandy sediment in < 20m water (near tidal) ▪ Ramore Head and Skerries ASSI (important for birds) ▪ Portrush NNR and ASSI ▪ Bann Estuary SAC and ASSI nearby ▪ Magilligan SAC nearby ▪ Marine mammals, seabirds and fish found throughout area ▪ Maerl beds, tidal rapids and reefs present in area ▪ Sprat and herring spawning area and important for migratory salmon ▪ Key commercial grounds for scallop fishing and fin fish trawling ▪ Other commercial fisheries include lobster, crab, seed mussel at mouth of Lough Foyle, cod, plaice, lemon sole, ray and skate ▪ Giant's Causeway World Heritage Site (WHS) ▪ Area of considerable archaeological interest ▪ Within a 'Potential to interfere' NERL area but not within 30km consultation zone for airports ▪ Low to moderate shipping (low in wave and tidal zone) ▪ Hibernia Atlantic telecommunications cable runs through northern part of zone. Also 'Project Kelvin' Hibernia cable to be installed 2009.
Tidal Resource Zone 2: Rathlin Island and Torr Head	▪ One active disposal site within the zone and three adjacent to the zone ▪ Risk of munitions migration from Beaufort's Dyke (North Channel) ▪ PAIH for rocky reef and sandy sediment in < 20m water (near tidal) ▪ Shamrock Pinnacle and Red Bay are possible marine SAC sites ▪ Rathlin Island SAC, SPA (important for seabirds) and ASSI ▪ Antrim Hills SPA (nearby) also important for seabirds ▪ Area supports approximately 66,000 birds plus Annex I species and migratory birds ▪ Kebble NNR ▪ Antrim Coast and Glens AONB ▪ Giants Causeway WHS adjacent to the zone ▪ Maerl beds, tidal rapids and reefs present in area ▪ Harbour porpoise, minke whales, bottlenose dolphin use area ▪ Grey and common seals use the area ▪ Sprat and herring spawning area and possible migratory salmon ▪ Important for king scallop, lobster and crab – but area not used for scallop dredging or fin fish trawling ▪ Area of considerable archaeological interest ▪ Variable shipping densities – low north of zone, high to east (zone adjacent to North Channel international shipping channel and TSS area) and between Rathlin Island and mainland ▪ Zone adjacent to Rathlin Island Port ▪ Important for recreational sailing and wildlife tours ▪ Rathlin Island interconnector runs through centre of the zone ▪ No existing or proposed aggregate extraction areas in the zone
Tidal Resource Zone 3: Maiden Islands	▪ Two active dredging spoil sites inshore of the zone ▪ PAIH for rocky reef ▪ Potential marine SAC site ▪ Antrim Coast and Glens ASSI (adjacent) ▪ Antrim Hills SPA important for migratory birds and Annex I species ▪ Adjacent coastline is an Important Bird Area (IBA) ▪ Larne Lough SAC, Ramsar and ASSI (in vicinity) ▪ Maerl beds, tidal rapids and reefs present in area ▪ Sprat and herring spawning area ▪ Harbour porpoise present in zone and common and grey seals may also be present ▪ Numerous reported and known shipwrecks ▪ Commercial lobster and crab potting around Maiden Islands ▪ Scallop dredging and pot fishing along adjacent Antrim Coast ▪ Shipping densities are low to moderate – but zone is adjacent to North Channel shipping channel (high intensity) ▪ Larne ferry port immediately south of the zone (on main ferry route to England, Wales and ROI) ▪ There are no cables, pipelines or aggregate extraction areas in the zone

Resource Zone	Key Sensitive Receptors
Tidal Resource Zone 4: Copeland Islands	▪ One active dredging spoil site within the zone ▪ Risk of contamination from munitions migration from Beaufort's Dyke (North Channel) ▪ PAIH for rocky reef and sandy sediment in < 20m water ▪ Area is under consideration as potential Marine SAC or Marine Conservation Zone (MCZ) ▪ Copeland Island AONB supports important seabird colonies ▪ Zone near to Outer Ards SPA, Ramsar and ASSI (important for seabirds) and Outer Ards Peninsula IBA. It is also near to the Belfast Lough SPA ▪ Area supports *Nephrops*, scallops and queen scallops, lobster and crab ▪ Sprat spawning areas overlap the zone. Belfast Lough may be used by migratory salmon and trout ▪ Grey seals breed on Copeland Islands ▪ Considerable archaeological and heritage interest in area ▪ Key commercial fisheries include lobster and crab pot fishing and some scallop (king) dredging. Also whelk potting and seed and bottom grown mussel in Belfast Lough ▪ Zone located within the North Channel which is a recognised international shipping lane ▪ There are no cables, pipelines or aggregate extraction areas in the zone
Tidal Resource Zone 5: Strangford Narrows	▪ Very narrow channel ▪ No active dredging spoil sites within the zone ▪ Risk of contamination from munitions migration from Beaufort's Dyke (North Channel) ▪ PAIH for rocky reef and sandy sediment in < 20m water ▪ Area is very important for nature conservation - designated NNR, MRN, Ramsar site, SPA, SAC and AONB and IBA. ▪ It is very important for seabirds supporting more than 60,000 waterfowl, Annex I species and migratory species ▪ Harbour and grey seals (SAC) and harbour porpoise also use the area ▪ Horse mussel beds and tidal rapids ▪ Area supports lobster, *Nephrops*, crab, cockles and whelks and queen scallops and scallops at entrance to Strangford Lough ▪ Sprat spawning areas also present ▪ Considerable archaeological and heritage interest in area ▪ Main commercial fisheries are lobster and crab potting and pacific oyster in the Lough with scallop dredging immediately outside the Lough ▪ Not used for shipping and navigation. Lough does have a ferry crossing ▪ As only MNR in Northern Ireland very important for wildlife tours and bird watching. Also important for recreational sailing ▪ There are no cables, pipelines or aggregate extraction areas in the zone
Wind Resource Zone 2: East Coast	▪ There are four active dredging spoil sites within the zone ▪ Risk of contamination from munitions migration from Beaufort's Dyke (North Channel) ▪ Zone includes the Outer Ards ASSI, SPA and Ramsar site which is important for seabirds. Zone also near Strangford Lough SPA which is very important for seabirds ▪ Murlough SAC is located along adjacent coastline ▪ PAIH for rocky reef and sandy sediment in < 20m water ▪ Considerable archaeological and heritage interest in the area ▪ Range of fin and shellfish including lobster, crab, *Nephrops*, and scallops. Nearby Strangford Lough supports cockles and whelks ▪ Commercial fisheries include *Nephrops*, king scallop, lobster, crab, herring, cod, haddock and whiting. There are several important seed mussel areas adjacent to Ards Peninsula ▪ Majority of the zone has high shipping densities although there are some areas where shipping movements are low. Zone is on the route from Belfast Port to Warrenpoint. Also contains three major fishing ports (Kilkeel, Ardglass and Portavogie) ▪ Important for wildlife tours and recreational sailing ▪ Within a 'Potential to interfere' NERL area. A small section to the south of the zone is within the 30km consultation zone for Belfast City Airport ▪ There are cables in the area ▪ There are no existing aggregate extraction within the zone although two have been provisionally accepted by The Crown Estate (10km off Kilkeel)

11.3 Confidence Levels

As discussed in the approach and method (Chapter 6), as part of the assessment process it is necessary to determine the level of confidence in the results of the assessment. The level of confidence assigned to an assessment result gives a good reflection of the certainty by which conclusions can be drawn from the results. Confidence levels are of particular importance in terms of this SEA as they are necessary to reflect where known data and knowledge gaps have influenced various results of the assessment.

The confidence levels assigned to the results of the resource zone assessment are presented in Table 11.5 below. These confidence levels are based on the criteria presented in Table 11.4.

Table 11.4: Criteria to Define Confidence Levels

Confidence Level	Description
High	High levels of confidence occur where: ▪ There are no gaps or very limited gaps in baseline data. ▪ Interactions between the environment and marine devices are well understood (e.g. there is recognised guidance or well documented and peer reviewed evidence of potential effects that could occur (e.g. offshore wind developments).
Medium	Medium levels of confidence are likely to occur where: ▪ There are gaps in baseline data but knowledge and experience from related projects or fields of work leads to a greater level of confidence in the assessment of potential effects that could occur. ▪ There are limitations in understanding of how devices interact with the environment but greater certainty in available baseline data and supplementary evidence from related areas of work/similar projects.
Low	Low levels of confidence are likely to occur where: ▪ There are known gaps in baseline data and no available supplementary information to support assessment of effects. ▪ There are known gaps in understanding how devices interact with the environment and no available supplementary information to support assessment of effects.

Table 11.5: Confidence Levels

SEA Directive Topics	DETI SEA Topics	Level of confidence							
		Wind Resource Zone Assessment		Tidal Resource Zone Assessment					Wave Resource Zone Assessment
		Zone 1	Zone 2	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 1
Water, Soil (Sediment)	Geology, geomorphological and sediment processes	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	Sediment contamination and water quality	High	High	High	High	High	High	High	High
Biodiversity, Flora and Fauna	Protected sites and species	High	High	High	High	High	High	High	High
	Benthic and intertidal ecology	Low	Low	Low	Low	Low	Low	Low	Low
	Fish and shellfish	Medium	Medium	Low	Low	Low	Low	Low	Medium
	Birds	High	High	Low	Low	Low	Low	Low	Low
	Marine mammals	Medium	Medium	Low	Low	Low	Low	Low	Low
	Marine reptiles	Low	Low	Low	Low	Low	Low	Low	Low
	Noise and vibration	Medium	Medium	Low	Low	Low	Low	Low	Low
	EMF (Electric and Magnetic Fields)	Low	Low	Low	Low	Low	Low	Low	Low
Cultural Heritage including Archaeological Heritage	Marine and coastal archaeology and wrecks	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Population and Human Health	Commercial fisheries	Medium	Medium	Low	Low	Low	Low	Low	Low
	Mariculture	High	High	High	High	High	High	High	High

SEA Directive Topics	DETI SEA Topics	Level of confidence							
		Wind Resource Zone Assessment		Tidal Resource Zone Assessment					Wave Resource Zone Assessment
		Zone 1	Zone 2	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 1
	Radar Interference	High	High	N/A	N/A	N/A	N/A	N/A	N/A
	Military practice areas	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
	Dumping areas	High	High	High	High	High	High	High	High
	Shipping and navigation (including ports and harbours)	High	High	Medium	Medium	Medium	Medium	Medium	High
	Recreation and tourism	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Material Assets	Cables and pipelines	High	High	High	High	High	High	High	High
	Mineral resources/aggregate extraction	High	High	High	High	High	High	High	High
	Renewable energy developments	N/A	N/A	N/A	N/A	N/A	N/A	Medium	N/A
Landscape	Landscape, seascape and visual receptors	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Climatic Factors	Carbon impacts of offshore wind and marine renewables (carbon cost)	High	High	High	High	High	High	High	High
	Carbon and gas storage	High	High	High	High	High	High	High	High

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
Bathymetry	**The information presented in this chapter has been used to inform the results of the assessment. No specific impacts on bathymetry are expected.**							
Geology, Geomorphology and Sediment Processes	**Changes in seabed morphology**	Installation Operation	Export cable trenching Devices using seabed foundations e.g. piled devices	**Wind**	**Negative**	The seabed is composed of sand and gravel that rests on glacial marine mud. The seabed is largely unremarkable. Seabed trenching and installation of device foundations will alter the seabed morphology locally. Strong currents could induce local sediment scour at the seabed around the piled devices and locally alter the morphology of the seabed.	Reduce the impacts of local sour by locating the turbines in areas where the amount of sediment available for mobilisation and transport is low. Potential effects of local scour on sediment transport will need to be assessed through morphological site surveys and hydrodynamic/sediment transport modelling at the project stage. Site specific geophysical and geotechnical survey will be required to establish a baseline and inform the impact assessment for individual developments.	**Negligible**
	Changes in coastal processes	Operation	Presence of device foundations	**Wind**	**Significant adverse to negative**	Impact to sediment transport processes will be localised. Given that the zone is well offshore of the coast, the potential effect on the geomorphology of the coastline is likely to be of negligible significance. The physical presence of turbine foundations on the seabed, may induce localised scour. The presence of devices on the seabed could act as a barrier or diversion to sediment transport during device operation. The extent to which this could have an impact on the adjacent coastline depends on the proximity to the shore and the dominant sediment transport pathways operating in the immediate vicinity of the turbines.	The degree of potential impacts depends on the process (floating or fixed structures), how closely individual devices are spaced, and how far offshore the devices are located. Careful site selection is key to keeping impacts to a minimum. Impacts at the coastline will be reduced with increasing distance from the shore, subject to more detailed studies and modelling to better understand impacts at the coast. Modelling the effects on coastal processes should form part of pre-project activities to optimise location.	**Negligible**
Seabed Contamination and Water Quality	**Accidental contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel cargo / fuel	**Wind**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Any accidental spillage of slick forming chemicals could be carried into Lough Foyle, where the effects on water quality will be greater than those in open waters. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects in this area would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Disturbance of contaminated sediment	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Significant adverse to negligible**	There are two active dredging spoil disposal sites within the Wind Resource Zone 1, which could therefore be disturbed by seabed activities in the immediate vicinity. Any contaminated material released is likely to be widely dispersed and diluted in the energetic environment. The effect on open sea water quality is likely to be of negligible significance. There is a possibility that re-suspended sedimentary material will enter Lough Foyle with the potential to have a negative significance. There is a small possibility that munitions relict from wartime activities (e.g. wrecks or minelaying) or from the adjacent weapons range may be encountered. Disturbance could result in significant adverse effects.	Available mitigation includes avoidance of potentially contaminated seabed areas (dredging areas - 500m buffer). Identification and avoidance of areas of munitions contamination through site survey at the project stage. If munitions are encountered Crown Estates 2006 (Dealing with munitions in marine aggregates) should be followed.	**Negligible**

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
Protected Sites and Species	**Impacts on protected sites**	Installation Operation	Wind turbines	**Wind**	**Significant adverse**	There are nine sensitive sites which coincide with Wind Resource Zone 1. Two of these overlap with the zone identified (PAIH for rocky reef in the northern part of the zone, and PAIH for sandy sediment in <20m water in the southern part of the zone) and one site (Ramore Head and the Skerries ASSI) is closely adjacent to the zone. The nearshore area between Ramore Head and Benbane Head is also under consideration as a marine SAC for skerries, reefs, sandbanks and caves. This site could potentially overlap with the southern portion of Wind Resource Zone 1. Portrush NNR and ASSI, designated due to their importance for geology are also in close proximity as are the Bann Estuary SAC and ASSI, and Magilligan SAC which are important for their sand dune systems. The rest of the zone is not covered by any existing or envisaged future protected areas. Depending on the location of any installation, potential impacts could affect the habitat directly (through physical disturbance, and substratum loss) or indirectly (through increased suspended sediment and turbidity, and smothering). For the SACs, NNR and ASSIs, which are not within the boundary identified of Wind Resource Zone 1, impacts are likely to be mainly associated with potential export cable installation and visual impacts but as the area is important for geology and breeding seabirds, impacts could also affect these receptors and impact on tourism in the area.	Impacts on protected areas could be mitigated by careful site selection avoiding sensitive sites for devices and export cables (i.e. existing and proposed protected sites). Impacts may still arise through indirect impacts on sediment movements during installation and operation, and would need to be assessed in more detail at the project stage. Possible mitigation measures relevant to the specific interest features of the sites and their seasonal and other sensitivities are described elsewhere in this table for the relevant topic areas.	**Negative to negligible**
	Impacts on protected species	Installation Operation	Wind turbines	**Wind**	**Significant adverse**	Although there are no protected sites designated specifically for species within Wind Resource Zone 1,(site designations in the area apply to habitats and geological formations) , a number of protected species including marine mammals, seals, seabirds and fish are found throughout the region, as are important benthic species. The impacts on these receptors are discussed in the relevant sections of the table below.	See sections below on benthic ecology, fish and shellfish, seabirds and marine mammals.	**Negative to negligible**
Benthic and Intertidal Ecology	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenches	**Wind**	**Negative**	Wind Resource Zone 1 is located in an area of predominately clean mobile sand inshore and sandy gravel further offshore. Disturbed sediments are predicted to be dispersed rapidly especially in areas with higher tidal flows. Sand bank benthic species are considered to be robust and either adapted to perturbed environments or highly mobile and resistant to temporary smothering. Coarse sand is likely to be already impoverished. Species in nearshore adjacent PAIH rocky reef habitat will also be robust to low levels of smothering including *Sabellaria spinulosa* reef. However, *Modiolus modiolus* beds are recorded inshore of this zone at the Skerries at Portrush. These are highly sensitive to smothering. Smothering impacts will be localised to the immediate vicinity of the seabed disturbing activities during installation.	The potential effects on benthic ecology can be reduced through avoidance (careful site selection). Potential effects on the distribution of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
Benthic and Intertidal Ecology	**Contamination – from sediment disturbance**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Negligible**	There is a potential for contaminated sediment from spoil dumping sites to be remobilised during seabed disturbing installation works. It is likely that any habitats with the potential to be adversely affected by contamination from these sites have already been subject to disturbance during the original dredging and deposition of material. Furthermore dredged sediment deposited at disposal sites in the area is thought to be relatively uncontaminated. Fine contaminated material will be diluted and dispersed, settling over a wide area with negligible effect on the benthic and intertidal ecology. Coarse material will be rapidly redeposited within the immediate area of installation operations.	The potential effects on benthic ecology can be reduced through avoidance (careful site selection). Avoidance of areas of known potential contamination for seabed disturbing works. Potential effects on areas of unknown benthic habitat will need to be assessed through site survey at the project stage.	**Negligible**

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
	Accidental contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Wind**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. The water depth is such that small spillages (< 1tonne) are unlikely to affect the benthos. Similarly small spillages from Wind Resource Zone 1are unlikely to come ashore. Large spillages have the potential to have a significant adverse effect, particularly on the intertidal ecology of the adjacent shoreline coastline, including within Lough Foyle. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on benthic and intertidal ecology would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan). Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Significant adverse**	All benthic communities can be expected to be sensitive to removal of their habitat. The long term loss of substratum due to the presence of devices that are attached to the seabed will therefore have a potentially significant adverse effect on any rare or important benthic habitats, such as those listed in the UKBAP and/or protected under the Habitats Directive such as *Sabellaria spinulosa.*	Effects on benthic ecology from substratum loss can be reduced either through avoidance (careful site selection). Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negative to negligible**
Fish and Shellfish	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Negative**	Wind Resource Zone 1overlaps with coastal areas known to support populations of lobster, edible crab and velvet crab. Scallops can also be found further offshore within a small portion of this zone. These species live on, near or in the bottom sediments of the seabed. Sprat and herring are also known to spawn on the seabed in the area. These species range from low to high sensitivity to smothering, although any impact will be localised to the immediate vicinity of seabed disturbing activities and limited to the installation period only.	For devices that require piling, and cable trenching, potential effects could be mitigated by avoiding installation during the sprat spawning season (May to August) and herring spawning (August – September) and avoidance of key shellfish areas.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Wind**	**Significant adverse**	High levels of noise such as during pile installation may cause physiological or displacement effects to marine fish although the extent to which this may occur is unknown. In particular, herring and cod are known to be highly sensitive to noise and may be able to detect piling noise up to 80km. Both species are present in the study area and therefore may be present Wind Resource Zone 1, although herring generally only occurs in coastal waters (0 to 20m). It is expected that noise levels from piling and the removal of piled devices will be greater than those generated by operational devices, and although pile driving only occurs during installation the effects may last for longer than the piling activities as fish may not immediately return to the area. The potential for noise from operational devices to lead to longer term species displacement is considered unlikely when considered in terms of natural background levels. This is supported by the knowledge that large numbers of fish are often found around 'noisy' offshore structures such as oil and gas installations.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive spawning periods.	**Negligible to Negative**
		Operation	Turbine noise transmitted through steelwork	**Wind**	**Negligible**		No specific mitigation measures have been identified	**Negligible**
	Collision risk	Operation	Turbines/moving part of devices / mooring chains and cables	**Wind**	**Negligible**	There is potential risk that all mobile fish species could collide with turbine foundation. Larger animals (such as basking sharks (UKBAP species)), and pelagic species are considered to be of greater risk. Basking shark and other pelagic fish species are present throughout the study area, and therefore may be present within Wind Resource Zone 1. However, given the lack of moving parts below water, and the likely dimensions and spacing of the offshore wind turbine foundations, the collision risk impact is considered to be negligible.	No specific mitigation measures have been identified.	**Negligible**
Fish and Shellfish	**Accidental contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel fuel	**Wind**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. There are a number of important shellfish species present in this area that overlap or may be influenced by activities associated with Wind Resource Zone 1. Sensitivity of shellfish to contamination is high. Sensitivity of finfish species in the area to contamination is unknown. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on fish and shellfish would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Wind**	**Neutral**	The presence of devices in the water could lead to habitat exclusion. Devices may exclude fish from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. Given the relatively wide spacing between wind turbine foundations, and the low level of operational noise in the context of natural background levels this is not considered to be a significant potential impact. The presence of offshore wind arrays may also have a positive effect on fish populations through fish stock recovery, should certain types of commercial fisheries be excluded from the array.	No specific mitigation identified	**Neutral**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Significant adverse**	Wind Resource Zone 1overlaps with coastal areas known to support populations of lobster, edible crab and velvet crab. Scallops can also be found further offshore within a small portion of the zone. These species live on, near or in the bottom sediments of the seabed, and are therefore sensitive to substratum loss. Sprat and herring are also known to spawn on the seabed in the area. Removal of habitat during installation and operation of wind turbines could result in the long term removal of the habitat used by these species, although alternative adjacent habitat may be available.	The potential effects of substratum loss on shellfish and benthic spawners could be reduced by avoiding sensitive areas e.g. key shellfish beds and spawning grounds.	**Negative to Negligible**
Fish and Shellfish	**Barrier to movement**	Operation	Device foundations	**Wind**	**Unknown - negligible**	Some species, such as Atlantic salmon, trout and eels spend part of their lifecycle in freshwater and part at sea. Migration between these two waterbodies is important for the survival of the species. The zone may be used by these species accessing the rivers Foyle, Roe, Lower Bann and Bush located on the adjacent coastline which are known to contain populations of salmon and sea trout. The presence of wind devices could potentially present a barrier to migration. However, given the relatively wide spacing between offshore wind turbine foundations, it is considered unlikely that placement of wind turbines would present a barrier to fish entering or leaving the adjacent estuaries.	No specific mitigation identified	**Unknown to negligible**
Fish and Shellfish	**EMF impacts**	Operation	Inter-turbine and export cables	**Wind**	**Unknown - negligible**	Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical renewable array power cable, but the field would not cause an avoidance reaction. Atlantic salmon, eels and Sea Trout are believed to be sensitive to magnetic fields. However, the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables. There is no evidence to indicate that existing cables have caused any significant effect on migration patterns of these species. However, the significance of potential effects cannot be adequately quantified on the basis of current information.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown to negligible**
Marine Birds	**Physical disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wind**	**Negative to negligible**	Physical disturbance is of particular importance in terms of breeding colonies as high levels of physical disturbance could lead to species displacement (short-term to long-term). Physical disturbance is also important in terms of foraging and loafing at sea. This zone borders the Ramore Head and the Skerries ASSI which is important for breeding seabirds. There are also a number of seabird colonies along the adjacent coast to the zone. This means that seabirds will be present in the area, and could use parts of the zone for foraging and loafing at sea. The effect of physical disturbance has been assessed as negligible significance for breeding colonies and negative significance for feeding and loafing areas which extend beyond the delineation of the ASSI protection.	Effects on breeding bird colonies could be reduced by avoiding the portion of the zone closest to the sensitive sites e.g. the Ramore Head and the Skerries ASSI and to restricting installation to avoid the most -sensitive seasons e.g. breeding. In some parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and or loafing areas and to aid site selection.	**Negligible**
	Noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Wind**	**Negative**	Based on studies of bird behaviour on land it is evident that they have acute hearing. Noise disturbance impacts are possible both during installation and operation. The noisiest activity associated with offshore windfarm installation is piling of monopole foundations.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive periods such as breeding or moulting.	**Negative to-negligible**

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
		Operation	Turbine noise above and below water (transmitted through steelwork)	**Wind**	**Negligible**	Whilst, there is limited understanding of birds ability to hear underwater, underwater noise from marine wind turbines will not cause a significant change above background levels. Above water operational noise will not have a direct impact on marine birds, but could contribute to habitat avoidance impacts, as described below.	No specific mitigation identified	**Negligible**
	Collision risk	Installation Operation Decom	Installation and decommissioning vessels; Operating turbines	**Wind**	**Significant adverse**	This coastline adjacent to Wind Resource Zone 1 is considered to be sensitive for marine breeding birds, including the Ramore Head and the Skerries ASSI which is important for breeding seabirds, and a number of seabird colonies in the vicinity of this zone. Anticipated impacts from siting of offshore wind farm array in an area known to be important for seabirds include direct impacts such as disturbance, habitat loss and collision. Given the proximity of this zone with the Ramore Head and the Skerries ASSI and seabird colonies along the adjacent coastline, impacts during installation could be an issue, disturbing habitats and bird species in the area. These impacts would decrease the further offshore the array was sited. However, regardless of the location of individual arrays within Wind Resource Zone 1, there is still the issue of collision impacts which would be an impact on any species of seabird using the study area for foraging or loafing, outside of the boundary of the ASSI or seabird areas. Collision impacts could be a significant risk if located on a major migration route. There is also some indication that wind turbines themselves may be barriers to bird movement – instead of flying around the turbines, birds fly around the outside of the cluster, i.e. displaying avoidance behaviour. This avoidance behaviour , whilst reducing collision impacts, may have indirect effects in terms of changing ecological links between feeding, breeding and roosting areas. For these reasons, the impact and operation of wind development is considered significant adverse.	During construction appropriate mitigation includes avoidance of sensitive sites and seasons; increasing vessel visibility; avoiding night working Other recommendations include siting turbines close together to minimise the area accommodated by a wind farm; grouping turbines to avoid alignment perpendicular to main flight paths; providing corridors (up to a few kilometres wide) between groups of turbines to allow passage by birds.	**Negative to negligible**
	Accidental contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Wind**	**Negative**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. All seabirds are sensitive to hydraulic fluid and fuel oil contamination. In addition wading birds within the Lough Foyle ASSI may experience negative effects. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine birds would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
Marine Birds	**Habitat exclusion**	Operation	Devices that occupy water surface and water column	**Wind**	**Significant adverse to negative**	Locating devices in areas used for foraging and loafing could result in habitat exclusion and possible species displacement. There is limited information on precise foraging and loafing "hotspots" for different species of marine birds. Birds could be displaced from an area wider than the array site due to their potential avoidance responses. Whilst birds are mobile and could therefore avoid devices the potential effects of increasing competitive pressures on adjacent populations and energetic costs of site avoidance also need to be considered. This could potentially have a significant adverse effect during the breeding season and a negative effect on marine birds at other times of the year, especially if it increased population pressures in other locations.	Without a more detailed understanding on the location of key foraging and loafing habitats, it is difficult to identify appropriate mitigation measures other than to avoid sensitive sites. Studies would be needed at the project level to identify the presence of key foraging hotspots and loafing areas in the development area to aid site selection.	**Significant adverse to negative**

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
Marine Mammals	**Physical disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wind**	**Unknown - negative**	Portrush and Portballintrae are both areas with high rates of cetacean sightings. Harbour porpoise (Annex II –Habitats Directive) are frequently sighted in this area and it is known to be a foraging area. Harbour porpoise calves have also been seen in this area. Minke whales and bottlenose dolphins (Annex II –Habitats Directive) are seen here occasionally. Grey and common seals (Annex II –Habitats Directive) also use the area. However it is currently unknown how important this area is to both cetaceans and seals. Increased boat traffic will increase the risks of direct physical interactions with marine mammals, although, as described below, collisions are unlikely given the speed at which construction vessels will be moving.	The relative importance of this area for seals and cetaceans is unknown therefore monitoring surveys would be required to design a suitable mitigation plan. The effects of installation activities on seal colonies could be reduced by avoiding the breeding and moulting seasons. Cable routing should be planned to avoid impacting on seal breeding colonies or haul out sites.	**Negligible to negative**
Marine Mammals	**Marine noise**	Installation	Piled foundations	**Wind**	**Significant adverse**	Piling generates high levels of noise. Studies at wind farms have demonstrated an effect on porpoise distribution during construction with animals displaced up to 15km. Noise can mask signals used by cetaceans to navigate, locate prey, and communicate effectively. Seals and cetaceans can detect piling noise up to a distance of 80km. Behavioural responses and physiological impacts such as temporary or permanent threshold shift in hearing could occur at closer distances. It is also quite possible that these noise sources mask biological relevant signals within the zone of audibility. The potential for noise from piling to affect these marine mammals is therefore considered to be "significant adverse". It is possible that minke whales detect wind farm related noise at considerable distances, (tens of km) during pile driving. Increased shipping associated with installation will also raise ambient noise levels in the area.	At-sea distribution data for seals is unknown for this area. Also cetacean abundance and habitat usage is unknown there fore dedicated marine mammal surveys would be required to identify the most appropriate site for development and to design adequate mitigation measures Seasonal or area restrictions could also be imposed so piling activities would be timed not to coincide with sensitive times such as seal moulting or pupping and porpoise breeding seasons. To mitigate for noise disturbance during piling there are a range of measures including the use of Marine Mammal Observers, exclusion zones, passive acoustic monitoring, pingers, soft starts/ramp up and/or bubble curtains.	**Significant adverse to negative**
Marine Mammals	**Marine noise**	Operation	Turbines	**Wind**	**Negative to negligible**	During operation the turbine can produce low frequency noise and vibrations that can pass into the water column and noise from operational devices can potentially affect seals' and cetaceans' ability to navigate, locate prey and communicate. Operational noise from wind turbines may be heard by seals and porpoises up to 200m and whilst may not cause hearing damage may affect behaviour.	Noise from operating turbines can be reduced by using isolators. However this has not been tested over long term and to account for cumulative effects.	**Negative to negligible**
Marine Mammals	**Collision risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wind**	**Negligible**	Marine mammals can potentially collide with vessels and equipment used during installation. Increased shipping activity transiting to the area during installation will increase this risk. Generally most fatal injuries arise with collisions with ships travelling over 14kts. Vessels associated with construction activities would usually not be travelling at these speeds.	Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals both during construction activities and in transit to the construction area if entering areas of high animal abundance.	**Negligible**
Marine Mammals	**Collision risk**	Operation	Turbine foundations	**Wind**	**Unknown - negative**	Collision with wind turbines is negligible for seals and small cetaceans however collision may be a concern for baleen whales such as minkes which may not detect the presence of these in the water and do not have the manoeuvrability of smaller cetaceans. The importance of this area to minke whales is unknown so the collision risk is difficult to quantify.	Consider measures to make turbine foundations more visible to marine mammals could reduce further the risk of collisions.	**Unknown to negative**
Marine Mammals	**Accidental contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel fuel	**Wind**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids during installation could have an effect on marine mammal health. Offshore wind farms could present a collision risk to shipping. A collision between ships or a ship and a turbine could result in fluid spills which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine mammals would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
Marine Mammals	**Habitat exclusion**	Operation	Devices that occupy seabed/water column	**Wind**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. Devices may exclude mammals from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. It is not possible to determine the potential significance of this effect.	No specific mitigation identified	**Unknown**

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
	Barrier to movement	Operation	Devices	**Wind**	**Unknown - significant adverse**	Development of wind farms offshore of Lough Foyle may cause a barrier effect and restrict marine mammal movement in and out of the Lough. The importance of this area for marine mammals is largely unknown but harbour porpoises and minke whales have been seen in the Lough. The greatest potential for offshore wind development using current technology is within the resource zone is in the nearshore area where water depths are less than 40 m. Placing turbines in this area could therefore present a perceptual barrier to mammals movement in and out of Lough Foyle, although the extent to which the piled foundations would be perceived as a barrier is not well understood. Overall, the movement of marine mammals around the coast of Northern Ireland is unknown so barrier effect is difficult to quantify.	Turbine placement should be planned so potential movement of animals into or out of Lough Foyle remains as unrestricted as possible. However, detailed study would be required to examine marine mammal distribution around the coast in order to fully understand and mitigate for this risk.	**Unknown to significant adverse**
Marine Mammals	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown - negligible**	The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains a complicated, understudied and unproven field of science (Basslink, 2001), with only circumstantial evidence. Cetaceans cross cables constantly, and there is no apparent evidence that existing electricity cables have influenced migration of cetaceans. However further study is thought warranted by the scientific community in this field (Gill *et al.*, 2005). It should also be borne in mind that the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown - negligible**
Marine Reptiles	**Collision risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wind**	**Unknown**	The importance of the coast of Northern Ireland to marine turtles is unknown but there have been sightings of leatherback and loggerhead turtles. Turtles have been seen off the Portrush area. There is no information on the effects of wind farm construction on marine turtles so the risk is difficult to quantify.	Possible mitigation includes planning installation to take place at times when there are fewer turtles present or avoid potential migration routes.	**Unknown**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Wind**	**Unknown**	There is no information on the effects of wind farm operation on marine turtles so the risk is difficult to quantify		**Unknown**
	Accidental contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Wind**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on turtle health. Offshore wind farms could present a collision risk to shipping. A collision between ships or a ship and a turbine could result in an oil spill which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine reptiles would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Barrier to movement	Operation	Devices	**Wind**	**Unknown**	The movement of marine turtles around the coast of Northern Ireland is unknown so it is difficult to quantify the level of barrier effect.	Mitigation measures to deal specifically with potential risks to marine turtles from offshore wind developments are unknown.	**Unknown**
Bats	**Collision Risk**	Operation	Turbines	**Wind**	**Unknown**	The presence of bats in offshore locations (off the north coast of Northern Ireland) is unknown. The potential interactions between bats and wind turbines and associated potential effects is also unknown due to a lack of data and research in this area	Unknown	**Unknown**
Marine and coastal archaeology and wrecks	**Effects on submarine historic environment**	Installation	Turbine and export cable installation	**Wind**	**Neutral**	There is considerable archaeological and heritage interest in this area with a high potential for presence of prehistoric submarine remains. PMRA protected aircraft wrecks may be present and numerous miscellaneous wrecks have been reported in the area. The wreck of the La Girona, which is designated under the Protection of Wrecks Act, can also be found close by at Lacada Point. There is potential for the installation of wind devices and export cables to impact submarine archaeology through direct disturbance of known and unknown sites on the seabed, or through changes to sediment movements causing an artefact to become buried and preventing later discovery. There is also a potential positive impact associated with development related seabed survey providing additional data for inclusion in the archaeological record of the area.	Follow NIEA and Crown Estates 2007 JNAPC code of conduct and guidance note for the offshore renewable energy sector. Carry out seabed investigations in preferred site locations prior to device installation. Avoid sites of interest and exclusion zones for protected sites.	**Neutral**

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
	Effects on coastal and terrestrial historic environment	Installation	Export cable installation	**Wind**	**Significant adverse**	The adjacent coastline contains a number of sites and features listed on the sites and monuments record, including an anti-aircraft battery at Magillian Point which is a Scheduled Monument, and Martello Tower on Magillian Point which is designated as being under state care. These historic sites could potentially be impacted during export cable installation. Nearby is Dunluce Castle, a historical monument situated on the coastline towards the town of Portballintrae. Cable installation in the vicinity of these protected sites could cause direct destruction of archaeologically important features.	The main form of mitigation is to avoid protected and other sites of interest. In addition to desk based studies it will be necessary to carry out field walkovers in preferred site locations to determine need for site investigations (geophysical surveys/trial trenching) in consultation with NIEA, Local Authorities and the Department of the Environment, Heritage and Local Government of the Republic of Ireland. With respect to cabling there is considerable opportunity to avoid effects through avoidance of protected archaeological sites.	**Negligible**
Commercial Fisheries	**Direct disturbance of fishing grounds**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Significant adverse to negative**	Commercial shellfish areas are most sensitive to direct disturbance as shellfish are generally much less mobile than fin fish. Inshore finfish grounds are also sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. Key commercial shellfish in this area are king scallop, lobster and crab, with an important area for seed mussel at the mouth of Lough Foyle. The area is also an important migration route for Atlantic salmon. Wind Resource Zone 1 coincides directly with the main scallop fishing and finfish trawling areas, and overlaps to some degree with lobster/crab potting areas. Development within these areas will therefore have a potentially negative significance effect on the fishing grounds. In terms of commercial fisheries this effect could potentially be of adverse significance.	In terms of direct disturbance to commercial shellfisheries and fin fisheries, the effects could be minimised by avoiding key commercial fishing grounds, and key seasons such as the period of mussel seed settlement (Feb-Apr; Sept) and the main period of salmon migration (May-Jul).	**Negative to negligible**
	Temporary displacement from traditional fishing grounds	Installation Decom	Vessels, installation equipment and devices	**Wind**	**Negative**	Inshore fishing grounds tend to be more constrained than offshore areas. Temporary displacement from these areas may lead to the concentration of fishermen in smaller areas, fishermen being unable to fish for short periods or fishermen being displaced to alternative, possibly less productive fishing grounds. Key commercial shellfish in this area are king scallop, lobster and crab. Temporary displacement will potentially have a negative significance effect on commercial fisheries.	Effects associated with the temporary displacement of traditional fishing grounds can be reduced by avoiding key commercial fishing grounds or by phasing construction activities to specific zones of wind resource zone 1. Liaison with the fishing community to keep them informed of installation operations is also key to managing the level of this impact.	**Negative to negligible**
	Long term displacement from traditional fishing grounds	Operation	Devices that occupy water surface, water column and seabed	**Wind**	**Significant adverse to negative**	All types of commercial fisheries could be affected by long term displacement from traditional fishing grounds. The key bottom trawl fisheries in Wind Resource Zone 1 include cod, plaice, lemon sole, ray and skate. King scallops are exploited by mechanical dredging gear. The potential effects could be of adverse significance for spatially constrained inshore fisheries and for bottom trawl and dredge fisheries. Use of rock armour, if required for cable protection, could introduce an obstruction for trawling activity, but could also create new habitat which could have a positive impact of fish stocks. In addition, long term exclusion of mobile gear from the area could be of benefit to fish stocks in the wider area. The effects of long term displacement on inshore fisheries could be of adverse significance. The effects of long term displacement of offshore and beam trawler/dredging fisheries could be of negative significance.	The long term displacement of commercial fisheries (shellfish and fin fish) could be reduced or avoided by avoiding key commercial fishing grounds or by spacing of turbines at wide enough intervals to permit use of mobile fishing gear.	**Significant adverse to negligible**
Mariculture	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Negligible**	Lough Foyle is a major area for shellfish production, notably bottom grown mussels, with an important area for seed mussel at the mouth of Lough Foyle. Any significant and prolonged rise in suspended solids could have a significant adverse on mussel growing areas. However, increases in suspended sediment is expected to be short term and localised to the immediate vicinity of the seabed disturbing works. Intrusion of sediment plumes into the Lough would therefore only result if the export cables were routed in the immediate vicinity. It is therefore considered there could be a negligible impact from wind energy development.	Should cable trenching work be undertaken within the Lough, impacts could also be reduced by using procedures that minimise the mobilisation of suspended solids such as plough installation.	**Negligible**

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Wind**	**Significant adverse**	Shellfish are highly sensitive to reductions in water quality caused by hydraulic fluids or tainting from other chemical substances. There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Therefore, although the likelihood of accidental contamination from devices is low, the potential effects any significant intrusion of hydraulic fluids into Lough Foyle could be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, and contingency measures for device failure/component failures. It should be noted that the quantity of hydraulic fluid in devices is likely to be very small, reducing the potential for significant environmental effects. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Substratum loss	Operation	Devices using seabed foundations e.g. piled devices	**Wind**	**Significant adverse**	This zone does not overlap with shellfish production areas. Should cables be routed through marine fish farms this would be an effect of adverse significance.	The key mitigation measure in terms of reducing effects on shellfish farms is avoidance. In practice, consent is unlikely to be achievable to site renewable energy arrays or cables within existing fish farms.	**Negligible**
Ports, Shipping and Navigation	**Displacement of shipping movement**	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Wind**	**Significant adverse**	The re-routing of vessels to avoid safety zones (during installation), operational devices and decommissioning activity would result in greater transit time and use of fuel with the associated costs to the vessel operator, and could also lead to an increase in vessel densities in areas that already have moderate vessel densities. This could lead to increased encounter rates and increased risk of collision. Within Wind Resource Zone 1 shipping intensity varies, there are areas of little to no shipping and there are areas where shipping density is more moderate and concentrated so as to imply specific routes. Placement of devices in areas of high shipping density could therefore displace shipping into adjacent areas, and would potentially be of adverse significance.	The potential for these effects to be reduced would depend entirely upon the siting of a device in relation to key shipping routes. There is potential to reduce or avoid significant adverse effects within this zone by siting devices away from areas of high vessel densities. The scale of potential effect on navigation should be assessed as part of the EIA and the Navigational Risk Assessment (NRA). The assessment should include: • A survey of vessels in the vicinity of the proposed development • Full NRA of the likely impact of the development on navigation, taking into consideration MGN 371 (MCA 2008), MGN 372 (MCA 2008b) and the DTI Guidance Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (DTI 2005) • Cumulative impact assessment	**Negative to Negligible**
		Operation	Physical presence of wind turbines	**Wind**	**Significant adverse**			
	Decreased trade/supply	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Wind**	**Significant adverse**	The deployment of installation and maintenance vessels, presence of devices and decommissioning activity could create temporary to long-term reductions in access to ports and harbours. Londonderry port, located on River Foyle at the southern end of Lough Foyle, is an important deepwater commercial port. Ports at Coleraine and Portrush are within 10km of Wind Resource Zone 1. Reduced access to these harbours could have a significant adverse effect on goods transport and accessibility.	Site selection for device arrays should take into account the requirement for continued access to port and harbours. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning.	**Negligible**
		Operation	Physical presence of wind turbines	**Wind**	**Significant adverse**			
	Reduced visibility	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wind**	**Negative**	Vessels and other equipment used during the installation of devices, and the operational devices themselves could obstruct views of other vessels and navigation features such as buoys, lights and the coastline. This is particularly important in areas of high vessel densities, constrained channels or areas where there is particular dependence on visual navigation aids as reduced visibility increases the risk of collision with other ships and other structures in the water (natural and man made). Wind Resource Zone 1 is not located in a constrained area. However, the southern extent of the zone is outside the entrance to Lough Foyle where a combination of moderate vessel densities and constrained route options leading to the entrance to the Lough may potentially impact negatively on visibility.	Significant adverse effects associated with reduced visibly can be reduced by avoiding areas of high vessel densities and areas constrained by land e.g. adjacent to the mouth of Loughs. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Any vessels and devices should be lit and marked in accordance with regulations and MCA and Trinity House guidance	**Negative to negligible**
		Operation	Physical presence of wind turbines	**Wind**	**Negative**			

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	**Characteristic**	**Type**				
	Collision risk	Installation Decom	Vessels and equipment used for installation and Decommissioning	**Wind**	**Significant adverse**	Collision risk considers the risk of navigating vessels colliding with vessels and equipment used during installation, maintenance and decommissioning, and the devices themselves once operational. Collision risk also considers the increased risk of collision between navigating vessels. In both circumstances the risk of collision is increased in constrained channels and areas with high vessel densities. The most constrained area of Wind Resource Zone 1 is adjacent to the entrance to Lough Foyle and the ports of Coleraine and Portrush, there are also moderate vessel densities accessing Lough Foyle. The risk of collision will potentially be significant adverse.	The risk of collision could be reduced by avoiding constrained areas or areas of high shipping densities and regularly used shipping routes. This could potentially be achieved through locating devices in the centre of Wind 1 where there is little to no shipping. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning. The scale of potential effect on navigation should be assessed as part of the EIA and NRA as outlined above.	**Negative to negligible**
		Operation	Physical presence of wind turbines	**Wind**	**Significant adverse**			**Negative to negligible**
Recreation and Tourism	Disturbance to Wildlife	Installation Operation Decom	Installation activities including noise, vessel movements, operation of devices, decommissioning activities	**Wind**	**Negative**	Lough Foyle is the winter home to internationally important numbers of Whooper Swan, Brent Goose and Bar-tailed Godwit. Marine mammals and turtles are encountered in Lough Foyle, and kayak wildlife watching tours operate within the Lough. Whilst tourism within the Lough itself will not be directly affected by installation of wind turbines in the offshore area, any impacts on marine wildlife using the Lough would have a knock-on effect on eco tourism in the area.	With respect to tourism activities the main form of mitigation will be the avoidance of areas that are popular with tourists and wildlife tour operators. Other mitigation measures aimed at reducing or avoiding disturbance to wildlife including sea mammals and birds is set out in the relevant parts of this table.	**Negligible**
	Safety and Collision Risk	Installation Operation Decom	Presence of new structures in the water	**Wind**	**Negative**	The key receptor affected is sailing. General Sailing Areas and light recreational use cruising routes for vessels entering and leaving Lough Foyle are likely to overlap with Wind Resource Zone 1, and there is the potential for negative effects.	Safety measures including lighting and marking and informing users of the locations of devices. Locate devices away from cruising routes. Use alternative devices which lie below the surface of the water to a depth which does not affect sailing.	**Negligible**
	Access Restrictions	Installation Operation Decom	Structures in the sea reducing or excluding access	**Wind**	**Negative**	The key receptor affected is sailing. General Sailing Areas and light recreational use cruising routes for vessels entering and leaving Lough Foyle are likely to overlap with Wind Resource Zone 1, and there is the potential for negative effects.	Avoid cruising routes. Devices which exclude access to an area will have greater effects than those which allow movement through the array. Use alternative devices which lie below the surface at a depth which does not affect sailing.	**Negligible**
Aviation Radar	**Radar Interference**	Operation	Physical presence of wind turbines	**Wind**	**Negative**	The entire area is within a "potential to interfere" NERL area and as such there is potential for negative effects on aviation. However, this area is not within any 30km consultation areas applied to airports and unlikely to affect airport radar systems.	Consultation with the CAA and NATS may be required to confirm whether wind turbines in the area will have a detrimental effect on radar.	**Negligible**
Military Exercise Areas	**Disruption to general activities**	Installation Operation	Wind turbines	**Wind**	**Significant adverse to negligible**	The eastern half of the zone overlaps with area X5537 - Skerries. This area is used by the Navy for submarine exercises, aircraft and H.M ships. Dependent on the extent to which the area is used by the navy, significance of this effect could be considered to be significant adverse to negligible. The weapons range area D505 Magillian Range lies in the southern tip of the area for 8km^2.	Consultation with the MOD will be required to enable appropriate site selection in order to reduce or eliminate the risk of interference associated with non-bylawed practice and exercise areas. The Magillian Range is a byelawed area and as such should be avoided for offshore renewable energy development.	**Negligible**
Disposal Areas	**Disruption to access**	Installation Operation	Wind turbines	**Wind**	**Significant adverse**	There are a two harbour spoil disposal sites within or adjacent to this area, one inshore of and one within Wind Resource Zone 1. Long term access restrictions could result from device operation in close proximity to the site, with temporary access restrictions during device and cable installation.	Avoidance of the sites by approximately 500m can mitigate against the possibility of access to the sites in the area being inhibited for users.	**Negligible**

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
Cables and Pipelines	**Direct damage**	Operation Installation	Wind turbines	**Wind**	**Significant adverse**	The Hibernia Atlantic telecommunications cable runs through the northern end of the area for 14km. There is also a proposed telecommunications cable (Project Kelvin) operated by Hibernia which at the time of writing will be installed in summer 2009. This cable links the Hibernia Atlantic cable to mainland Northern Ireland and runs across the western extent of the study area for 22km. Any direct damage to an existing cable would be most likely to occur during installation of device arrays and cables but also could occur maintenance phases. The impact is considered to be significant adverse (should it occur) as international telecommunications could be seriously disrupted.	A 500m avoidance zone should be employed when selecting sites for marine renewable energy developments (in accordance with ICPC guidelines) and crossing agreements with existing infrastructure should be adhered to. These mitigation measures will eliminate or significantly reduce significance and likelihood of impacts on cables.	**No effect**
	Reduced access	Operation Installation	Wind turbines	**Wind**	**Significant adverse**	There is potential that the presence of devices in waters close to existing and proposed cables could restrict access to the cables for maintenance purposes. Also, installation of cables can be detrimentally impact access.	A 500m avoidance zone should be employed when selecting sites for marine renewable energy developments (in accordance with ICPC guidelines) and crossing agreements with existing infrastructure should be adhered to. These mitigation measures will eliminate or significantly reduce significance and likelihood of effects on cables.	**Negligible**
Aggregate extraction	**Presence of devices**	Operation Installation	Wind turbines	**Wind**	**Unknown** / **No effect**	There are no existing or proposed aggregate dredging areas within this area therefore there will be no effects on aggregate extraction. Impacts on possible future aggregate extraction sites, based on aggregate resources that have not yet been identified include restricted access to and sterilisation of possible sites. However these impacts are impossible to quantify at this stage.	None identified	**Unknown** / **No effect**
Oil and gas resources	**Presence of devices**	Operation	Wind turbines	**Wind**	**Unknown**	The installation of wind turbines has the potential to sterilise areas that could have been used for oil and gas exploitation. The Rathlin Basin which overlaps with this zone is identified as an area with oil and gas potential. However, there is currently insufficient data to establish possible future exploitation of oil and gas from this area. Therefore, whilst no sites are currently under consideration for oil and gas exploitation in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**
Natural Gas and CO_2 storage	**Presence of devices**	Operation	Wind turbines	**Wind**	**Unknown**	The installation of wind turbines has the potential to sterilise areas that could have been used for CO2 or natural gas storage. There is currently insufficient data to establish potential for use of the marine environment for storage of CO_2. Therefore, whilst no sites are currently under consideration for natural gas or CO_2 storage in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**

Table 11.6: North Coast (Wind Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device details			Potential effect significance (without mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (with mitigation)
		Phase	Characteristic	Type				
Landscape/Seascape	Effects on seascape	Operation	Wind turbine arrays of up to 140 m blade height	**Wind**	**Significant effects** **(based on development occurring between 0 and 26km offshore from the coast)**	Offshore Wind Zone 1 is located to the North of the north Antrim Coast. Within this stretch of the coastline there are four main seascape types: • 5: Narrow coastal strip with raised hinterland – exposed with elevated dramatic open and expansive views out to sea. • 6: Complex indented coast, small bays and offshore islands – changing vistas from enclosed views associated with indented bays and inlets to long expansive views from raised headlands and hinterland. • 7: Plateaus and high cliffs – dramatic seascape with open expansive and elevated views with a coastal edge of vertical cliff faces, arches and raised plateau. • 9: Giants Causeway – unique geology, steep cliffs and small rocky bays, exposed, rugged and dramatic seascape with long open views. These are all of high sensitivity to the development of offshore wind farms. Parts of the north Antrim Coast are also covered by a number of designations these include: • Giant's Causeway World Heritage Site (WHS) – designated in 1986 in recognition of its geological and geomorphological values, its history of scientific study and its exceptional landscape values. There are extensive and dramatic vista's from the causeway out to sea and along the coast to the Donegal Mountains. The area is also an important tourist attraction. • Causeway Coast AONB – designated in 1998, this stretch of the north Antrim Coast is deemed to be one of the most dramatic stretches of coastline in Europe. The AONB includes the Giant's Causeway WHS. • North Derry AONB – this is located to the west of the main north Antrim Coast, adjacent to Lough Foyle. • Especially High Scenic Amenity under Policy BNH 5 of the Donegal County Plan- Areas of the west coast of Lough Foyle and north coast of Donegal including high cliffed coastal zones and upland mountain areas with long vistas to Lough Foyle, Derry and Causeway Coast. Donegal Council's policies for landscape conservation offer the highest degree of protection to these areas of highest scenic landscape quality Given the high value of this seascape and extent of open and expansive views it is likely that any offshore wind farm will be highly visible within and beyond the 15km threshold of visibility for offshore wind turbines increasing the likelihood of the occurrence of significant adverse effects.	Potential adverse effects on seascape can be reduced through the sensitive siting of offshore wind farms. Key factors to be considered in locating an offshore wind farm include: • Wind farms should not be sited where they appear to block or close the entrance to bays/l oughs/narrows/sounds or where they separate a bay from the open sea; • Wind farms should reflect the shape of the coastline and align with the dominant coastal edge; • Wind farms should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate; • Wind farms should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement; • Wind farms should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms; • Consideration should be given to locating devices in already industrialised and developed seascapes;	**Significant effects** **(due to sensitivity of the Causeway Coast and Giant's Causeway WHS it is unlikely that potential effects will reduce with mitigation)**
Climate	Carbon Impacts	Operation	Wind turbines	**Wind**	**Positive**	It is recognised that development of offshore wind farms will contribute towards achieving the Northern Ireland target for 40% energy to be provided from renewable energy sources. In meeting this target the Northern Ireland Assembly will be working towards the wider national, European and international commitment to combat global climate change and reduce the potential associated adverse environmental effects e.g. changing population distributions, species extinction, sea level rise etc. However, whilst seeking to combat climate change there is also a need to respond to it in terms of: • Protecting the existing environment and increasing its robustness and ability to adapt to climate change • Protecting existing and future infrastructure from effects of climate change e.g. increased storm events , flooding and sea level rise	Ensure that coastal infrastructure is sited in locations that are at lower risk from flooding, sea level rise and storm damage and do not increase the risk of flooding or damage to coastal infrastructure elsewhere. This will require close consultation at the project design stage with the relevant land use planning authority.	**Positive**
	Carbon Storage	Installation Operation	Wind turbines	**Wind**	**No effect**	Based on current available information no existing or proposed carbon or gas storage sites have been identified within this area (Offshore Wind Resource Zone 1) therefore there will be no effect resulting from the development of offshore wind farms.	None required	**No effect**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Bathymetry	**The information presented in this chapter has been used to inform the results of the assessment. No specific impacts on bathymetry are expected.**							
Geology, geomorphology and sediment processes	**Changes in seabed morphology**	Installation	Export cable trenching Devices using seabed foundations e.g. piled devices	**Wave**	**Negative**	The seabed is composed of sand and gravel that rests on glacial marine mud. The seabed is largely unremarkable. The presence of seabed foundations, coupled with the strong currents, could induce local sediment scour at the seabed, which would alter the morphology of the seabed locally. Structures on seabed could alter tidal current directions and sediment transport pathways locally but not adversely significant. Cable trenching will alter the seabed morphology locally.	Reduce the impacts of local sour by locating the devices in areas where the amount of sediment available for mobilisation and transport is low. Potential effects of local scour on sediment transport will need to be assessed through morphological site surveys and hydrodynamic/sediment transport modelling at the project stage. Site specific geophysical and geotechnical survey will be required to establish a baseline and inform the impact assessment for individual developments.	**Negligible**
	Changes in coastal processes	Operation	Devices using energy generated by waves	**Wave**	**Negligible**	The physical presence of devices on the seabed, and removal of wave energy can cause localised scour and hydrodynamic changes. It is estimated that such changes will extend up to 50 m from devices and is therefore localised to the vicinity of the device array, but will be effective for the operational life of the device. Removal of wave energy from the sea can lower wave energy levels reaching the coastline and may reduce or interrupt longshore sediment transport, possibly inducing deposition in the vicinity of the devices while increasing erosion down coast from the wave devices. Given that Wave Resource Zone 1 is located about 7 km from the nearest adjacent coastline, it is considered unlikely that there would be any impact at the coastline.	The degree of potential impacts depends on the process (floating or fixed structures), how closely individual devices are spaced, and how far offshore the plant is located. Careful site selection is key to keeping impacts to a minimum. Impacts at the coastline will be reduced with increasing distance from the shore, subject to more detailed studies and modelling to better understand impacts at the coast. Modelling the effects on coastal processes should form part of pre-project activities to optimise location.	**Negligible**
Seabed Contamination and Water Quality	**Accidental contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel fuel	**Wave**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Where quantities spilled are small it is unlikely that water quality will be adversely affected as contaminants will weather and disperse. Significant spillages may affect coastal and inshore waters. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects in this area would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Disturbance of contaminated sediment	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wave**	**Negligible to significant adverse**	There is one active harbour dredging spoil disposal site within the southern portion of Wave Resource Zone 1 and one further inshore. These could potentially be disturbed if seabed disturbing activities (turbine or cable installation) occur in these sites. The dredged material is unlikely to contain high levels of contamination, and any disturbed sediment is likely to rapidly disperse with negligible effect. Munitions relict from wartime activities (e.g. wrecks or minelaying) or from the adjacent weapons range may be encountered. Disturbance could result in significant adverse effects.	Available mitigation includes avoidance of potentially contaminated seabed areas (dredging areas – 500m buffer). Identification and avoidance of areas of munitions contamination through site survey at the project stage. If munitions are encountered Crown Estates 2006 (Dealing with munitions in marine aggregates) should be followed	**Negligible**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Protected Sites and Species	**Impacts on protected sites**	Installation Operation	Marine devices	**Wave**	**Significant adverse**	The northern section of Wave Resource Zone 1 is the most sensitive as it coincides with a Potential Annex I Habitat, important for rocky reefs. Rocky reefs are extremely variable both in structure and the communities they support. Reefs are usually characterised by communities of attached algae and invertebrates, usually including a range of mobile animals such as fish. The nearshore area between Ramore Head and Benbane Head is also under consideration as a marine SAC for skerries, reefs, sandbanks and caves. This site could potentially be impacted by export cable installation. Depending on the location of any installation, potential impacts could affect the habitat directly (through physical disturbance, and substratum loss) or indirectly (through increased suspended sediment and turbidity, and smothering). This would be an issue both for the habitat itself and the communities supported.	Site specific survey at the project stage could identify the extent of any sensitive / protected habitats within the rocky reef PAIH in the northern portion of the zone. Impacts on protected areas could be mitigated by careful site selection avoiding sensitive sites for devices and export cables (i.e. existing and proposed protected sites). Possible mitigation measures relevant to the specific interest features of the sites and their seasonal and other sensitivities are described elsewhere in this table for the relevant topic areas. Impacts may still arise through indirect impacts on sediment movements during installation and operation, and would need to be assessed in more detail at the project stage.	**Negative to negligible**
	Impacts on protected species	Installation Operation	Marine devices	**Wave**	**Significant adverse**	Although there are no protected sites designated for specifically for species within Wave Resource Zone 1,(site designations in the area apply to habitats and geological formations) , a number of protected species including marine mammals, seals, seabirds and fish are found throughout the region, as are important benthic species. The impacts on these receptors are discussed in the relevant sections of the table below.	See sections below on benthic ecology, fish and shellfish, seabirds and marine mammals.	**Negative to negligible**
Benthic and Intertidal Ecology	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenches	**Wave**	**Negative**	Wave Resource Zone 1 is located in an area of offshore sand and gravel. Disturbed sediments are predicted to be dispersed rapidly especially in areas with higher tidal flows. Adjacent sand bank benthic species are considered to be robust and either adapted to perturbed environments or highly mobile and resistant to temporary smothering. Species in nearshore adjacent PAIH rocky reef habitat are robust to low levels of smothering including *Sabellaria spinulosa* reef. Smothering impacts will be localised to the immediate vicinity of the seabed disturbing activities during installation.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (such as anchors or clump weights). Potential effects on unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
	Contamination – from sediment disturbance	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wave**	**Negligible**	There is a potential for contaminated sediment from spoil dumping sites to be remobilised. It is likely that any habitats with the potential to be adversely affected by contamination from these sites have already been subject to disturbance during the original dredging and deposition of material. Fine contaminated material will be diluted and dispersed, settling over a wide area with negligible effect on the benthic and intertidal ecology. Coarse material will be rapidly redeposited within the immediate area of installation operations.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (such as anchors or clump weights). Avoidance of areas of known potential contamination for seabed disturbing works. Potential effects on areas of unknown benthic habitat will need to be assessed through site survey at the project stage.	**Negligible**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Wave**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. The water depth is such that small spillages (< 1tonne) are unlikely to affect the benthos. Similarly small spillages from this zone are unlikely to come ashore. Large spillages have the potential to have a significant adverse effect, particularly on the intertidal ecology of the adjacent shoreline. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on benthic and intertidal ecology would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan). Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
	Changes in wave regime	Operation	Devices that extract energy generated by waves	**Wave**	**Significant adverse**	Wave Resource Zone 1 is located in an area of offshore sand and sandy gravel. There is currently a data gap for benthic information in this area. Maerl beds, tidal rapid and reef habitats are all highly sensitive to changes in wave energy regimes, and may be present in the area. Given the potential for these UKBAP habitats to be present in wave resource areas, the effects could potentially be of adverse significance	Avoidance of these important habitats though careful site selection would reduce the potential effects of energy extraction, although it may not be possible for these effects to be removed completely. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negative**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Wave**	**Significant adverse**	All benthic communities can be expected to be sensitive to removal of their habitat. The long term loss of substratum due to the presence of devices that are attached to the seabed will therefore have a potentially significant adverse effect on any rare or important benthic habitats, such as those listed in the UKBAP and protected under the Habitats Directive	Effects on benthic ecology from substratum loss can be reduced either through avoidance (careful site selection) or using devices that have a smaller footprint on the seabed e.g. anchored devices, or clump weights. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
Fish and Shellfish	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wave**	**Negative**	A small portion of this zone supports populations of scallops, whilst closer to shore, outside Wave Resource Zone 1, populations of lobster, edible crab and velvet crab can be found. These species live on, near or in the bottom sediments of the seabed. Sprat and herring are also known to spawn in the area. These species range from low to high sensitivity to smothering, although this impact will be localised to the immediate vicinity of seabed disturbing activities and limited to during installation.	For devices that require piling, and cable trenching, potential effects could be mitigated by avoiding installation during the sprat spawning season (May to August) and herring spawning (August – September) and avoidance of key shellfish areas.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Wave**	**Negligible**	Wave devices are generally attached to the seabed through anchors or clump weights. Only wave rotor devices currently require attachment to the seabed on piled foundations. Any noise during installation is likely to be generated from shipping activities and other installation activities. The effect of this increase in ambient noise levels is therefore likely to be negligible for wave developments. The potential for noise from operational devices to lead to longer term species displacement is considered unlikely when considered in terms of natural background levels. This is supported by the knowledge that large numbers of fish are often found around 'noisy' offshore structures such as oil and gas installations.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive spawning periods.	**Negligible**
		Operation	Turbines/flexing joints/device components	**Wave**	**Negligible**		No specific mitigation measures have been identified	**Negligible**
	Collision risk	Operation	Turbines/moving part of devices / mooring chains and cables	**Wave**	**Negligible**	There is potential risk that all mobile fish species could collide with turbines or moving parts of submerged devices. Larger animals (such as basking sharks (UKBAP species)), and pelagic species are considered to be of greater risk. Basking shark and other pelagic fish species are present throughout the study area, and will be present within Wave Resource Zone 1. However, given the lack of moving parts for the majority of wave devices, the collision risk impact is considered to be negligible.	Potential effects associated with collision risk and fish could be reduced through device design e.g. use of protective nets or grids. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**Negligible**
Fish and Shellfish	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel fuel	**Wave**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Small spillages are likely to have a negligible impact. Large spillages, particularly where they impinge on the coastline or enter Lough Foyle could have a significant adverse impact	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Wave**	**Neutral**	The presence of devices in the water could lead to habitat exclusion. In terms of demersal species this effect would only apply to devices using seabed foundations. For pelagic species the position of submerged devices in the water column and the proportion of the water column occupied would be most relevant. Due to the vast number of variables associated with device types and the types of fish that could be affected it is not possible to determine the potential significance of this effect with certainty. However the significance of this impact should be considered in context of Wave Resource Zone 1's location in relatively open offshore water and the likelihood that alternative habitat will be available to local fish. The presence of offshore wind arrays may also have a positive effect on fish populations through fish stock recovery, should certain types of fisheries be excluded from the array.	No specific mitigation identified	**Neutral**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Wave**	**Significant adverse**	A small portion of the zone supports populations of scallops, whilst closer to shore, outside Wave Resource Zone 1, populations of lobster, edible crab and velvet crab can be found. These species live on, near or in the bottom sediments of the seabed, and are therefore sensitive to substratum loss. Sprat and herring are also known to spawn on the seabed in the area. Removal of habitat during installation and operation of wave turbines could result in the long term removal of the habitat used by these species, although alternative adjacent habitat may be available.	The potential effects of substratum loss on shellfish and benthic spawners could be reduced by avoiding sensitive areas e.g. key spawning grounds.	**Negligible**
Fish and Shellfish	**Barrier to movement**	Operation	Devices that occupy the water column	**Wave**	**Unknown – negligible**	Some species, such as Atlantic salmon, trout and eels spend part of their lifecycle in freshwater and part at sea. Migration between these two waterbodies is important for the survival of the species. The zone may be used by these species accessing the rivers Foyle, Roe, Lower Bann and Bush located on the adjacent coastline which are known to contain populations of salmon and sea trout. Whilst the presence of wind devices could present a barrier to migration, the potential significance of this impact should be considered in the context of Wave Resource Zone 1's location in relatively open offshore waters.	No specific mitigation identified	**Unknown to negligible**
Fish and shellfish	**EMF impacts**	Operation	Inter-turbine and export cables	**Wave**	**Unknown - negligible**	Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical renewable array power cable, but the field would not cause an avoidance reaction. Atlantic salmon, eels and Sea Trout are believed to be sensitive to magnetic fields. However, the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables. There is no evidence to indicate that existing cables have caused any significant effect on migration patterns of these species. However, the significance of potential effects cannot be adequately quantified on the basis of current information.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown to negligible**
Marine Birds	**Physical disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wave**	**Negative**	Physical disturbance is of particular importance in terms of breeding colonies as high levels of physical disturbance could lead to species displacement (short-term to long-term). Physical disturbance is also important in terms of foraging and loafing at sea. This zone does not overlap with any areas protected for seabirds, although there are a number of seabird colonies along the coast, and the Ramore Head and the Skerries ASSI is important for breeding seabirds. Therefore, whilst habitat loss is not considered to be an issue, installation is considered to cause an impact of negative significance for those birds foraging and loafing offshore.	Effects on breeding bird colonies could be reduced by restricting installation to avoid the most sensitive seasons e.g. breeding. In some parts of the zone, site specific surveys may be required at the project level to identify the presence of key foraging hotspots and or loafing areas and to aid site selection.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Wave**	**Negligible**	Based on studies of bird behaviour on land it is evident that they have acute hearing. Whilst, there is limited understanding of birds ability to hear underwater, underwater noise from marine wave devices is not expected to cause a significant change above natural background levels.	No specific mitigation identified	**Negligible**
		Operation	Turbines/flexing joints/device components					
	Collision risk	Installation Operation Decom	Installation and decommissioning vessels; Turbines/moving parts of device; mooring chains and cables	**Wave**	**Unknown to negative**	This area is considered to be of moderate importance for seabirds, as the adjacent coastline supports a number of seabird colonies, and the nearby Ramore Head and the Skerries ASSI is important for breeding seabirds. Therefore, there is potential for seabirds to use the area for foraging and loafing. All species of marine birds present within Wave Resource Zone 1 are potentially sensitive to collision impacts. Of these, the divers and pursuit divers are considered to be the most sensitive. Due to limitations in knowledge on the interactions between marine birds and devices with moving parts it is difficult to determine the potential significance of this effect which potentially has implications for all surface and diving birds.	During construction appropriate mitigation includes avoidance of sensitive sites and seasons; increasing vessel visibility; avoiding night working. During operation visibility of above water and below water structures could be increased. In many parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and to aid site selection. Potential effects associated with collision risk could also be reduced through device design e.g. use of protective nets or grids.	**Unknown to negative**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Accidental contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Wave**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. All seabirds are sensitive to hydraulic fluid and fuel oil contamination. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine birds would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
Marine Birds	**Habitat exclusion**	Operation	Devices that occupy water surface and water column	**Wave**	**Negative**	Locating devices in areas used for foraging and loafing could result in habitat exclusion and possible species displacement. There is limited information on precise foraging and loafing "hotspots" for different species of marine birds. Birds could be displaced from an area wider than the array site due to their potential avoidance responses. There are no protected bird areas (SPAs) in close proximity to Wave Resource Zone 1, although birds from the adjacent coastline could still be present. Although birds are mobile and could therefore avoid devices the potential effects of increasing competitive pressures on adjacent populations and energetic costs of site avoidance also need to be considered. This could potentially have a significant adverse effect during the breeding season and a negative effect on marine birds at other times of the year, especially if it increased population pressures in other locations.	Without a more detailed understanding on the location of key foraging and loafing habitats, it is difficult to identify appropriate mitigation measures other than to avoid sensitive sites. Studies should be undertaken at the project level to identify the presence of key foraging hotspots and loafing areas in the development area to aid site selection.	**Negligible**
Marine Mammals	**Physical disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wave**	**Negative**	Portrush and Portballintrae are both areas with high rates of cetacean sightings. Harbour porpoise (Annex II –Habitats Directive) are frequently sighted in this area and it is known to be a foraging area. Harbour porpoise calves have also been seen in this area. Minke whales and bottlenose dolphins (Annex II –Habitats Directive) are seen here occasionally. Grey and common seals (Annex II –Habitats Directive) also use the area. However it is unknown how important this area is to both cetaceans and seals. Increased boat traffic will also increase ambient noise in the area and may disturb marine mammals, although, as described below, collisions are unlikely given the speed at which construction vessels will be moving.	The relative importance of this area for seals and cetaceans is unknown therefore monitoring surveys would be required to design a suitable mitigation plan. The effects of installation activities on seal colonies could be reduced by avoiding the breeding and moulting seasons. Cable routing should be planned to avoid impacting on seal breeding colonies or haul out sites.	**Negative to negligible**
	Marine noise	Installation	Devices using seabed foundations e.g. piled devices	**Wave**	**Negligible**	Wave devices are generally attached to the seabed through anchors or clump weights. There are limited wave devices that require attachment to the seabed on piled foundations. Any noise during installation is likely to be generated from shipping activities and other installation activities. The effect of this increase in ambient noise levels is therefore likely to be negligible for wave developments.	At sea distribution data for seals is unknown for this area. Also cetacean abundance and habitat usage is unknown therefore dedicated marine mammal surveys would be required to identify the most appropriate site for development and to design adequate mitigation measures	**Negligible**
		Operation	Turbines/flexing joints/device components	**Wave**	**Unknown**	Effects of operational noise from wave devices are unknown and may vary substantially with device design. However, in general, underwater noise from marine wave devices are not expected to cause a significant change above background levels.	Operational noise from operating wave energy devices are unknown and are likely to vary according to device design. Mitigation measures will need to be device specific and as yet proven techniques are unknown.	**Unknown**
Marine Mammals	**Collision risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wave**	**Negligible**	Marine mammals can potentially collide with vessels and equipment used during installation. Increased shipping activity transiting to the area during installation will increase this risk. Generally most fatal injuries arise with collisions with ships travelling over 14 knots. Vessels associated with construction activities would usually not be travelling at these speeds.	Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals both during construction activities and in transit to the construction area if entering areas of high animal abundance.	**Negligible**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Wave**	**Unknown to negative**	Collision risk with wave energy devices is unknown for seals and cetaceans and the level of risk would depend on device design. Collision with fixed cables and anchor ropes may be a concern for baleen whales such as minke which may not detect the presence of these in the water and do not have the manoeuvrability of smaller cetaceans. The importance of this area to minke whales is unknown so the collision risk is difficult to quantify.	Collision risk during operation could be minimised through enhancing the visibility of marine devices to marine mammals, to maximise the possibility that the animals could detect it in time to react and avoid it. Consider potential measures to increase the acoustic visibility of undersea cables to marine mammals. New developments in active acoustic technology (e.g. sonar) are currently underway and may provide a potential monitoring and mitigation measure for operating devices in the future.	**Unknown to negative**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Accidental contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Wave**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids pollutants could have an effect on marine mammal health. Offshore wave devices could present a collision risk to shipping. A collision between ships or a ship and a wave device could result in fluid spills which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine mammals would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Wave**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. Devices may exclude mammals from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. It is not possible to determine the potential significance of this effect.	No specific mitigation identified	**Unknown**
	Barrier to movement	Operation	Devices	**Wave**	**Unknown to negative**	Development of wave energy devices offshore of Lough Foyle may cause a barrier effect and restrict marine mammal movement in and out of the Lough, however for wave resource zone 1 this is unlikely as it is located in open water at least 8 km offshore of the Lough entrance. The importance of this area for marine mammals is largely unknown but harbour porpoises and minke whales have been seen in the Lough. Overall the movement of marine mammals around the coast of Northern Ireland is unknown so barrier effects are difficult to quantify.	Development should be planned not to restrict potential movement of animals in or out of Loughs or other constrained areas. A detailed study would be required to examine seasonal marine mammal distribution and migration around the coast in order to fully understand and mitigate for this risk.	**Unknown to negligible**
Marine Mammals	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown to negligible**	The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains a complicated, understudied and unproven field of science (Basslink, 2001), with only circumstantial evidence. Cetaceans cross cables constantly, and there is no apparent evidence that existing electricity cables have influenced migration of cetaceans. However further study is thought warranted by the scientific community in this field (Gill *et al.*, 2005). It should also be borne in mind that the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown to negligible**
Marine Reptiles	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wave**	**Unknown**	The importance of the coast of Northern Ireland to marine turtles is unknown but there have been sightings of leatherback and loggerhead turtles. Turtles have also been seen off the Portrush area. There is no information on the effects of wave energy device construction on marine turtles so the risk is difficult to quantify.	Possible mitigation includes planning installation to take place at times when there are fewer turtles present or avoid potential migration routes.	**Unknown**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Wave**	**Unknown**	There is no information on the effects of wind farm operation on marine turtles so the risk is difficult to quantify		**Unknown**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Wave**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on turtle health. Wave energy devices could present a collision risk to shipping. A collision between ships or a ship and a wave energy device could result in an oil spill which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine retiles would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Barrier to movement	Operation	Devices	**Wave**	**Unknown**	The movement of marine turtles around the coast of Northern Ireland is unknown so it is difficult to quantify the level of barrier effect.	Mitigation measures to deal specifically with potential risks to marine turtles from offshore wind developments are unknown.	**Unknown**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Marine and coastal archaeology and wrecks	**Effects on submarine historic environment**	Installation	Piling, dredging, placing structures on seabed, cables, coring	**Wave**	**Negative**	There is considerable archaeological and heritage interest in this area with a high potential for presence of prehistoric submarine remains. PMRA protected aircraft wrecks may be present and numerous miscellaneous wrecks have been reported in the area. The wreck of the La Girona, which is designated under the Protection of Wrecks Act, can also be found close by at Lacada Point. There is potential for the installation of wave devices and export cables to impact submarine archaeology through direct disturbance of known and unknown sites on the seabed, or through changes to sediment movements causing an artefact to become buried and preventing later discovery. There is also a potential positive impact associated with development related seabed survey providing additional data for inclusion in the archaeological record in the area.	Follow NIEA and Crown Estates 2007 JNAPC code of conduct and guidance note for the offshore renewable energy sector. Carry out seabed investigations in preferred site locations prior to device installation. Avoid sites of interest and exclusion zones for protected sites.	**Neutral**
	Effects on coastal and terrestrial historic environment	Installation	Cables, shoreline devices	**Wave**	**Significant adverse to negative**	The adjacent coastline contains a number of sites and features listed on the sites and monuments record, including an anti-aircraft battery at Magillian Point which is a Scheduled Monument, and Martello Tower on Magillian Point which is designated as being under state care. These historic sites could potentially be impacted during export cable installation. Cable installation in the vicinity of these protected sites could cause direct destruction of archaeologically important features.	The main form of mitigation is to avoid protected and other sites of interest. In addition to desk based studies it will be necessary to carry out field walkovers in preferred site locations to determine need for site investigations (geophysical surveys/trial trenching) in consultation with NIEA, Local Authorities and the Department of the Environment, Heritage and Local Government of the Republic of Ireland. With respect to cabling there is considerable opportunity to avoid or reduce effects. The siting and design of shoreline devices will be important in determining their residual impact.	**Negligible**
Commercial Fisheries	**Direct disturbance of fishing grounds**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wave**	**Significant adverse to negative**	Commercial shellfish areas are most sensitive to direct disturbance as shellfish are generally much less mobile than fin fish. Inshore finfish grounds are also sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. Wave Resource Zone 1 coincides directly with the main scallop fishing and finfish trawling areas. Development will therefore have a potentially negative significance effect on the fishing grounds. In terms of commercial fisheries this effect could potentially be of adverse significance.	In terms of direct disturbance to commercial shellfisheries and fin fisheries, the main form of mitigation would be to avoid key commercial fishing grounds. The effects could also be minimised by using devices that use less intrusive forms of attachment e.g. anchoring or clump weights.	**Negative to negligible**
	Temporary displacement from traditional fishing grounds	Installation Decom	Vessels, installation equipment and devices	**Wave**	**Significant adverse to negative**	Inshore fishing grounds tend to be more constrained than offshore areas. Temporary displacement from these areas may lead to the concentration of fishermen in smaller areas, fishermen being unable to fish for short periods or fishermen being displaced to alternative, possibly less productive fishing grounds. Wave Resource Zone 1 coincides directly with the main scallop fishing and finfish trawling areas. Temporary displacement will potentially have a negative significance effect on commercial fisheries.	Effects associated with the temporary displacement of traditional fishing grounds can be reduced by avoiding key commercial fishing grounds or by phasing construction activities to specific parts of the Wave Resource Zone 1. Liaison with the fishing community to keep them informed of installation operations is also key to managing the level of this impact.	**Negative to negligible**
	Long term displacement from traditional fishing grounds	Operation	Devices that occupy water surface, water column and seabed	**Wave**	**Significant adverse to negative**	All types of commercial fisheries could be affected by long term displacement from traditional fishing grounds. The key bottom trawl fisheries in the wave 1 zone include cod, plaice, lemon sole, ray and skate. King scallops are exploited by mechanical dredging gear. The potential effects could be of adverse significance for spatially constrained inshore fisheries and for bottom trawl and dredge fisheries which may be restricted by cable routes. Use of rock armour, if required for cable protection, could introduce an obstruction for trawling activity, but could also create new habitat which could have a positive impact of fish stocks. Conversely, long term exclusion of mobile gear from the area could be of benefit to fish stocks in the wider area. The effects of long term displacement on inshore fisheries (see above) could be of adverse significance. The effects of long term displacement of offshore and beam trawler/dredging fisheries could be of negative significance.	The long term displacement of commercial fisheries (shellfish and fin fish) could be reduced or avoided by avoiding key commercial fishing grounds or by spacing of devices at wide enough intervals to permit use of mobile fishing gear.	**Negative to negligible**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Mariculture	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wave**	**Negligible**	Lough Foyle is a major area for shellfish production, notably bottom grown mussel. Any significant and prolonged rise in suspended solids could have a significant adverse on mussel growing areas. However, increases in suspended sediment is expected to be short term and localised to the immediate vicinity of the seabed disturbing works. Intrusion of sediment plumes into the lough would therefore only result if the export cables were routed in the immediate vicinity. It is therefore considered there could be a negligible impact from wave energy development.	Should cable trenching work be undertaken within the Lough, impacts could also be reduced by using procedures that minimise the mobilisation of suspended solids such as plough installation.	**Negligible**
	Accidental contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Wave**	**Significant adverse**	Shellfish are highly sensitive to reductions in water quality caused by hydraulic fluids or tainting from other chemical substances. There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Therefore, although the likelihood of accidental contamination from devices is low, the potential effects any significant intrusion of hydraulic fluids into Lough Foyle could be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, and contingency measures for device failure/component failures. It should be noted that the quantity of hydraulic fluid in devices is likely to be very small, reducing the potential for significant environmental effects. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Substratum loss	Operation	Devices using seabed foundations e.g. piled devices	**Wave**	**Significant adverse**	Area of interest for wave energy development does not overlap with shellfish production areas. Should cables be routed through marine fish farms this would be an effect of adverse significance.	The key mitigation measure in terms of reducing effects on shellfish farms is avoidance. In practice, consent is unlikely to be achievable to site renewable energy arrays or cables within existing fish farms.	**Negligible**
Ports, Shipping and Navigation	**Displacement of shipping movement**	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Wave**	**Significant adverse**	The re-routing of vessels to avoid safety zones (during installation), operational devices and decommissioning activity would result in greater transit time and use of fuel with the associated costs to the vessel operator, and could also lead to an increase in vessel densities in areas that already have moderate vessel densities. This could lead to increased encounter rates and increased risk of collision. Wave Resource Zone 1 is located in an unconstrained area of low shipping densities. However, the pattern of shipping density implies that vessels use regular routes which pass through the northern and western extent of the zone. Placement of devices in these areas could therefore displace shipping into adjacent areas, and would potentially be of adverse significance.	The potential for these effects to be reduced would depend entirely upon the siting of a device in relation to key shipping routes. There is potential to reduce or avoid significant adverse effects within this zone by siting devices where there is little or no shipping. The scale of potential effect on navigation should be assessed as part of the EIA and the Navigational Risk Assessment (NRA). The assessment should include: • A survey of vessels in the vicinity of the proposed development • Full NRA of the likely impact of the development on navigation, taking into consideration MGN 371 (MCA 2008) and MGN 372 (MCA 2008b) and the DTI Guidance Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (DTI 2005) (also considered relevant for other renewable devices). • Cumulative impact assessment	**Negligible**
		Operation	Wave devices	**Wave**	**Significant adverse**			
	Decreased trade/supply	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Wave**	**No effect**	The deployment of installation and maintenance vessels, presence of devices and decommissioning activity could create temporary to long-term reductions in access to ports and harbours. Wave Resource Zone 1 is located approximately 12km from the entrance to Lough Foyle and is unlikely to obstruct access to the Lough. It is therefore considered unlikely that siting devices within this zone would reduce access to ports and so there will be no effect on goods transport and accessibility.	N/A	**No effect**
		Operation	Wave devices	**Wave**	**No effect**			
	Reduced visibility	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wave**	**Negative**	Vessels and other equipment used during the installation of devices, and the operational devices themselves could obstruct views of other vessels and navigation features such as buoys, lights and the coastline. This is particularly important in areas of high vessel densities, constrained channels or areas where there is particular dependence on visual navigation aids as reduced	Negative effects associated with reduced visibly can be reduced by avoiding areas of high vessel densities and areas constrained by land e.g. adjacent to the mouth of Loughs.	**Negligible**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details: Phase	Device Details: Characteristic	Device Details: Type	Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Operation	Wave devices	**Wave**	**Negative**	isibility increases the risk of collision with other ships and other structures in the water (natural and man made). Wave Resource Zone 1 is not constrained by land and shipping densities are low but, as the pattern of shipping density implies, vessels use regular routes which pass through the northern and western extent of the zone. Therefore the effect of reduced visibility is likely to have a negative impact.	In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Any vessels and devices should be lit and marked in accordance with regulations and MCA and Trinity House guidance	
	Collision risk	Installation Decom	Vessels and equipment used for installation and Decommissioning	**Wave**	**Negative**	Collision risk considers the risk of navigating vessels colliding with vessels and equipment used during installation, maintenance and decommissioning, and the devices themselves once operational. Collision risk also considers the increased risk of collision between navigating vessels. In both circumstances the risk of collision is increased in constrained channels and areas with high vessel densities.	The risk of collision could be reduced by avoiding constrained areas or areas of high shipping densities and regularly used shipping routes. This could be achieved through locating devices in the centre of Wave Resource Zone 1 where there is little to no shipping. Near shipping routes, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning. The scale of potential effect on navigation should be assessed as part of the EIA and NRA as outlined above.	**Negligible**
		Operation	Wave devices	**Wave**	**Negative**	Wave Resource Zone 1 is located in a navigable, unconstrained area of low shipping densities. As mentioned previously, despite low shipping densities there appear to be distinct shipping routes located to the north and east of Wave 1, installation of devices in these locations may increase collision risk and would therefore have a potential negative effect.		
Recreation and Tourism	**Disturbance to Wildlife**	Installation Operation Decom	Installation activities including noise, vessel movements, operation of devices, decommissioning activities	**Wave**	**Negative**	Lough Foyle is the winter home to internationally important numbers of Whooper Swan, Brent Goose and Bar-tailed Godwit. Marine mammals and turtles are encountered in Lough Foyle, and kayak wildlife watching tours operate within the Lough. Whilst tourism within the Lough itself will not be directly affected by installation of wave turbines in the offshore area, any impacts on marine wildlife using the Lough would have a knock-on effect on eco tourism in the area.	With respect to tourism activities the main form of mitigation will be the avoidance of areas that are popular with tourists and wildlife tour operators. Other mitigation measures aimed at reducing or avoiding disturbance to wildlife including sea mammals and birds is set out in the relevant parts of this table.	**Negligible**
	Safety and Collision Risk	Installation Operation Decom	Presence of new structures in the water	**Wave**	**Negative**	The key receptor affected is sailing. General Sailing Areas and light recreational use cruising routes for vessels entering and leaving Lough Foyle are likely to overlap with Wave Resource Zone 1. Therefore there is potential for negative effects.	Safety measures including lighting and marking and informing users of the locations of devices. Locate devices away from cruising routes. Use alternative devices which lie below the surface of the water to a depth which does not affect sailing.	**Negligible**
	Access Restrictions	Installation Operation Decom	Structures in the sea reducing or excluding access	**Wave**	**Negative**	The key receptor affected is sailing. General Sailing Areas and light recreational use cruising routes for vessels entering and leaving Lough Foyle are likely to overlap with Wave Resource Zone 1. Therefore increasing the potential for negative effects.	Avoid cruising routes. Devices which exclude access to an area will have greater effects than those which allow movement through the array. Use alternative devices which lie below the surface at a depth which does not affect sailing.	**Negligible**
Military Exercise Areas	**Disruption to general activities**	Installation Operation	All wave devices	**Wave**	**Significant adverse to negligible**	The eastern half of this zone overlaps with area X5537 – Skerries. This area is used by the Navy for submarine exercises, aircraft and H.M ships. Dependent on the extent to which the area is used by the navy, significance of this effect could be considered to be significant adverse to negligible.	Consultation with the MOD will be required to enable appropriate site selection in order to reduce or eliminate the risk of interference associated with non-bylawed practice and exercise areas.	**Negligible**
Disposal Areas	**Disruption to access**	Installation Operation	All wave devices	**Wave**	**Significant adverse**	There is one open harbour spoil disposal site closely adjacent to Wave Resource Zone 1 and one well inshore. Long term access restrictions could result from device operation in close proximity to the site, with temporary access restrictions during device and cable installation.	Avoidance of the sites by approximately 500m can mitigate against the possibility of access to the sites in the area being inhibited for users.	**Negligible**
Cables and Pipelines	**Direct damage**	Operation Installation	All wave devices Cables	**Wave**	**Significant adverse**	The Hibernia Atlantic telecommunications cable runs through the northern end of the area for 14km. There is also a proposed telecommunications cable (Project Kelvin) operated by Hibernia which at the time of writing will be installed in summer 2009. This cable links the Hibernia Atlantic cable to mainland Northern Ireland and runs across the western extent of the study area for 14km. Direct damage to an existing cable would be most likely to occur during installation of device arrays and cables but also could occur maintenance phases. The potential effect would be significant adverse (should it occur) as international telecommunications could be seriously disrupted.	A 500m avoidance zone should be employed when selecting sites for marine renewable energy developments (in accordance with ICPC guidelines) and crossing agreements with existing infrastructure should be adhered to. These mitigation measures will eliminate or significantly reduce significance and likelihood of impacts on cables.	**No effect**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Reduced access	Operation Installation	All wave devices Cables	**Wave**	**Significant adverse**	There is potential that the presence of devices in waters close to existing cables could restrict access to the cables for maintenance purposes. The potential significance of this effect could be significant adverse.	A 500m avoidance zone should be employed when selecting sites for marine renewable energy developments (in accordance with ICPC guidelines) and crossing agreements with existing infrastructure should be adhered to. These mitigation measures will eliminate or significantly reduce significance and likelihood of effects on cables.	**Negligible**
Aggregate extraction	**Presence of devices**	Operation Installation	All wave devices	**Wave**	**Unknown / No effect**	There are no existing or proposed aggregate dredging areas within this area therefore there will be no effects on aggregate extraction. Impacts on possible future aggregate extraction sites, based on aggregate resources that have not yet been identified include restricted access to and sterilisation of possible sites. However these impacts are impossible to quantify at this stage.	None identified	**Unknown / No effect**
Oil and gas resources	**Presence of devices**	Operation	All devices	**Wave**	**Unknown**	The installation of wave devices has the potential to sterilise areas that could have been used for oil and gas exploitation. The Rathlin Basin which overlaps with this zone is identified as an area with oil and gas potential. However, there is currently insufficient data to establish possible future exploitation of oil and gas from this area. Therefore, whilst no sites are currently under consideration for oil and gas exploitation in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**
Natural Gas and CO_2 storage	**Presence of devices**	Operation	Piled devices	**Wave**	**Unknown**	The installation of piled wave devices has the potential to sterilise areas that could have been used for CO2 or natural gas storage. There is currently insufficient data to establish potential for use of the marine environment for storage of CO_2. Therefore, whilst no sites are currently under consideration for natural gas or CO_2 storage in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**
Landscape/seascape	**Effects on seascape**	Operation	Arrays of on-surface linear structures	**Wave**	**Moderate effect (between 5 and 15km offshore from coast)** **Slight effect (beyond 15km offshore from the coast)**	Wave Zone 1 is located to the North of the north Antrim Coast. Within this stretch of the coastline there are four main seascape types: • 5: Narrow coastal strip with raised hinterland – experiences elevated dramatic open and expansive views out to sea. Feels exposed. • 6: Complex indented coast, small bays and offshore islands – changing views from enclosed views associated with indented bays/ inlets to long expansive views from raised headlands and hinterland. • 7: Plateaus and high cliffs – dramatic seascape with open expansive and elevated views which contrast against vertical cliff faces arches and raised plateau. • 9: Giants Causeway – steep cliffs and small rocky bays, exposed, rugged and dramatic seascape with long open views. Parts of this coast are also covered by a number of designations these include: • Giant's Causeway World Heritage Site (WHS) – designated in 1986 in recognition of its geological and geomorphological values, its history of scientific study and its exceptional landscape values. There are extensive and dramatic vista's from the causeway out to sea and along the coast to the Donegal Mountains. Important tourist attraction. • Causeway Coast AONB – designated in 1998, this stretch of the north Antrim Coast is deemed to be one of the most dramatic stretches of coastline in Europe. The AONB includes the Giant's Causeway WHS. • North Derry AONB – this is located to the west of the main north Antrim Coast, adjacent to Lough Foyle. The potential effects of wave developments in this area would be negative (between 5 and 15km offshore) and negligible beyond 15m. This is due to the reduced visibility of wave arrays compared to offshore wind farms and a lower level of sensitivity of the seascape types (medium, except 9 which is high)	Potential adverse effects on seascape can be reduced through the sensitive siting of wave device arrays. Key factors to be considered in locating a wave array include: • Wave arrays should not be sited where they appear to block or close the entrance to bays/loughs/ narrows/sounds or where they separate a bay from the open sea; • Wave arrays should reflect the shape of the coastline and align with the dominant coastal edge; • Wave arrays should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate; • Wave arrays should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement; • Wave arrays should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms; • Consideration should be given to locating devices in already industrialised and developed seascapes.	**Slight effect**

Table 11.7: North Coast (Wave Resource Zone 1) – Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Landscape/seascape	**Effects on seascape**	Operation	Arrays of on-surface linear structures	**Wave**	**Significant effect (0 to 5km)** **Moderate effect (between 5 and 15km offshore from coast)** **Slight effect (beyond 15km offshore from the coast)**	Depending on the height to which devices protrude above the surface, there is the potential for large on surface wave point structures e.g. multi-point absorbers to have a significant adverse effect on seascape if located within 0 to 5km from the coast. Shoreline devices are also likely to have a significant adverse effect in this location due to the sensitivity and high value of the north Antrim Coast landscape/seascape.	Potential adverse effects on seascape can be reduced through the sensitive siting of wave device arrays. Key factors to be considered in locating a wave array include: • Wave arrays should not be sited where they appear to block or close the entrance to bays/loughs/ narrows/sounds or where they separate a bay from the open sea; • Wave arrays should reflect the shape of the coastline and align with the dominant coastal edge; • Wave arrays should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate; • Wave arrays should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement; • Wave arrays should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms; Consideration should be given to locating devices in already industrialised and developed seascapes.	**Moderate to slight effects**
Climate	Carbon Impacts	Operation	Wind turbines	**Wind**	**Positive**	It is recognised that development of offshore wind farms will contribute towards achieving the Northern Ireland target for 40% energy to be provided from renewable energy sources. In meeting this target the Northern Ireland Assembly will be working towards the wider national, European and international commitment to combat global climate change and reduce the potential associated adverse environmental effects e.g. changing population distributions, species extinction, sea level rise etc. However, whilst seeking to combat climate change there is also a need to respond to it in terms of: • Protecting the existing environment and increasing its robustness and ability to adapt to climate change • Protecting existing and future infrastructure from effects of climate change e.g. increased storm events , flooding and sea level rise	Ensure that coastal infrastructure is sited in locations that are at lower risk from flooding, sea level rise and storm damage and do not increase the risk of flooding or damage to coastal infrastructure elsewhere. This will require close consultation at the project design stage with the relevant land use planning authority.	**Positive**
	Carbon Storage	Installation Operation	Wind turbines	**Wind**	**No effect**	Based on current available information no existing or proposed carbon or gas storage sites have been identified within this area (Offshore Wind Resource Zone 1) therefore there will be no effect resulting from the development of offshore wind farms.	None required	**No effect**

Table 11.8: North Coast (Tidal Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Bathymetry	**The information presented in this chapter has been used to inform the results of the assessment. No specific impacts on bathymetry are expected.**							
Geology, geomorphology and sediment processes	**Changes in seabed morphology**	Installation	Tidal devices Export cables	**Tidal**	**Negative**	The seabed offshore of Lough Foyle is composed of sand and gravel that rests on glacial marine mud. The seabed is largely unremarkable. Tidal devices will induce local scour around its base which will alter the seabed morphology locally. Cables should have negligible impact to the seabed morphology. The presence of the structures on the seabed will alter the hydrodynamics locally which will impact on the sediment transport regime locally.	Reduce the impacts of local sour by locating the turbines in areas where the amount of sediment available for mobilisation and transport is low. Potential effects of local scour on sediment transport will need to be assessed through morphological site surveys and hydrodynamic/sediment transport modelling at the project stage. Site specific geophysical and geotechnical survey will be required to establish a baseline and inform the impact assessment for individual developments.	**Negligible**
	Changes in coastal processes	Operation	Devices using energy generated by waves or tidal currents	**Tidal**	**Negligible**	The physical presence of devices on the seabed, and removal of tidal energy can cause localised scour and hydrodynamic changes. It is estimated that such changes will extend up to 50 m from devices and is therefore localised to the vicinity of the device array, but will be effective for the operational life of the device. Removal of tidal energy will not adversely alter the coastal process providing that the tidal array is located sufficiently offshore and outside the zone of active alongshore sediment transport. The proposed Tidal Resource Zone 1 is located more than 7km offshore and therefore will present no significant impact at the coastline.	The degree of potential impacts depends on the process (floating or fixed structures), how closely individual devices are spaced, and how far offshore the plant is located. Careful site selection is key to keeping impacts to a minimum. Modelling the effects of device operation on the tide and wave regime should form part of pre-project activities to optimise location.	**Negligible**
Seabed Contamination and Water Quality	**Accidental contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel cargo / fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Where quantities spilled are small it is unlikely that water quality will be adversely affected as contaminants will weather and disperse. Significant spillages may affect coastal and inshore waters. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects in this area would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Disturbance of contaminated sediment	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse to Negative**	There are two active harbour dredging spoil disposal sites inshore of Tidal Resource Zone 1 which could potentially be disturbed during cable installation. Contamination arising from disturbance may have a negative effect on local water quality, including within Lough Foyle. Munitions relict from wartime activities (e.g. wrecks or minelaying) or from the adjacent weapons range may be encountered. Disturbance could result in Significant adverse effects.	Effects on water quality due to the disturbance of contaminated sediment can be reduced through avoidance of potentially contaminated seabed areas (500m buffer). Identification and avoidance of areas of munitions contamination through site survey at the project stage. If munitions are encountered follow guidance in Crown Estates 2006 (Dealing with munitions in marine aggregates).	**Negligible**
Protected Sites and Species	**Impacts on protected sites**	Installation Operation	Marine devices	**Tidal**	**Negative to negligible**	Tidal Resource Zone 1 does not overlap with any existing or potential offshore protected sites. An area of PAIH rocky reef is located 500m from the zone. Rocky reefs are extremely variable both in structure and the communities they support. Reefs are usually characterised by communities of attached algae and invertebrates, usually including a range of mobile animals such as fish. Depending on the location of any installation, potential impacts could affect the habitat directly or indirectly (through increased suspended sediment and turbidity, and smothering). This would be an issue both for the habitat itself and the communities supported. The nearshore area between Ramore Head and Benbane Head is also under consideration as a marine SAC for skerries, reefs, sandbanks and caves. This site could potentially be impacted by export cable installation.	Site specific survey at the project stage could identify the extent of any sensitive / protected habitats within the rocky reef PAIH in the northern portion of the zone. Impacts on protected areas could be mitigated by careful site selection avoiding sensitive sites for devices and export cables (i.e. existing and proposed protected sites). Impacts may still arise through indirect impacts on sediment movements during installation and operation, and would need to be assessed in more detail at the project stage. Possible mitigation measures relevant to the specific interest features of the sites and their seasonal and other sensitivities are described elsewhere in this table for the relevant topic areas.	**Negative to Negligible**
	Impacts on protected species	Installation Operation	Marine device	**Tidal**	**Significant adverse**	Although there are no protected sites designated for specifically for species within Tidal Resource Zone 1,(site designations in the area apply to habitats and geological formations) , a number of protected species including marine mammals, seals, seabirds and fish are found throughout the region, as are important benthic species. The impacts on these receptors are discussed in the relevant sections of the table below.	See sections below on benthic ecology, fish and shellfish, seabirds and marine mammals.	**Negative to Negligible**

Table 11.8: North Coast (Tidal Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Benthic and Intertidal Ecology	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenches	**Tidal**	**Negative**	Tidal Resource Zone 1 is located in an area of offshore sand and gravel. Disturbed sediments are predicted to be dispersed rapidly especially in areas with higher tidal flows. Adjacent sand bank benthic species are considered to be robust and either adapted to perturbed environments or highly mobile and resistant to temporary smothering. Species in nearshore adjacent PAIH rocky reef habitat are robust to low levels of smothering including *Sabellaria spinulosa* reef. Smothering impacts will be localised to the immediate vicinity of the seabed disturbing activities during installation.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (such as gravity bases). Potential effects on unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
Benthic and Intertidal Ecology	**Contamination – from sediment disturbance**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negligible**	There are no recorded disposal sites within Tidal Resource Zone 1; however two sites, one offshore one inshore may be disturbed during ancillary operations (e.g. cable installation). Contamination arising from disturbance of the offshore site is likely to rapidly disperse with negligible effect.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (such as gravity bases). Avoidance of areas of known potential contamination for seabed disturbing works. Potential effects on areas of unknown benthic habitat will need to be assessed through site survey at the project stage.	**Negligible**
	Accidental contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Where quantities spilled are small it is unlikely that water quality will be adversely affected as contaminants will weather and disperse. Significant spillages may affect coastal and inshore waters. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects in this area would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan). Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
	Changes in tidal flow	Operation	Devices that extract energy generated by tidal currents	**Tidal**	**Significant adverse**	Tidal Resource Zone 1 is located in an area of offshore sand and sandy gravel. There is currently a data gap for benthic information in this area. Maerl beds, tidal rapid and reef habitats are all highly sensitive to changes in tidal flow, and may be present in the area. Given the potential for these UKBAP habitats to be present in tidal resource areas, the effects could potentially be of adverse significance	Avoidance of these important habitats though careful site selection would reduce the potential effects of energy extraction, although it may not be possible for these effects to be removed completely. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negative**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	All benthic communities can be expected to be sensitive to removal of their habitat. The long term loss of substratum due to the presence of devices that are attached to the seabed will therefore have a potentially significant adverse effect on any rare or important benthic habitats, such as those listed in the UKBAP and protected under the Habitats Directive.	Effects on benthic ecology from substratum loss can be reduced either through avoidance (careful site selection) or using devices that have a smaller footprint on the seabed e.g. anchored devices, or clump weights. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
Fish and Shellfish	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative**	Tidal Resource Zone 1 is within an area which supports scallops, whilst far outside of the zone, closer to shore, populations of lobster, edible crab and velvet crab can be found. These species live on, near or in the bottom sediments of the seabed. Sprat and herring are also known to spawn in the area. These species range from low to high sensitivity to smothering, although this impact will be localised to the immediate vicinity of seabed disturbing activities and limited to during installation.	For devices that require piling, and cable trenching, potential effects could be mitigated by avoiding installation during the sprat spawning season (May to August) and herring spawning (August – September) and avoidance of key shellfish areas.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	High levels of noise such as during pile installation may cause physiological or displacement effects to marine fish although the extent to which this may occur is unknown. In particular, herring and cod are known to be highly sensitive to noise and may be able to detect piling noise up to 80km. Both species are	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive spawning periods.	**Negligible to negative**

Table 11.8: North Coast (Tidal Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**	present in the study area and therefore may be present in Tidal Resource Zone 1, although herring generally only occurs in coastal waters (0 to 20m). It is expected that noise levels from piling and the removal of piled devices will be greater than those generated by operational devices, and although pile driving only occurs during installation the effects may last for longer than the piling activities as fish may not immediately return to the area. There is potential for noise from operational devices to lead to longer term species displacement which could increase pressures on fish populations in other locations and force fish into predator habitats.	No specific mitigation measures have been identified	**Unknown**
	Collision risk	Operation	Turbines/moving part of devices / mooring chains and cables	**Tidal**	**Unknown**	There is potential risk that all mobile fish species could collide with turbines or moving parts of submerged devices. Larger animals (such as basking sharks (UKBAP species)), and pelagic species are considered to be of greater risk. Basking shark and other pelagic fish species are present throughout the study area, and will be present within Tidal Resource Zone 1. However, due to uncertainties with data and knowledge on the interactions between fish and devices, the potential significance of collision risk effects is unknown.	Potential effects associated with collision risk and fish could be reduced through device design e.g. use of protective nets or grids. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**Unknown**
	Hydraulic injury	Operation	Shrouded devices (i.e. venturi devices)	**Tidal**	**Unknown**	There is potential risk that mobile fish could suffer injury or mortality through pressure changes occurring within the turbine as water is sucked through it. This effect is only relevant for shrouded tidal devices such as venturi devices, which use shrouding to constrict the flow, thus leading to a pressure low after the constriction. This effect is likely to be more significant for smaller species. Larger species sucked through the turbine would be more likely to suffer collision impacts.	Possible impacts associated with shrouded turbines can be addressed by using screens to prevent marine organisms from entering the device. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**No impact**
Fish and Shellfish	**Accidental contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Small spillages are likely to have a negligible impact. Large spillages, particularly where they impinge on the coastline or enter Lough Foyle could have a significant adverse impact.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Tidal**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. In terms of demersal species this effect would only apply to devices using seabed foundations. For pelagic species the position of submerged devices in the water column and the proportion of the water column occupied would be most relevant. Due to the vast number of variables associated with device types and the types of fish that could be affected it is not possible to determine the potential significance of this effect. However, the presence of tidal arrays may also have a positive effect on fish populations through fish stock recovery, should certain types of fisheries be excluded from the array.	No specific mitigation identified	**Unknown**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative**	Tidal Resource Zone 1 is close to a small area which supports scallops, whilst far outside of the zone, closer to shore, populations of lobster, edible crab and velvet crab can be found. These species live on, near or in the bottom sediments of the seabed, and are therefore sensitive to substratum loss. Sprat and herring are also known to spawn on the seabed in the area. Removal of habitat during installation and operation of tidal turbines could result in the long term removal of the habitat used by these species, although alternative adjacent habitat may be available.	The potential effects of substratum loss on shellfish and benthic spawners could be reduced by avoiding sensitive areas e.g. shellfish beds and key spawning grounds, or using devices that use less intrusive seabed attachment such as anchors or clump weights.	**Negative to negligible**
Fish and Shellfish	**Barrier to movement**	Operation	Devices that occupy the water column	**Tidal**	**Unknown**	Some species, such as Atlantic salmon, trout and eels spend part of their lifecycle in freshwater and part at sea. Migration between these two waterbodies is important for the survival of the species. The zone may be used by these species accessing the rivers Foyle, Roe, Lower Bann and Bush located on the adjacent coastline which are known to contain populations of salmon and sea trout. The presence of wind devices could present a barrier to migration, although the exact impacts on fish species is unknown.	No specific mitigation identified	**Unknown**

Table 11.8: North Coast (Tidal Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Fish and Shellfish	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown - negligible**	Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical renewable array power cable, but the field would not cause an avoidance reaction. Atlantic salmon, eels and Sea Trout are believed to be sensitive to magnetic fields. However, the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables. There is no evidence to indicate that existing cables have caused any significant effect on migration patterns of these species. However, the significance of potential effects cannot be adequately quantified on the basis of current information.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown to negligible**
Marine Birds	**Physical disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Significant adverse to negative**	Physical disturbance is of particular importance in terms of breeding colonies as high levels of physical disturbance could lead to species displacement (short-term to long-term). Physical disturbance is also important in terms of foraging and loafing at sea. This area does not overlap with any sensitive areas for seabirds, but there are a number of seabird colonies along the adjacent coastline, and the Ramore Head and the Skerries ASSI is important for breeding seabirds. The effect of physical disturbance is potentially of adverse significance for breeding colonies and negative significance for feeding and loafing areas which extend beyond the ASSI and coastal area.	Effects on breeding bird colonies could be reduced by avoiding sensitive sites and to restricting installation to avoid the most sensitive seasons e.g. breeding. In some parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and or loafing areas and to aid site selection.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Tidal**	**Negative**	Based on studies of bird behaviour on land it is evident that they have acute hearing. Noise disturbance impacts are possible both during installation and operation. The noisiest activity associated with tidal device installation is piling of monopole foundations. However, there is limited understanding of birds ability to hear underwater. Therefore, it is not possible to determine the level of significance of operational noise effects on marine birds.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive periods such as breeding or moulting.	**Negligible**
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**		No specific mitigation identified	**Unknown**
	Collision risk	Installation Operation Decom	Installation and decommissioning vessels; Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown**	The area is not considered to be of high importance for breeding seabirds, although the Ramore Head and the Skerries ASSI is within 13km of the zone identified, and is important for breeding seabirds. There are also a number of seabird colonies along the adjacent coastline to this zone. Therefore, it is likely that the offshore area will be used by seabirds for foraging and loafing. All species of marine birds present within the zone are potentially sensitive to collision impacts. Of these, the divers and pursuit divers are considered to be the most sensitive. Due to limitations in knowledge on the interactions between marine birds and devices with moving parts, it is difficult to determine the potential significance of this effect which potentially has implications for all surface and diving birds.	During construction appropriate mitigation includes avoidance of sensitive sites and seasons; increasing vessel visibility; avoiding night working. During operation visibility of above water and below water structures could be increased. In many parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and to aid site selection. Potential effects associated with collision risk could also be reduced through device design e.g. use of protective nets or grids.	**Unknown**
	Accidental contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. All surface birds are sensitive to hydraulic fluid contamination, and in particular auks (regularly occurring migratory birds – Article 4.2 Birds Directive) and divers (Annex 1 – Birds Directive) are highly sensitive to this effect. The waters of Northern Ireland are known to contain a number of auks and divers including common guillemot, razorbill and red throated divers. Whilst there are no protected areas designated for these species which overlap with the zone of interest, it is likely that they will occur in the region, using the offshore area for foraging and loafing. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine birds would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**

Table 11.8: North Coast (Tidal Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Marine Birds	**Habitat exclusion**	Operation	Devices that occupy water surface and water column	**Tidal**	**Negative**	Locating devices in areas used for foraging and loafing could result in habitat exclusion and possible species displacement. There is limited information on precise foraging and loafing "hotspots" for different species of marine birds. Birds could be displaced from an area wider than the array site due to their potential avoidance responses. There are no protected bird areas (SPAs) in close proximity with Tidal Resource Zone 1, although birds from the adjacent coastline may be present in the zone. Although birds are mobile and could therefore avoid devices, the potential effects of increasing competitive pressures on adjacent populations and energetic costs of site avoidance also need to be considered.	Effects on breeding bird colonies could be reduced by avoiding sensitive sites e.g. SPAs and areas close to seabird colonies. In some parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and or loafing areas and to aid site selection.	**Negligible**
Marine Mammals	**Physical Disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Negative**	Portrush and Portballintrae are both areas with high rates of cetacean sightings. Harbour porpoise (Annex II –Habitats Directive) are frequently sighted in this area and it is known to be a foraging area. Harbour porpoise calves have also been seen in this area. Minke whales and bottlenose dolphins (Annex II –Habitats Directive) are seen here occasionally. Grey and common seals (Annex II –Habitats Directive) also use the area. However it is unknown how important this area is to both cetaceans and seals. Increased boat traffic will also increase ambient noise in the area and may disturb marine mammals, although, as described below, collisions are unlikely given the speed at which construction vessels will be moving.	The relative importance of this area for seals and cetaceans is unknown therefore monitoring surveys would be required to design a suitable mitigation plan. The effects of installation activities on seal colonies could be reduced by avoiding the breeding and moulting seasons. Cable routing should be planned to avoid impacting on seal breeding colonies or haul out sites.	**Negligible to negative**
	Marine Noise	Installation	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	Piling generates high levels of noise. Studies at wind farms have demonstrated an effect on porpoise distribution during construction with animals displaced up to 15km. Noise can mask signals used by cetaceans to navigate, locate prey, and communicate effectively. Seals and cetaceans can detect piling noise up to a distance of 80km. Behavioural responses and physiological impacts such as temporary or permanent threshold shift in hearing could occur at closer distances. It is also quite possible that these noise sources mask biological relevant signals within the zone of audibility. The potential for noise from piling to affect these marine mammals is therefore considered to be "significant adverse". It is possible that minke whales detect wind farm related noise at considerable distances, (tens of km) during pile driving. Increased shipping associated with installation will also raise ambient noise levels in the area.	At sea distribution data for seals is unknown for this area. Also cetacean abundance and habitat usage is unknown therefore dedicated marine mammal surveys would be required to identify the most appropriate site for development and to design adequate mitigation measures The use of gravitational concrete foundations is an alternative to piling but is only suitable in certain conditions. Seasonal or area restrictions could also be imposed so piling activities would be timed not to coincide with sensitive times such as seal moulting or pupping and porpoise breeding seasons. To mitigate for noise disturbance during piling there are a range of measures including the use of Marine Mammal Observers, exclusion zones, passive acoustic monitoring, pingers, soft starts/ramp up and/or bubble curtains. The efficacy of many of these procedures has not been proven to date.	**Significant adverse to Negative**
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**	Effects of operational noise from tidal energy devices are unknown and may vary substantially with device design. There may be cumulative effects when many devices are operating together or when combined with other noise sources such as operational noise from nearby wind farms.	Noise from operating tidal energy devices are unknown and are likely to vary according to device design. Mitigation measures will need to be device specific and as yet proven techniques are unknown.	**Unknown**
Marine Mammals	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Negligible**	Marine mammals can potentially collide with vessels and equipment used during installation. Increased shipping activity transiting to the area during installation will increase this risk. Generally most fatal injuries arise with collisions with ships travelling over 14 knots. Vessels associated with construction activities would usually not be travelling at these speeds..	Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals both during construction activities and in transit to the construction area if entering areas of high animal abundance.	**Negligible**

Table 11.8: North Coast (Tidal Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details: Phase	Device Details: Characteristic	Device Details: Type	Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Operation	Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown to significant adverse**	Collision risk with tidal energy devices is unknown for seals and cetaceans and the level of risk would depend on device design. However, for turbines with moving parts there is a clear collision risk for marine mammals, which could potentially be significant adverse for tidal devices, although further study is needed to better understand this impact. Collision with moving parts and fixed cables may also be a concern for baleen whales such as minke which may not detect the presence of these in the water and do not have the manoeuvrability of smaller cetaceans. However, the importance of this area to minke whales is unknown so the collision risk is difficult to quantify.	Collision risk during operation could be minimised through enhancing the visibility of marine devices to marine mammals, to maximise the possibility that the animals could detect it in time to react and avoid it. Consider potential measures to increase the acoustic visibility of undersea cables to marine mammals. New developments in active acoustic technology (e.g. sonar) are currently underway and may provide a potential monitoring and mitigation measure for operating turbines in the future.	**Unknown to negative**
	Accidental contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on marine mammal health. Offshore tidal energy devices could present a collision risk to shipping. A collision between ships or a ship and a tidal device could result in fluid spills which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine mammals would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Tidal**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. Devices may exclude mammals from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. It is not possible to determine the potential significance of this effect.	No specific mitigation identified	**Unknown**
	Barrier to movement	Operation	Devices	**Tidal**	**Unknown to negative**	Overall the movement of marine mammals around the coast of Northern Ireland is unknown so barrier effect is difficult to quantify. Impacts associated with barriers to movements are likely to be most significant where device arrays are located in constrained areas such as the entrance to Lough Foyle, as this may restrict marine mammal movement to and from the Lough. Tidal Resource Zone 1 is located 20 km offshore of the entrance to Lough Foyle, in relatively open waters. Whilst it could potentially affect animals entering and leaving the Lough, there are unrestricted areas of sea either side of the zone which could potentially be utilised by the animals as an alternative route.	The key mitigation measure for the impact is careful site selection to avoid key transit routes in and out of sea Loughs and other constrained areas. These areas are currently not well understood. Detailed study would be required to examine marine mammal distribution around the coast in order to fully understand and mitigate for this risk.	**Unknown to negligible**
Marine Mammals	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown - negligible**	The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains a complicated, understudied and unproven field of science (Basslink, 2001), with only circumstantial evidence. Cetaceans cross cables constantly, and there is no apparent evidence that existing electricity cables have influenced migration of cetaceans. However further study is thought warranted by the scientific community in this field (Gill *et al*., 2005). It should also be borne in mind that the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown to negligible**
Marine Reptiles	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Unknown**	The importance of the coast of Northern Ireland to marine turtles is unknown but there have been sightings of leatherback and loggerhead turtles. Turtles have been seen off the Portrush area. There is no information on the effects of tidal device construction on marine turtles so the risk is difficult to quantify.	Possible mitigation includes planning installation to take place at times when there are fewer turtles present or avoid potential migration routes.	**Unknown**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown**	There is no information on the effects of tidal devices on marine turtles so the risk is difficult to quantify		**Unknown**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on turtle health. Tidal energy devices could present a collision risk to shipping. A collision between ships or a ship and a tidal energy device could result in an oil spill which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine reptiles would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**

Table 11.8: North Coast (Tidal Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Barrier to movement	Operation	Devices	**Tidal**	**Unknown**	The movement of marine turtles around the coast of Northern Ireland is unknown so it is difficult to quantify the level of barrier effect.	Mitigation measures to deal specifically with potential risks to marine turtles from offshore wind developments are unknown.	**Unknown**
Marine and coastal archaeology and wrecks	**Effects on submarine historic environment**	Installation	Piling, dredging, placing structures on seabed, cables, coring	**Tidal**	**Neutral**	There is considerable archaeological and heritage interest in this area with a high potential for presence of prehistoric submarine remains. PMRA protected aircraft wrecks may be present and numerous miscellaneous wrecks have been reported in the area. The wreck of the La Girona, which is designated under the Protection of Wrecks Act, can also be found close by at Lacada Point. There is potential for the installation of tidal devices and export cables to impact submarine archaeology through direct disturbance of known and unknown sites on the seabed, or through changes to sediment movements causing an artefact to become buried and preventing later discovery. There is also a potential positive impact associated with development related seabed survey providing additional data for inclusion in the archaeological record in the area.	Follow NIEA and Crown Estates 2007 JNAPC code of conduct and guidance note for the offshore renewable energy sector. Carry out seabed investigations in preferred site locations prior to device installation. Avoid sites of interest and exclusion zones for protected sites.	**Neutral**
	Effects on coastal and terrestrial historic environment	Installation	Cables, shoreline devices	**Tidal**	**Significant adverse to Negative**	The adjacent coastline contains a number of sites and features listed on the sites and monuments record, including an anti-aircraft battery at Magillian Point which is a Scheduled Monument, and Martello Tower on Magillian Point which is designated as being under state care. These historic sites could potentially be impacted during export cable installation. Cable installation in the vicinity of these protected sites could cause direct destruction of archaeologically important features.	The main form of mitigation is to avoid protected and other sites of interest. In addition to desk based studies it will be necessary to carry out field walkovers in preferred site locations to determine need for site investigations (geophysical surveys/trial trenching) in consultation with NIEA, Local Authorities and the Department of the Environment, Heritage and Local Government of the Republic of Ireland. With respect to cabling there is considerable opportunity to avoid or reduce effects. The siting and design of shoreline devices will be important in determining their residual impact.	**Negligible**
Commercial Fisheries	**Direct disturbance of fishing grounds**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative to Significant adverse**	Commercial shellfish areas are most sensitive to direct disturbance as shellfish are generally much less mobile than fin fish. Inshore finfish grounds are also sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. The key commercial shellfish in this area is king scallop. Tidal Resource Zone 1 coincides directly with the main scallop fishing and finfish trawling areas, but may be limited to a small area in relation to overall area of fishing grounds. Development will therefore have a potentially negative significance effect on the fishing grounds. In terms of commercial fisheries this effect could potentially be of adverse significance.	In terms of direct disturbance to commercial shellfisheries and fin fisheries, the main form of mitigation would be to avoid key commercial fishing grounds. The effects could also be minimised by using devices that use less intrusive forms of attachment e.g. gravity bases.	**Negative to negligible**
	Temporary displacement from traditional fishing grounds	Installation Decom	Vessels, installation equipment and devices	**Tidal**	**Negative**	Inshore fishing grounds tend to be more constrained than offshore areas. Temporary displacement from these areas may lead to the concentration of fishermen in smaller areas, fishermen being unable to fish for short periods or fishermen being displaced to alternative, possibly less productive fishing grounds. Tidal Resource Zone 1 coincides directly with the main scallop fishing and finfish trawling areas, but may be limited to a small area in relation to overall area of fishing grounds. Temporary displacement will potentially have a negative significance effect on commercial fisheries.	Effects associated with the temporary displacement of traditional fishing grounds can be reduced by avoiding key commercial fishing grounds or by phasing construction activities to specific areas within Tidal Resource Zone 1. Liaison with the fishing community to keep them informed of installation operations is also key to managing the level of this impact.	**Negative to negligible**
	Long term displacement from traditional fishing grounds	Operation	Devices that occupy water surface, water column and seabed	**Tidal**	**Negative to Significant adverse**	All types of commercial fisheries could be affected by long term displacement from traditional fishing grounds. The key bottom trawl fisheries in Tidal Resource Zone 1 include cod, plaice, lemon sole, ray and skate. King scallops are exploited by mechanical dredging gear. The potential effects could be of adverse significance for spatially constrained inshore fisheries and for bottom trawl and dredge fisheries which may be restricted by cable routes. Use of rock armour, if required for cable protection, could introduce an obstruction for trawling activity, but could also create new habitat which could have a positive impact of fish stocks. In addition, long term exclusion of mobile gear from the area could be of benefit to fish stocks in the wider area. The effects of long term displacement on inshore fisheries (see above) could be of adverse significance. The effects of long term displacement of offshore and beam trawler/dredging fisheries could be of negative significance.	The long term displacement of commercial fisheries (shellfish and fin fish) could be reduced or avoided by avoiding key commercial fishing grounds or by spacing of tidal devices at wide enough intervals to permit use of mobile fishing gear.	**Negative to negligible**

Table 11.8: North Coast (Tidal Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Mariculture	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negligible**	Lough Foyle is a major area for shellfish production, notably bottom grown mussel. Any significant and prolonged rise in suspended solids could have a significant adverse on mussel growing areas. However, increases in suspended sediment is expected to be short term and localised to the immediate vicinity of the seabed disturbing works. Intrusion of sediment plumes into the lough would therefore only result if the export cables were routed in the immediate vicinity. It is therefore considered there could be a negligible impact from tidal energy development.	Should cable trenching work be undertaken within the Lough, impacts could also be reduced by using procedures that minimise the mobilisation of suspended solids such as plough installation.	**Negligible**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	Shellfish are highly sensitive to reductions in water quality caused by hydraulic fluids or tainting from other chemical substances. There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Therefore, although the likelihood of accidental contamination from devices is low, the potential effects any significant intrusion of hydraulic fluids into Lough Foyle could be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, and contingency measures for device failure/component failures. It should be noted that the quantity of hydraulic fluid in devices is likely to be very small, reducing the potential for significant environmental effects. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Substratum loss	Operation	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	Area of interest for tidal energy development does not overlap with shellfish production areas. Should cables be routed through marine fish farms this would be an effect of adverse significance.	The key mitigation measure in terms of reducing effects on shellfish farms is avoidance. In practice, consent is unlikely to be achievable to site renewable energy arrays or cables within existing fish farms.	**Negligible**
Ports, Shipping and Navigation	**Displacement of shipping movement**	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Tidal**	**Negligible**	The re-routing of vessels to avoid safety zones (during installation), operational devices and decommissioning activity would result in greater transit time and use of fuel with the associated costs to the vessel operator, and could also lead to an increase in vessel densities in areas that already have moderate vessel densities. This could lead to increased encounter rates and increased risk of collision. Within Tidal Resource Zone 1 shipping intensity is negligible and so installation of tidal devices is unlikely to displace shipping. The effect of re-routing vessels would be negligible.	The scale of potential effect on navigation should be assessed as part of the EIA and the Navigational Risk Assessment (NRA). The assessment should include: • A survey of vessels in the vicinity of the proposed development • Full NRA of the likely impact of the development on navigation, taking into consideration MGN 371 (MCA 2008), MGN 372 (MCA 2008b) and the DTI Guidance Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (DTI 2005) (also considered relevant for other renewable devices). • Cumulative impact assessment	**No effect**
		Operation	Tidal devices	**Tidal**	**Negligible**			
	Decreased trade/supply	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Tidal**	**No effect**	The deployment of installation and maintenance vessels, presence of devices and decommissioning activity could create temporary to long-term reductions in access to ports and harbours. Tidal Resource Zone 1 is located approximately 20km from the entrance to Lough Foyle and is unlikely to obstruct access to the Lough. It is therefore considered unlikely that siting devices within this zone would reduce access to ports and so there will be no effect on goods transport and accessibility.	N/A	**No effect**
		Operation	Tidal devices	**Tidal**	**No effect**			
	Reduced visibility	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**No effect**	Vessels and other equipment used during the installation of devices, and the operational devices themselves could obstruct views of other vessels and navigation features such as buoys, lights and the coastline. This is particularly important in areas of high vessel densities, constrained channels or areas where there is particular dependence on visual navigation aids as reduced visibility increases the risk of collision with other ships and other structures in the water (natural and man made). Tidal Resource Zone 1 is not constrained by land and shipping densities are negligible so reduced visibility is likely to have no impact.	N/A	**No effect**
		Operation	Tidal devices	**Tidal**	**No effect**			
	Collision risk	Installation Decom	Vessels and equipment used for installation and Decommissioning	**Tidal**	**Negligible**	Collision risk considers the risk of navigating vessels colliding with vessels and equipment used during installation, maintenance and decommissioning, and the devices themselves once operational. Collision risk also considers the increased risk of collision between navigating vessels. In both circumstances the risk of collision is increased in constrained channels and areas with high vessel densities. Tidal Resource Zone 1 is located in a navigable, unconstrained area of negligible shipping densities where collision risk is low. The risk of collision in this area would be negligible.	Potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning. The scale of potential effect on navigation should be assessed as part of the EIA and NRA as outlined above.	**Negligible**
		Operation	Tidal devices	**Tidal**	**Negligible**			

Table 11.8: North Coast (Tidal Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Recreation and Tourism	Disturbance to Wildlife	Installation Operation Decom	Installation activities including noise, vessel movements, operation of devices, decommissioning activities	**Tidal**	**Negative**	Lough Foyle is the winter home to internationally important numbers of Whooper Swan, Brent Goose and Bar-tailed Godwit. Marine mammals and turtles are encountered in Lough Foyle, and kayak wildlife watching tours operate within the Lough. Whilst tourism within the Lough itself will not be directly affected by installation of tidal turbines in the offshore area, any impacts on marine wildlife using the Lough would have a knock-on effect on eco tourism in the area.	With respect to tourism activities the main form of mitigation will be the avoidance of areas that are popular with tourists and wildlife tour operators. Other mitigation measures aimed at reducing or avoiding disturbance to wildlife including sea mammals and birds is set out in the relevant parts of this table.	**Negligible**
	Safety and Collision Risk	Installation Operation Decom	Presence of new structures in the water	**Tidal**	**Negative**	The key receptor affected is sailing. General Sailing Areas and light recreational use cruising routes for vessels entering and leaving Lough Foyle are likely to overlap with Tidal Resource Zone 1. This could potentially have a negative effect on recreational sailing.	Safety measures including lighting and marking and informing users of the locations of devices. Locate devices away from cruising routes. Use alternative devices which lie below the surface of the water to a depth which does not affect sailing.	**Negligible**
	Access Restrictions	Installation Operation Decom	Structures in the sea reducing or excluding access	**Tidal**	**Negative**	The key receptor affected is sailing. General Sailing Areas and light recreational use cruising routes for vessels entering and leaving Lough Foyle are likely to overlap with Tidal Resource Zone 1, This could potentially have a negative effect on recreational sailing.	Avoid cruising routes. Devices which exclude access to an area will have greater effects than those which allow movement through the array. Use alternative devices which lie below the surface at a depth which does not affect sailing.	**Negligible**
Military Exercise Areas	**Disruption to general activities**	Installation Operation	All tidal devices	**Tidal**	**Significant adverse to Negligible**	The entire area lies within the military practice and exercise area X5537 - Skerries. This area is used by the Navy for submarine exercises, aircraft and H.M ships. Dependent on the extent to which the area is used by the navy, significance of this effect could be considered to be significant adverse to negligible.	Consultation with the MOD will be required to enable appropriate site selection in order to reduce or eliminate the risk of interference associated with non-bylawed practice and exercise areas.	**Negligible**
Disposal Areas	**Disruption to access**	Installation Operation	All Tidal devices	**Tidal**	**Negative**	There are two harbour spoil disposal sites inshore of Tidal Resource Zone 1, and none within the site itself. Export cable installation could potentially be undertaken in the immediate vicinity, resulting in a temporary access restriction during installation. It is unlikely that operation will affect access to these sites.	Avoidance of the sites by approximately 500m can mitigate against the possibility of access to the sites in the area being inhibited for users.	**Negligible**
Cables and Pipelines	**Direct damage**	Operation Installation	All tidal devices Cables	**Tidal**	**No effect**	There are no cables or pipelines in the study area therefore no impacts are expected.	None required	**No effect**
	Reduced access	Operation Installation	All tidal devices Cables	**Tidal**	**No effect**	There are no cables or pipelines in the study area therefore no impacts are expected.	None required	**No effect**
Aggregate extraction	**Presence of devices**	Operation Installation	All tidal devices	**Tidal**	**Unknown / No effect**	There are no existing or proposed aggregate dredging areas within this area therefore there will be no effects on aggregate extraction. Impacts on possible future aggregate extraction sites, based on aggregate resources that have not yet been identified include restricted access to and sterilisation of possible sites. However these impacts are impossible to quantify at this stage.	None identified	**Unknown / No effect**
Oil and gas resources	**Presence of devices**	Operation	All tidal devices	**Tidal**	**Unknown**	The installation of tidal devices has the potential to sterilise areas that could have been used for oil and gas exploitation. The Rathlin Basin which overlaps with this zone is identified as an area with oil and gas potential. However, there is currently insufficient data to establish possible future exploitation of oil and gas from this area. Therefore, whilst no sites are currently under consideration for oil and gas exploitation in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**
Natural Gas and CO_2 storage	**Presence of devices**	Operation	Piled devices	**Tidal**	**Unknown**	The installation of piled tidal devices has the potential to sterilise areas that could have been used for CO2 or natural gas storage. There is currently insufficient data to establish potential for use of the marine environment for storage of CO_2. Therefore, whilst no sites are currently under consideration for natural gas or CO_2 storage in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**

Table 11.8: North Coast (Tidal Resource Zone 1) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	**Description of effect**	**Device Details**			**Potential effect significance (without Mitigation)**	**Key sensitivities and impact description**	**Mitigation**	**Residual effect significance (With Mitigation)**
		Phase	**Characteristic**	**Type**				
Landscape/seascape	**Effects on seascape**	Operation	Arrays of surface point structures over 14m above surface	**Tidal**	**Negligible (beyond 15km offshore from the coast)**	Tidal Zone 1 is located to the North of the north Antrim Coast. Within this stretch of the coastline there are four main seascape types: • 5: Narrow coastal strip with raised hinterland – exposed with elevated dramatic open and expansive views out to sea. • 6: Complex indented coast, small bays and offshore islands – changing views from enclosed views associated with indented bays and inlets to long expansive views from raised headlands and hinterland. • 7: Plateaus and high cliffs – dramatic seascape with open expansive and elevated views with a coastline of vertical cliff faces arches and raised plateau. • 9: Giants Causeway – steep cliffs and small rocky bays, exposed, rugged and dramatic seascape with long open views. Parts of the north Antrim Coast are also covered by a number of designations these include: • Giant's Causeway World Heritage Site (WHS) – designated in 1986 in recognition of its geological and geomorphological values, its history of scientific study and its exceptional landscape values. There are extensive and dramatic vista's from the causeway out to sea and along the coast to the Donegal Mountains. The area is also an important tourist attraction. • Causeway Coast AONB – designated in 1998, this stretch of the north Antrim Coast is deemed to be one of the most dramatic stretches of coastline in Europe. The AONB includes the Giant's Causeway WHS. • North Derry AONB – this is located to the west of the main north Antrim Coast, adjacent to Lough Foyle. Seascapes 5 and 7 are of medium sensitivity to on-surface point tidal devices and seascapes 6 and 9 are of high sensitivity to these types of devices. Although these do not protrude above the surface to the same extend as offshore wind devices they could reach heights of up to 14m above the water surface. The threshold of visibility (which influences magnitude of change) for tidal devices is also lower than for offshore wind. There is potential for significant adverse effects to occur between 0 and 5km from the coast. However, these effects will reduce to negative between 5 and 15km from the coast to negligible beyond 15km. Given that the main tidal resource zone is >15km offshore it is likely that any effects on seascape will be negligible.	Potential adverse effects on seascape can be reduced through the sensitive siting of tidal device arrays. Key factors to be considered in locating a tidal array include: • Identifying opportunities to deploy submerged devices where possible to avoid adverse effects. • Limit the use of markers (buoys and lights) in highly sensitive areas and recognising the requirements in terms of navigational safety. • Maximising the distance from shore of tidal array developments • Avoid deploying tidal arrays that protrude above the water surface in areas where they appear to block or close the entrance to bays/loughs/ narrows/sounds or where they separate a bay from the open sea • Tidal arrays that protrude above the water surface should reflect the shape of the coastline and align with the dominant coastal edge; • Tidal arrays that protrude above the water surface should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate; • Tidal arrays that protrude above the surface should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement; • Tidal arrays that protrude above the surface should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms.	**Negligible**
		Operation	Arrays of submerged structures	**Tidal**	**Negligible**	It is expected that there would be minimal effects on seascape quality and character from submerged devices although there could be some adverse effects associated with buoys or navigation lights which may be required for safety reasons. However, it is likely that the effects of these will be negligible.	Limit use of safety lights where appropriate (and providing this does not reduce navigational safety in the area)	**Negligible**
Climate	Carbon Impacts	Operation	Wind turbines	**Wind**	**Positive**	It is recognised that development of offshore wind farms will contribute towards achieving the Northern Ireland target for 40% energy to be provided from renewable energy sources. In meeting this target the Northern Ireland Assembly will be working towards the wider national, European and international commitment to combat global climate change and reduce the potential associated adverse environmental effects e.g. changing population distributions, species extinction, sea level rise etc. However, whilst seeking to combat climate change there is also a need to respond to it in terms of: • Protecting the existing environment and increasing its robustness and ability to adapt to climate change • Protecting existing and future infrastructure from effects of climate change e.g. increased storm events , flooding and sea level rise	Ensure that coastal infrastructure is sited in locations that are at lower risk from flooding, sea level rise and storm damage and do not increase the risk of flooding or damage to coastal infrastructure elsewhere. This will require close consultation at the project design stage with the relevant land use planning authority.	**Positive**
	Carbon Storage	Installation Operation	Wind turbines	**Wind**	**No effect**	Based on current available information no existing or proposed carbon or gas storage sites have been identified within this area (Offshore Wind Resource Zone 1) therefore there will be no effect resulting from the development of offshore wind farms.	None required	**No effect**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Bathymetry	**The information presented in this chapter has been used to inform the results of the assessment. No specific impacts on bathymetry are expected.**							
Geology, geomorphology and sediment processes	**Changes in seabed morphology**	Installation	Export cable trenching Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant Adverse**	The seabed around Rathlin Island is composed of exposed bedrock which reflects the high tidal currents in the area. Further offshore of the island the seabed is composed of gravel deposits interspaced with sand. There are also rare submarine geological features of interest around Rathlin Island. Piling and trenching activities through exposed bedrock could cause significant adverse impacts to the seabed morphology off Rathlin Island. The area around Rathlin island is also geologically recognised for its prehistoric marine landscape, and there could therefore be significant adverse impacts to the marine landscape during installation of tidal devices if located in this zone. The fast flowing currents around Rathlin Island will also induce sediment scour around the devices where the seabed is composed of sand and gravel, and therefore impact locally on the seabed morphology.	Careful site selection is key to keeping impacts to a minimum. Potential effects of local scour on sediment transport where seabed is composed of sand and gravel will need to be assessed through morphological site surveys and hydrodynamic/sediment transport modelling at the project stage. Site specific geophysical and geotechnical survey will be required to establish a baseline and inform the impact assessment for individual developments.	**Unknown - Negative**
	Changes in coastal processes	Operation	Devices using energy generated by tidal currents	**Tidal**	**Negative to Significant Adverse**	The physical presence of devices on the seabed, may induce localised scour and alter the hydrodynamics by obstructing the flow regime and removing the tidal energy, which could impact locally on the sediment transport processes. It is estimated that such changes will extend up to 50 m from devices and is therefore localised to the vicinity of the device array, but will be effective for the operational life of the device. If located close to the coast, tidal arrays may impact on the coastal processes by removing the tidal energy that would otherwise transport suspended sediment alongshore. This will possibly lead to deposition of sediment in the vicinity of the tidal array while depriving sediment deposition downcoast possible leading to coastal erosion.	The degree of potential impacts depends on the process of fixing the devices to the seabed, how closely individual devices are spaced, and how far offshore the plant is located. Careful site selection is key to keeping impacts to a minimum. Impacts at the coastline will be reduced with increasing distance from the shore, subject to more detailed studies and modelling to better understand impacts at the coast. Modelling the effects of device operation on the tide regime and sediment transport processes should form part of pre-project activities to optimise location.	**Negative**
Seabed Contamination and Water Quality	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel cargo / fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Minor (<1 tonne) discharges that do no impact the coastline are unlikely to have a significant effect on water quality as they will rapidly weather and dissipate. Larger spillages and spillages which come ashore may have significant adverse impacts.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Disturbance of contaminated sediment	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negligible to Significant adverse**	There is one active spoil disposal sites present within, and one immediately adjacent to Tidal Resource Zone 2 which could potentially be disturbed by seabed disturbing activity if they occur within the disposal sites. The dredged material is unlikely to contain high levels of contamination, and due to the high tidal currents in the area any disturbed sediment is likely to rapidly disperse with negligible effect. Munitions migrated from Beauforts Dyke munitions disposal site, some 40 km away, or relict from wartime activities (e.g. wrecks or minelaying) may be encountered. Disturbance could result in significant adverse effects.	Effects on water quality due to the disturbance of contaminated sediment can be reduced through avoidance of potentially contaminated seabed areas (500m buffer). Identification and avoidance of areas of munitions contamination through site survey at the project stage. If munitions are encountered follow guidance in Crown Estates 2006 (Dealing with munitions in marine aggregates).	**Negligible**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Protected Sites and Species	**Impacts on protected sites**	Installation Operation	Marine devices	**Tidal**	**Significant adverse**	A number of existing and potential protected areas overlap with, or are adjacent to Tidal Resource Zone 2. This zone contains a number of areas identified as potential Annex I habitat for sandy sediment in <20m water, and rocky reef, which are important for their structure and the communities which they support. The PAIH for rocky reefs are usually characterised by communities of attached algae and invertebrates, usually including a range of mobile animals such as fish. The north-east portion of this zone (around Shamrock Pinnacle) is also under consideration as a marine SAC. The nearshore area adjacent to the southern extent of the zone at Red Bay is under consideration for designation as a marine SAC for sandbanks and maerl. Also within Tidal Resource Zone 2 are the Rathlin Island SPA and SAC. The SAC is designated for the vegetated sea cliffs, sea caves and sandbanks. The SPA is to protect breeding peregrine, migratory species (guillemot, razorbill and kittiwake) and an important seabird assemblage of ~66,000 individual seabirds. Tidal Resource Zone 2 also includes the Rathlin Island ASSI which supports a wide variety of flora and associated fauna, and is important for breeding seabirds. Furthermore, there is the Kebble NNR and Antrim Coast and the Glens AONB. The adjacent mainland coastline to Tidal Resource Zone 2, is also heavily protected as World Heritage Site, SAC, SPA, ASSI and AONB. As such, this zone is considered extremely sensitive, and the potential impacts arising from installation of marine devices are likely to be significant adverse, due to direct impacts such as physical disturbance and habitat loss and loss of substratum, and indirect impacts such as smothering, increased suspended sediment and turbidity.	Careful site selection is key to keeping impacts to a minimum. The potential effects of physical disturbance of habitat or substratum loss could be reduced by avoiding sensitive areas. Site specific survey at the project stage could identify the extent of any sensitive / protected habitats within the rocky reef PAIH. Impacts may also still arise through indirect impacts on sediment movements during installation and operation, and would need to be assessed in more detail at the project stage.	**Negative to negligible**
	Impacts on protected species	Installation Operation	Marine device	**Tidal**	**Significant adverse**	The area is known to be sensitive for seabirds (designated as SPA for Annex I species, migratory species and seabird assemblages). In addition, marine mammals, seals and fish are found throughout the region and are therefore likely to be present within Tidal Resource Zone 2, as are important benthic species. The impacts on these receptors are discussed in the relevant sections of the table below.	See sections below on benthic ecology, fish and shellfish, seabirds and marine mammals.	**Negative to Negligible**
Benthic and Intertidal Ecology	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenches	**Tidal**	**Significant adverse**	Maerl and reef habitat are highly sensitive to smothering resulting from seabed disturbance. Reef habitat is an Annex 1 habitat for Rathlin Island SAC and maerl beds are recorded along the north east coast. Potential Annex I reef habitat is also present within this zone. Strong tidal streams will disperse disturbed sediment rapidly. Smothering impacts will be localised to the immediate vicinity of the seabed disturbing activities during installation. However as this will potentially impact Annex I habitats of European importance, this is potentially a significant adverse impact.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (such as gravity bases). Potential effects on unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
Benthic and Intertidal Ecology	**Contamination – from sediment disturbance**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negligible**	Tidal rapids and reef habitat are highly sensitive to contamination. Both are present in Tidal Resource Zone 2. However the dredged material present at the disposal sites in the zone is unlikely to contain high levels of contamination, and due to the high tidal currents in the area any disturbed sediment is likely to rapidly disperse with negligible effect.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (such as gravity bases). Avoidance of areas of known potential contamination for seabed disturbing works. Potential effects on areas of unknown benthic habitat will need to be assessed through site survey at the project stage.	**Negligible**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. This area contains tidal rapids and reef habitat that are highly sensitive to contamination. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on benthic ecology would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan). Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
	Changes in tidal flow	Operation	Devices that extract energy generated by tidal currents	**Tidal**	**Significant adverse**	Maerl beds and tidal rapids are all highly sensitive to changes in tidal current regime. Given the presence of these UKBAP habitats in or adjacent to Tidal Resource Zone 2, the effects could potentially be of adverse significance.	Avoidance of these important habitats though careful site selection would reduce the potential effects of energy extraction, although it may not be possible for these effects to be removed completely. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negative**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	All benthic communities can be expected to be sensitive to removal of their habitat. The long term loss of substratum due to the presence of devices that are attached to the seabed will therefore have a potentially significant adverse effect on any rare or important benthic habitats, such as those listed in the UKBAP and protected under the Habitats Directive.	Effects on benthic ecology from substratum loss can be reduced either through avoidance (careful site selection) or using devices that have a smaller footprint on the seabed e.g. gravity bases. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
Fish and Shellfish	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative**	The waters around Rathlin Island support key shellfish areas e.g. for lobster, *Nephrops*, edible crab and velvet crab. These species live on, near or in the bottom sediments of the seabed. Spawning grounds for sprat also coincide with Tidal Resource Zone 2. These species range from low to high sensitivity to smothering, although this impact will be localised to the immediate vicinity of seabed disturbing activities and limited to during installation.	For devices that require piling, and cable trenching, potential effects could be mitigated by avoiding installation during the sprat spawning season (May to August) and avoidance of key shellfish areas.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	High levels of noise such as during pile installation may cause physiological or displacement effects to marine fish although the extent to which this may occur is unknown. In particular, herring and cod are known to be highly sensitive to noise and may be able to detect piling noise up to 80km. Both species are present in the study area and therefore may be present Tidal Resource Zone 2, although herring generally only occurs in coastal waters (0 to 20m). It is expected that noise levels from piling and the removal of piled devices will be greater than those generated by operational devices, and although pile driving only occurs during installation the effects may last for longer than the piling activities as fish may not immediately return to the area. There is potential for noise from operational devices to lead to longer term species displacement which could increase pressures on fish populations in other locations and force fish into predator habitats.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive spawning periods.	**Negative - negligible**
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**		No specific mitigation measures have been identified	**Unknown**
	Collision risk	Operation	Turbines/moving part of devices / mooring chains and cables	**Tidal**	**Unknown**	There is potential risk that all mobile fish species could collide with turbines or moving parts of submerged devices. Larger animals (such as basking sharks (UKBAP species)), and pelagic species are considered to be of greater risk. Basking shark and other pelagic fish species are present throughout the study area, and are therefore likely to be present within Tidal Resource Zone 2. However, due to uncertainties with data and knowledge on the interactions between fish and devices, the potential significance of collision risk effects is unknown.	Potential effects associated with collision risk and fish could be reduced through device design e.g. use of protective nets or grids. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**Unknown**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Hydraulic injury	Operation	Shrouded devices (i.e. venturi devices)	**Tidal**	**Unknown**	There is potential risk that mobile fish could suffer injury or mortality through pressure changes occurring within the turbine as water is sucked through it. This effect is only relevant for shrouded tidal devices such as venturi devices, which use shrouding to constrict the flow, thus leading to a pressure low after the constriction. This effect is likely to be more significant for smaller species. Larger species sucked through the turbine would be more likely to suffer collision impacts.	Possible impacts associated with shrouded turbines can be addressed by using screens to prevent marine organisms from entering the device. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**No impact**
Fish and Shellfish	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. There are also a number of important shellfish species present in this area that overlap with or may be influenced by activities associated with Tidal Resource Zone 2. Sensitivity of shellfish to contamination is high. Sensitivity of finfish in the area to contamination is unknown. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on fish and shellfish would be of adverse significance.	Effects associated with contamination from devices could also be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Tidal**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. In terms of demersal species this effect would only apply to devices using seabed foundations. For pelagic species the position of submerged devices in the water column and the proportion of the water column occupied would be most relevant. Due to the vast number of variables associated with device types and the types of fish that could be affected it is not possible to determine the potential significance of this effect. The presence of tidal arrays may also have a positive effect on fish populations through fish stock recovery, should certain types of fisheries be excluded from the array.	No specific mitigation identified	**Unknown**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	The waters around Rathlin Island support shellfish areas e.g. for lobster, edible crab, *Nephrops* and velvet crab. These species live on, near or in the bottom sediments of the seabed, and are therefore sensitive to substratum loss. Spawning grounds for sprat also coincide with the zone. Removal of habitat during installation and operation of tidal turbines could result in the long term removal of the habitat used by these species, although alternative adjacent habitat may be available.	The potential effects of substratum loss on shellfish and benthic spawners could be reduced by avoiding sensitive areas e.g. key shellfish beds and spawning grounds, or using devices that use less intrusive seabed attachment such as anchors or clump weights.	**Negative - Negligible**
Fish and Shellfish	**Barrier to movement**	Operation	Devices that occupy the water column	**Tidal**	**Unknown**	Some species, such as Atlantic salmon, trout and eels spend part of their lifecycle in freshwater and part at sea. Migration between these two waterbodies is important for the survival of the species. The zone may be used by these species accessing the rivers Glensheak, Glendum and Glenariff located on the adjacent coastline which are known to contain populations of salmon and sea trout. Installation of tidal devices could present a barrier to migration, although the exact impacts on fish species is unknown.	No specific mitigation identified	**Unknown**
Fish and shellfish	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown**	Torr Head is known to be a major migration route for Northern Ireland salmon populations. Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical renewable array power cable, but the field would not cause an avoidance reaction. Atlantic salmon, eels and Sea Trout are believed to be sensitive to magnetic fields. However, the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables. There is no evidence to indicate that existing cables have caused any significant effect on migration patterns of these species. However, the significance of potential effects cannot be adequately quantified on the basis of current information.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Marine Birds	**Physical disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Significant adverse to Negative**	Physical disturbance is of particular importance in terms of breeding colonies as high levels of physical disturbance could lead to species displacement (short-term to long-term). Physical disturbance is also important in terms of foraging and loafing at sea. Tidal Resource Zone 2 is considered to be of high importance for marine birds, as within the boundary of the zone there is the Rathlin Island SPA and several seabird colonies, and the Antrim Hills SPA and Sheep Island SPA are within close proximity to the boundary of the zone. Furthermore, the area has been identified as an IBA. During the breeding season, the area is important for seabird assemblage, when ~66,000 individual seabirds are supported as well as Annex I species and migratory birds. The effect of physical disturbance is potentially of adverse significance for breeding colonies and negative significance for feeding and loafing areas which extend beyond SPA boundaries.	Effects on breeding bird colonies could be reduced by avoiding sensitive sites e.g. SPAs and areas close to seabird colonies and to restricting installation to avoid the most sensitive seasons e.g. breeding. However, it may not be possible to avoid interactions with feeding and loafing birds present outside of the designated sites. In some parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and or loafing areas and to aid site selection.	**Negative**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Tidal**	**Negative**	Based on studies of bird behaviour on land it is evident that they have acute hearing. Noise disturbance impacts are possible both during installation and operation. The noisiest activity associated with tidal device installation is piling of monopole foundations. However, there is limited understanding of birds ability to hear underwater. Therefore, it is not possible to determine the level of significance of operational noise effects on marine birds.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive periods such as breeding or moulting.	**Negligible**
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**		No specific mitigation identified	**Unknown**
	Collision risk	Installation Operation Decom	Installation and decommissioning vessels; Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown**	Tidal Resource Zone 2 is considered to be of high importance for marine breeding birds, as within the boundary of this zone there is the Rathlin Island SPA, and the Antrim Hills SPA is at its closest point, <1km outside of the zone. Furthermore, the area has been identified as an IBA. During the breeding season, the area is important for seabird assemblage, when ~66,000 individual seabirds are supported as well as Annex I species, and migratory birds. All species of marine birds present within this zone are potentially sensitive to collision impacts. Of these, the divers and pursuit divers are considered to be the most sensitive. Due to limitations in knowledge on the interactions between marine birds and devices with moving parts (e.g. turbines) it is difficult to determine the significance of this effect which potentially has implications for all surface and diving birds.	During construction appropriate mitigation includes avoidance of sensitive sites and seasons; increasing vessel visibility; avoiding night working. During operation visibility of above water and below water structures could be increased. In many parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and to aid site selection. Potential effects associated with collision risk could also be reduced through device design e.g. use of protective nets or grids.	**Unknown**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. All surface birds are sensitive to hydraulic fluid contamination, and in particular Auks (regularly occurring migratory birds – Article 4.2 Birds Directive) and divers (Annex 1 – Birds Directive) are highly sensitive to this effect. Tidal Resource Zone 2 is considered sensitive for seabirds, on account of the Rathlin Island SPA and adjacent Antrim Hills SPA, and in recognition as an IBA. As such, auks and divers will be present within the area. Therefore, although the likelihood of accidental contamination from devices is low, should it occur the potential effects on marine birds would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures.	**Negligible**
Marine Birds	**Habitat exclusion**	Operation	Devices that occupy water surface and water column	**Tidal**	**Negative to Significant adverse**	Locating devices in areas used for foraging and loafing could result in habitat exclusion and possible species displacement. There is limited information on precise foraging and loafing "hotspots" for different species of marine birds. Birds could be displaced from an area wider than the array site due to their potential avoidance responses. Although birds are mobile and could therefore avoid devices, the potential effects of increasing competitive pressures on adjacent populations and energetic costs of site avoidance also need to be considered. This could potentially have a significant adverse effect during the breeding season and a negative effect on marine birds at other times of the year, especially if it increased population pressures in other locations.	Effects on breeding bird colonies could be reduced by avoiding sensitive sites e.g. SPAs and areas close to seabird colonies. However, it may not be possible to avoid interactions with feeding and loafing birds present outside of the designated sites. In some parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and or loafing areas and to aid site selection.	**Negative to negligible**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Marine Mammals	**Physical Disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Negative**	Harbour porpoise (Annex II –Habitats Directive) are frequently sighted off Torr Head and Rathlin Island. Minke whales and bottlenose dolphins (Annex II – Habitats Directive) are seen here occasionally. Grey and common seals (Annex II –Habitats Directive) also use the area. Increased boat traffic will increase ambient noise in the area and may disturb marine mammals, although, as described below, collisions are unlikely given the speed at which construction vessels will be moving.	The relative importance of this area for seals and cetaceans is unknown therefore monitoring surveys would be required to design a suitable mitigation plan. The effects of installation activities on seal colonies could be reduced by avoiding the breeding and moulting seasons. Cable routing should be planned to avoid impacting on seal breeding colonies or haul out sites.	**Negligible to negative**
	Marine Noise	Installation	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	Piling generates high levels of noise. Studies at wind farms have demonstrated an effect on porpoise distribution during construction with animals displaced up to 15km. Noise can mask signals used by cetaceans to navigate, locate prey, and communicate effectively. Seals and cetaceans can detect piling noise up to a distance of 80km. Behavioural responses and physiological impacts such as temporary or permanent threshold shift in hearing could occur at closer distances. It is also quite possible that these noise sources mask biological relevant signals within the zone of audibility. The potential for noise from piling to affect these marine mammals is therefore considered to be "significant adverse". It is possible that minke whales detect wind farm related noise at considerable distances, (tens of km) during pile driving. Increased shipping associated with installation will raise ambient noise levels in the area	At sea distribution data for seals is unknown for this area. Also cetacean abundance and habitat usage is unknown therefore dedicated marine mammal surveys would be required to identify the most appropriate site for development and to design adequate mitigation measures The use of gravitational concrete foundations is an alternative to piling but is only suitable in certain conditions. Seasonal or area restrictions could also be imposed so piling activities would be timed not to coincide with sensitive times such as seal moulting or pupping and porpoise breeding seasons. To mitigate for noise disturbance during piling there are a range of measures including the use of Marine Mammal Observers, exclusion zones, passive acoustic monitoring, pingers, soft starts/ramp up and/or bubble curtains. The efficacy of many of these procedures has not been proven to date.	**Negative to significant adverse**
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**	Effects of operational noise from tidal energy devices are unknown and may vary substantially with device design. There may be cumulative effects when many devices are operating together.	Noise from operating tidal energy devices are unknown and are likely to vary according to device design. Mitigation measures will need to be device specific and as yet proven techniques are unknown.	**Unknown**
Marine Mammals	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**negligible**	Marine mammals can potentially collide with vessels and equipment used during installation. Increased shipping activity transiting to the area during installation will increase this risk. Generally most fatal injuries arise with collisions with ships travelling over 14kts. Vessels associated with construction activities would usually not be travelling at these speeds..	Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals both during construction activities and in transit to the construction area if entering areas of high animal abundance.	**Negligible**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown - Significant adverse**	Collision risk with tidal energy devices is unknown for seals and cetaceans and the level of risk would depend on device design. However, for turbines with moving parts there is a clear collision risk for marine mammals, which could potentially be significant adverse for tidal devices, although further study is needed to better understand this impact. Collision with moving parts and fixed cables may also be a concern for baleen whales such as minke which may not detect the presence of these in the water and do not have the manoeuvrability of smaller cetaceans. However, the importance of this area to minke whales is unknown so the collision risk is difficult to quantify.	Collision risk during operation could be minimised through enhancing the visibility of marine devices to marine mammals, to maximise the possibility that the animals could detect it in time to react and avoid it. Consider potential measures to increase the acoustic visibility of undersea cables to marine mammals. New developments in active acoustic technology (e.g. sonar) are currently underway and may provide a potential monitoring and mitigation measure for operating turbines in the future.	**Unknown to negative**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on marine mammal health. Offshore tidal energy devices could present a collision risk to shipping. A collision between ships or a ship and a tidal device could result in fluid spills which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine mammals would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Tidal**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. Devices may exclude mammals from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. It is not possible to determine the potential significance of this effect.	No specific mitigation identified	**Unknown**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Barrier to movement	Operation	Devices	**Tidal**	**Unknown - Significant Adverse**	Overall the movement of marine mammals around the coast of Northern Ireland is unknown so barrier effect is difficult to quantify. However, given that development of tidal energy devices in constrained areas such between Rathlin Island and the mainland may cause a barrier effect and restrict marine mammal movement, it is likely that this could have a significant adverse effect. Installation of tidal arrays in the area between Rathlin Island and the mainland is therefore likely to have a greater significant impact to any mammals transiting through this constrained area, compared to device installation in the more open waters offshore of Rathlin. Further site specific mammals surveys would be required to confirm this assumption.	The key mitigation measure for the impact is careful site selection to avoid key transit routes in and out of sea Loughs and other constrained areas. These areas are currently not well understood. Detailed study would be required to examine marine mammal distribution around the coast in order to fully understand and mitigate for this risk.	**Unknown to negative**
Marine mammals	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown - negligible**	The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains a complicated, understudied and unproven field of science (Basslink, 2001), with only circumstantial evidence. Cetaceans cross cables constantly, and there is no apparent evidence that existing electricity cables have influenced migration of cetaceans. However further study is thought warranted by the scientific community in this field (Gill *et al.*, 2005). It should also be borne in mind that the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown to negligible**
Marine Reptiles	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Unknown**	The importance of the coast of Northern Ireland to marine turtles is unknown but there have been sightings of leatherback and loggerhead turtles. There is no information on the effects of tidal device construction on marine turtles so the risk is difficult to quantify.	Mitigation measures to deal specifically with potential risks to marine turtles from tidal energy developments are unknown.	**Unknown**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown**	There is no information on the effects of tidal devices on marine turtles so the risk is difficult to quantify		**Unknown**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on turtle health. Tidal energy devices could present a collision risk to shipping. A collision between ships or a ship and a tidal energy device could result in an oil spill which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine reptiles would be of adverse significance.	Design a contingency plan to deal with accidental spillages. The use of toxic chemicals should be limited. Procedures should be put in place to reduce navigational hazards.	**Negligible**
	Barrier to movement	Operation	Devices	**Tidal**	**Unknown**	The movement of marine turtles around the coast of Northern Ireland is unknown so it is difficult to quantify the level of barrier effect.	Development could be planned to take place at times when there are fewer turtles present or avoid potential migration routes.	**Unknown**
Marine and coastal archaeology and wrecks	**Effects on submarine historic environment**	Installation	Piling, dredging, placing structures on seabed, cables, coring	**Tidal**	**Neutral**	There is considerable archaeological and heritage interest in this area with a high potential for presence of prehistoric submarine remains. PMRA protected aircraft wrecks may be present and numerous miscellaneous wrecks have been reported in the area. There is potential for the installation of tidal devices and export cables to impact submarine archaeology through direct disturbance of known and unknown sites on the seabed, or through changes to sediment movements causing an artefact to become buried and preventing later discovery. There is also a potential positive impact associated with development related seabed survey providing additional data for inclusion in the archaeological record of the area.	Follow NIEA and Crown Estates 2007 JNAPC code of conduct and guidance note for the offshore renewable energy sector. Carry out seabed investigations in preferred site locations prior to device installation. Avoid sites of interest and exclusion zones for protected sites.	**Neutral**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Effects on coastal and terrestrial historic environment	Installation	Cables, shoreline devices	**Tidal**	**Significant adverse to Negative**	There is considerable terrestrial archaeological and heritage interest on the shoreline adjacent to the area, both on the mainland and Rathlin Island. Locally and regionally important archaeological remains and sites (NMRS) are present along the coast. Numerous listed buildings are also present. On Rathlin Island there are several coastal scheduled sites including a quay complex near Kinramer South and Bruce's Castle near Inannanooan. On the mainland coastline the nearest scheduled site is the ruins of Drumnakill Church on Drumnakill Point. The wreck of the La Girona, which is designated under the Protection of Wrecks Act, can also be found close by at Lacada Point. Cable installation in the vicinity of these protected sites could cause direct destruction of archaeologically important features.	The main form of mitigation is to avoid protected and other sites of interest. In addition to desk based studies it will be necessary to carry out field walkovers in preferred site locations to determine need for site investigations (geophysical surveys/trial trenching) in consultation with NIEA and Local Authorities. With respect to cabling there is considerable opportunity to avoid or reduce effects. The siting and design of shoreline devices will be important in determining their residual impact.	**Negative to negligible**
Commercial Fisheries	**Direct disturbance of fishing grounds**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative to Significant adverse**	Commercial shellfish areas are most sensitive to direct disturbance as shellfish are generally much less mobile than fin fish. Inshore finfish grounds are also sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. The key commercial shellfish in Tidal Resource Zone 2 are king scallop, lobster and crab. Tidal Resource Zone 2 also overlaps to some degree with the lobster potting areas, but mobile dredging gear for scallop and finfish cannot be operated in the areas of strong tidal energy. Development in this zone will therefore have a potentially negative significance effect on lobster potting areas. In terms of commercial fisheries this effect could potentially be of adverse significance.	In terms of direct disturbance to commercial shellfisheries, the main form of mitigation would be to avoid key commercial fishing grounds. The effects could also be minimised by using devices that use less intrusive forms of attachment e.g. gravity bases.	**Negative to negligible**
	Temporary displacement from traditional fishing grounds	Installation Decom	Vessels, installation equipment and devices	**Tidal**	**Negative**	Inshore fishing grounds tend to be more constrained than offshore areas. Temporary displacement from these areas may lead to the concentration of fishermen in smaller areas, fishermen being unable to fish for short periods or fishermen being displaced to alternative, possibly less productive fishing grounds. Key commercial shellfish in Tidal Resource Zone 2 are king scallop, lobster and crab. Temporary displacement will potentially have a negative significance effect on commercial fisheries.	Effects associated with the temporary displacement of traditional fishing grounds can be reduced by avoiding key commercial fishing grounds or by phasing construction activities to specific areas within Tidal Resource Zone 2. Liaison with the fishing community to keep them informed of installation operations is also key to managing the level of this impact.	**Negative to negligible**
	Long term displacement from traditional fishing grounds	Operation	Devices that occupy water surface, water column and seabed	**Tidal**	**Negative to Significant adverse**	All types of commercial fisheries could be affected by long term displacement from traditional fishing grounds. Tidal Resource Zone 2 overlaps to some degree with the lobster potting areas, but mobile dredging gear for scallop and finfish cannot be operated in the areas of strong tidal energy. The effects of long term displacement on inshore lobster potting areas could be of adverse significance. The effects of long term displacement of offshore and beam trawler/dredging fisheries in the general area could be of negative significance. Use of rock armour, if required for cable protection, could introduce an obstruction for trawling activity, but could also create new habitat which could have a positive impact of fish stocks.	The long term displacement of commercial shellfish fisheries could be reduced or avoided by avoiding key fishing grounds or by spacing of tidal devices at wide enough intervals to permit use of mobile fishing gear.	**Negative to negligible**
Mariculture	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**No effect**	There are no aquaculture developments in or near to Tidal Resource Zone 2 and future development is unlikely due to absence of required physical conditions and Rathlin Island SAC designation.	N/A	**No effect**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Tidal**	**No effect**	There are no aquaculture developments in or near to Tidal Resource Zone 2 and future development is unlikely due to absence of required physical conditions and Rathlin Island SAC designation.	N/A	**No effect**
	Substratum loss	Operation	Devices using seabed foundations e.g. piled devices	**Tidal**	**No effect**	There are no aquaculture developments in or near to Tidal Resource Zone 2 and future development is unlikely due to absence of required physical conditions and Rathlin Island SAC designation.	N/A	**No effect**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Ports, Shipping and Navigation	**Displacement of shipping movement**	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Tidal**	**Significant adverse to Negative**	The re-routing of vessels to avoid safety zones (during installation), operational devices and decommissioning activity would result in greater transit time and use of fuel with the associated costs to the vessel operator, and could also could lead to an increase in vessel densities in areas that already have moderate vessel densities. This could lead to increased encounter rates and increased risk of collision. Within Tidal Resource Zone 2 shipping intensities vary greatly from little to no shipping around the northern and eastern coast of Rathlin Island to high shipping densities in the North Channel and in the constrained channel between the NI mainland and Rathlin Island. The North Channel is an important area for shipping and navigation as such it is a “recognised sea lane essential to international navigation” with an IMO Traffic Separation Scheme (TSS) located at its northern extent. Tidal Resource Zone 2 is located adjacent to this TSS and encroaches slightly on the southbound traffic lane. The area is also crossed by the former Campletown to Ballycastle ferry service operated by Cal Mac. Although this service ceased operation in 2000 there have been recent discussions between DETI and Scottish Government into the possibility of reinstating the service. The effect of re-routing vessels to accommodate tidal devices would therefore potentially be of adverse significance, as vessels may be forced into the high density area or subject to increased encounter rates and collision risk in Rathlin Sound. However, there are areas within Tidal Resource Zone 2 that have minimal shipping densities, re-routing in these areas would have less significant impact.	The potential for these effects to be reduced would depend entirely upon the siting of a device in relation to key shipping routes. There is potential to reduce or avoid significant adverse effects within this zone by siting devices away from areas of high vessel densities. The scale of potential effect on navigation should be assessed as part of the EIA and the Navigational Risk Assessment (NRA). The assessment should include: • A survey of vessels in the vicinity of the proposed development • Full NRA of the likely impact of the development on navigation, taking into consideration MGN 371 (MCA 2008), MGN 372 (MCA 2008b) and the DTI Guidance Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (DTI 2005) (also considered relevant for other renewable devices). • Cumulative impact assessment	**Negative to negligible**
		Operation	Tidal devices	**Tidal**	**Significant adverse to Negative**			
	Decreased trade/supply	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Tidal**	**Significant adverse**	The deployment of installation and maintenance vessels, presence of devices and decommissioning activity could create temporary to long-term reductions in access to ports and harbours. This is particularly important in island locations which rely on boats for the export and import of goods and as a means of access. Tidal Resource Zone 2 encompasses Rathlin Island and is adjacent to the port of Ballycastle. Reduced access both to Ballycastle and to Rathlin Island would have a significant adverse effect on local communities in terms of goods transport and accessibility. Again there are large areas of Tidal Resource Zone 2 where installation of devices would have no effect transport of goods or accessibility in these areas.	Site selection for device arrays should take into account the requirement for continued access to port and harbours. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning.	**No effect**
		Operation	Tidal devices	**Tidal**	**Significant adverse**			
	Reduced visibility	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Significant adverse to Negative**	Vessels and other equipment used during the installation of devices, and the operational devices themselves could obstruct views of other vessels and navigation features such as buoys, lights and the coastline. This is particularly important in areas of high vessel densities, constrained channels or areas where there is particular dependence on visual navigation aids as reduced visibility increases the risk of collision with other ships and other structures in the water (natural and man made). The effect of reduced visibility will potentially be of adverse significance in the constrained channel between Rathlin Island and the NI mainland and in the vicinity of the North Channel. The effects in the less constrained, low vessel density areas around the north coast of Rathlin Island may be less significant although this area is surrounded by regularly used routes.	Significant adverse effects associated with reduced visibly can be reduced by avoiding areas of high vessel densities and areas constrained by land e.g. island channels. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Any vessels and devices should be lit and marked in accordance with regulations and MCA and Trinity House guidance	**Negative to negligible**
		Operation	Tidal devices	**Tidal**	**Significant adverse to Negative**			
	Collision risk	Installation Decom	Vessels and equipment used for installation and Decommissioning	**Tidal**	**Significant adverse**	Collision risk considers the risk of navigating vessels colliding with vessels and equipment used during installation, maintenance and decommissioning, and the devices themselves once operational. Collision risk also considers the increased risk of collision between navigating vessels. In both circumstances the risk of collision is increased in constrained channels and areas with high vessel densities.	The risk of collision could be reduced by avoiding constrained areas or areas of high shipping densities and regularly used shipping routes. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels	**Negative to negligible**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
		Operation	Tidal devices	**Tidal**	**Significant adverse**	Tidal Resource Zone 2 encompasses constrained areas of high shipping densities, the risk of collision in this area will potentially be adverse significance.	required and the area occupied during installation. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning. The scale of potential effect on navigation should be assessed as part of the EIA and NRA as outlined above.	
Recreation and Tourism	Disturbance to Wildlife	Installation Operation Decom	Installation activities including noise, vessel movements, operation of devices, decommissioning activities	**Tidal**	**Negative**	The receptors affected are tourism activities associated with wildlife and bird watching. These are popular activities with those who visit Rathlin Island, which is a particularly popular birdwatching location. Effects on local tourism would occur where disturbance and/or exclusion from an area overlaps with the locations frequented by visitors and touring vessels.	With respect to tourism activities the main form of mitigation will be the avoidance of areas that are popular with tourists and wildlife tour operators. Other mitigation measures aimed at reducing or avoiding disturbance to wildlife including sea mammals and birds is set out in the relevant parts of this table.	**Negligible**
	Safety and Collision Risk	Installation Operation Decom	Presence of new structures in the water	**Tidal**	**Negative**	The key receptor affected is sailing. Cruising routes for vessels passing to the south (heavy recreational use), east and west (light recreational use) of Rathlin Island are likely to overlap with the Tidal Resource Zone 2, This could have potentially negative effects on recreational sailing.	Safety measures including lighting and marking and informing users of the locations of devices. Locate devices away from cruising routes. Use alternative devices which lie below the surface of the water to a depth which does not affect sailing.	**Negligible**
	Access Restrictions	Installation Operation Decom	Structures in the sea reducing or excluding access	**Tidal**	**Negative**	The key receptor affected is sailing. Cruising routes for vessels passing to the south (heavy recreational use), east and west (light recreational use) of Rathlin Island are likely to overlap with the Tidal Resource Zone 2. This could have potentially negative effects on recreational sailing.	Avoid cruising routes. Devices which exclude access to an area will have greater effects than those which allow movement through the array. Use alternative devices which lie below the surface at a depth which does not affect sailing.	**Negligible**
Military Exercise Areas	**Disruption to general activities**	Installation Operation	All tidal devices	**Tidal**	**Significant adverse to Negligible**	The entire area lies within the military practice and exercise area X5536 – Rathlin. This area is used by the Navy for submarine exercises, aircraft and H.M ships. Dependent on the extent to which the area is used by the navy, significance of this effect could be considered to be significant adverse to negligible.	Consultation with the MOD will be required to enable appropriate site selection in order to reduce or eliminate the risk of interference associated with non-bylawed practice and exercise areas.	**Negligible**
Disposal Areas	**Disruption to access**	Installation Operation	All Tidal devices	**Tidal**	**Negligible**	There are three harbour spoil disposal sites adjacent to Tidal Resource Zone 2, and one within the site itself. Access to these is therefore unlikely to be affected by installation or operation of any devices.	Avoidance of the sites by approximately 500m can mitigate against the possibility of access to the sites in the area being inhibited for users.	**Negligible**
Cables and Pipelines	**Direct damage**	Operation Installation	All tidal devices Cables	**Tidal**	**Negative**	The Rathlin Island interconnector power cable runs through the centre of the study area for 8km from Rathlin Island to the main land. Direct damage to an existing cable would be most likely to occur during installation of device arrays and cables but also could occur maintenance phases. The impact is considered to be significant adverse (should it occur) as domestic electricity supplies would be disrupted.	A 500m avoidance zone should be employed when selecting sites for marine renewable energy developments (in accordance with ICPC guidelines) and crossing agreements with existing infrastructure should be adhered to. These mitigation measures will eliminate or significantly reduce significance and likelihood of impacts on cables.	**No effect**
	Reduced access	Operation Installation	All tidal devices Cables	**Tidal**	**Significant adverse**	There is potential that the presence of devices in waters close to existing cables could restrict access to the cables for maintenance purposes. The potential significance of this effect could be significant adverse.	A 500m avoidance zone should be employed when selecting sites for marine renewable energy developments (in accordance with ICPC guidelines) and crossing agreements with existing infrastructure should be adhered to. These mitigation measures will eliminate or significantly reduce significance and likelihood of effects on cables.	**Negligible**
Aggregate extraction	**Presence of devices**	Operation Installation	All tidal devices	**Tidal**	**Unknown / No effect**	There are no existing or proposed aggregate dredging areas within this area therefore there will be no effects on aggregate extraction. Impacts on possible future aggregate extraction sites, based on aggregate resources that have not yet been identified include restricted access to and sterilisation of possible sites. However these impacts are impossible to quantify at this stage.	None identified	**Unknown / No effect**
Oil and gas resources	**Presence of devices**	Operation	All tidal devices	**Tidal**	**Unknown**	The installation of tidal turbines has the potential to sterilise areas that could have been used for oil and gas exploitation. The Rathlin Basin and Larne Basin which overlap with this zone is identified as an area with oil and gas potential. However, there is currently insufficient data to establish possible future exploitation of oil and gas from this area. Therefore, whilst no sites are currently under consideration for oil and gas exploitation in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Natural Gas and CO_2 storage	**Presence of devices**	Operation	Piled devices	**Tidal**	**Unknown**	The installation of piled tidal devices has the potential to sterilise areas that could have been used for CO2 or natural gas storage. There is currently insufficient data to establish potential for use of the marine environment for storage of CO_2. Therefore, whilst no sites are currently under consideration for natural gas or CO_2 storage in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**
Landcape/Seascape	Effects on seascape	Operation	Arrays of surface point structures over 14m above surface	**Tidal**	**Significant Effect (0 to 5km)** **Moderate Effect (between 5 and 15km offshore from coast)** **Slight Effect (beyond 15km offshore from the coast)**	Tidal Zone 2 is located around Rathlin Island and Torr head. Within this stretch of the coastline there are three main seascape types: • 5: Narrow coastal strip with raised hinterland – experiences elevated dramatic open and expansive views out to sea. Feels exposed. • 6: Complex indented coast, small bays and offshore islands – changing views from enclosed views associated with indented bays and inlets to long expansive views from raised headlands and hinterland. • 7: Plateaus and high cliffs – dramatic seascape with open expansive and elevated views which contrast against vertical cliff faces arches and raised plateau. • 9: Giants Causeway – steep cliffs and small rocky bays, exposed, rugged and dramatic seascape with long open views Parts of this coastline are also covered by a number of designations these include: • Giant's Causeway World Heritage Site (WHS) – designated in 1986 in recognition of its geological and geomorphological values, its history of scientific study and its exceptional landscape values. There are extensive and dramatic vista's from the causeway out to sea and along the coast to the Donegal Mountains. The area is also an important tourist attraction. • Causeway Coast AONB – designated in 1998, this stretch of the north Antrim Coast is deemed to be one of the most dramatic stretches of coastline in Europe. The AONB includes the Giant's Causeway WHS. • Antrim Coast and Glens AONB – designated 1998 for its varied and dramatic landscape and seascape predominantly of cliffs, incised and narrow coastal strip with wide bays at the foot of steeply raked glens. Seascapes 5 and 7 are of medium sensitivity to on-surface point tidal devices and seascapes 6 and 9 are of high sensitivity to these types of devices. Although these do not protrude above the surface to the same extend as offshore wind devices they could reach heights of up to 14m above the water surface. The threshold of visibility (which influences magnitude of change) for tidal devices is also lower than for offshore wind. There is potential for significant adverse effects to occur between 0 and 5km from the coast. However, these effects will reduce to negative between 5 and 15km from the coast to negligible beyond 15km. Given that the main tidal resource is located around Rathlin Island it is most likely most developments would be located within 0 to 5 km from the coast.	Potential adverse effects on seascape can be reduced through the sensitive siting of tidal device arrays. Key factors to be considered in locating a tidal array include: • Identifying opportunities to deploy submerged devices where possible to avoid adverse effects. • Limit the use of markers (buoys and lights) in highly sensitive areas and recognising the requirements in terms of navigational safety. • Maximising the distance from shore of tidal array developments • Avoid deploying tidal arrays that protrude above the water surface in areas where they appear to block or close the entrance to bays/loughs/ narrows/sounds or where they separate a bay from the open sea • Tidal arrays that protrude above the water surface should reflect the shape of the coastline and align with the dominant coastal edge; • Tidal arrays that protrude above the water surface should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate; • Tidal arrays that protrude above the surface should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement; • Tidal arrays that protrude above the surface should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms	**Moderate effect**
		Operation	Arrays of submerged structures	**Tidal**	**Moderate Effect (0 to 5km)** **Slight Effect (5 to 15km)** **No effect (beyond 15km offshore)**	It is expected that there would be minimal effects on seascape quality and character from submerged devices although there could be some adverse effects associated with buoys or navigation lights which may be required for safety reasons. Given that this area overlaps with areas of moderate use by vessels, it is likely that there will be a requirement for any submerged devices to be clearly marked with buoys and lights. In the nearshore area (0 to 5km) this could have a negative effect on seascape quality. However this will reduce to negligible offshore.	Limit use of safety lights where appropriate (and providing this does not reduce navigational safety in the area)	**Slight effect**

Table 11.9: Rathlin Island and Torr Head (Tidal Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Climate	Carbon Impacts	Operation	Wind turbines	**Wind**	**Positive**	It is recognised that development of offshore wind farms will contribute towards achieving the Northern Ireland target for 40% energy to be provided from renewable energy sources. In meeting this target the Northern Ireland Assembly will be working towards the wider national, European and international commitment to combat global climate change and reduce the potential associated adverse environmental effects e.g. changing population distributions, species extinction, sea level rise etc. However, whilst seeking to combat climate change there is also a need to respond to it in terms of: • Protecting the existing environment and increasing its robustness and ability to adapt to climate change • Protecting existing and future infrastructure from effects of climate change e.g. increased storm events , flooding and sea level rise	Ensure that coastal infrastructure is sited in locations that are at lower risk from flooding, sea level rise and storm damage and do not increase the risk of flooding or damage to coastal infrastructure elsewhere. This will require close consultation at the project design stage with the relevant land use planning authority.	**Positive**
	Carbon Storage	Installation Operation	Wind turbines	**Wind**	**No effect**	Based on current available information no existing or proposed carbon or gas storage sites have been identified within this area (Offshore Wind Resource Zone 1) therefore there will be no effect resulting from the development of offshore wind farms.	None required	**No effect**

Table 11.10: Maiden Islands (Tidal Resource Zone 3) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Bathymetry	**The information presented in this chapter has been used to inform the results of the assessment. No specific impacts on bathymetry are expected.**							
Geology, geomorphology and sediment processes	**Changes in seabed morphology**	Installation	Export cable trenching Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	The Maiden Islands are characterised as two (east and west) low lying islands that are surrounded by a rock shelf and rocky outcrops but no beaches. The two islands are separated by sounds and channels. The currents are very strong around and between the islands, and the surrounding seabed is host to an extensive aphotic reef system. Away from the rocky outcrop, the seabed is characterised as a low bed stress coarse sediment plain of sand and gravel. Trenching and piling activities will cause a significant adverse impact to the seabed morphology on the rocky seabed. The devices will induce localised scour around the structures if positioned on sand and gravel and will negatively impact on the seabed morphology.	Careful site selection is key to keeping impacts to a minimum. To reduce impacts, devices should be sited away from the rocky outcrops close to the islands. Potential effects of local scour on sediment transport will need to be assessed through morphological site surveys and hydrodynamic/sediment transport modelling at the project stage. Site specific geophysical and geotechnical survey will be required to establish a baseline and inform the impact assessment for individual developments.	**Negative - Negligible**
	Changes in coastal processes	Operation	Devices using energy generated by tidal currents	**Tidal**	**Significant adverse**	The physical presence of devices on the seabed, will not only induce local scour but also alter the pattern of flow and the dynamics of the flow regime by removing the tidal energy. It is estimated that such changes will extend up to 50 m from devices and is therefore localised to the vicinity of the device array, but will be effective for the operational life of the device. Suspended sediment transported into the vicinity of the tidal array by the currents may be locally deposited where there is an appreciable reduction in tidal energy. If located close to the coast, tidal arrays could impact on the coastal processes by removing the tidal energy that would otherwise transport suspended sediment along the coast. The reduction in tidal energy could possibly lead to deposition of sediment in the vicinity of the tidal array while depriving sediment deposition downcoast possible leading to coastal erosion. Tidal Resource Zone 3 extends between 4 km and 10 km from the adjacent mainland, and between 0 and 7 km from the Maiden islands themselves. Development in the section closest to the relevant shorelines could potentially lead to significant adverse impacts on the coast.	The degree of potential impacts depends on the process of fixing the structures to the seabed, how closely individual devices are spaced, and how far offshore the plant is located. Careful site selection is key to keeping impacts to a minimum. Impacts at the coastline will be reduced with increasing distance from the shore, subject to more detailed studies and modelling to better understand impacts at the coast. Modelling the effects of device operation on the current and sediment transport regime should form part of pre-project activities to optimise location.	**Negative - Negligible**
Seabed Contamination and Water Quality	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Minor (<1 tonne) discharges that do no impact the coastline are unlikely to have a significant effect on water quality as they will rapidly weather and dissipate. Larger spillages and spillages which come ashore may have Significant adverse impacts	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Disturbance of contaminated sediment	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	Open dredging spoil disposal sites are present within and adjacent to Tidal Resource Zone 3. It is unlikely that such sites will be disturbed except during ancillary operations (e.g. cable installation). In view of the high tidal flows in this area it is likely that deposited material has already been dispersed. If contaminated material is disturbed it will be rapidly diluted and dissipated. Therefore the effect on water and sediment quality is likely to be negligible. Munitions migrated from Beauforts dyke munitions disposal site, some 17 km away, or relict from wartime activities (e.g. wrecks or minelaying) may be encountered. Disturbance could result in significant adverse effects.	Available mitigation includes avoidance of potentially contaminated seabed areas (dredging areas - 500m buffer). Identification and avoidance of areas of munitions contamination through site survey at the project stage. If munitions are encountered Crown Estates 2006 (Dealing with munitions in marine aggregates) should be followed.	**Negligible**

Table 11.10: Maiden Islands (Tidal Resource Zone 3) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Protected Sites and Species	**Impacts on protected sites**	Installation Operation	Marine devices	**Tidal**	**Significant adverse**	Tidal Resource Zone 3 overlaps with an area of potential Annex I habitat for rocky reefs. This is found over the entire zone, and the area is also under consideration for designation as an offshore SAC. Rocky reefs are extremely variable both in structure and the communities they support. They are usually characterised by communities of attached algae and invertebrates, usually including a range of mobile animals such as fish. The coastline adjacent to the zone is also protected as the Antrim Coast and the Glens ASSI. Larne Lough, which is also in the vicinity of the zone, is designated as SPA, Ramsar and ASSI. Areas of potential maerl beds are also in close proximity to this zone. Impacts from installation of marine tidal devices could result in direct impacts such as physical disturbance and loss of substratum, and also indirect impacts such as smothering or increased suspended sediment and turbidity. As such, this has been considered of adverse significance.	There is no potential to avoid the potential Annex I rocky reef habitat through site selection. However, the actual extent of any habitats conservation importance would need to be determined through site survey. The potential for devices to be sited within the zone in areas which are not considered to have potential for designation as offshore SACs would need to be determined in the results of the site specific survey.	**Significant adverse - negative**
	Impacts on protected species	Installation Operation	Marine device	**Tidal**	**Significant adverse**	Although there are no protected sites designated for specifically for species within Tidal Resource Zone 3 (site designations in the area apply to habitats) a number of protected species including marine mammals, seals, seabirds and fish are found throughout the region, as are important benthic species. The impacts on these receptors are discussed in the relevant sections of the table below.	See sections below on benthic ecology, fish and shellfish, seabirds and marine mammals.	**Negative to Negligible**
Benthic and Intertidal Ecology	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenches	**Tidal**	**Significant adverse**	Maerl, tidal rapids and reef habitat are highly sensitive to smothering resulting from seabed disturbance. Maerl is recorded at a number of sites between Garron Point and Ballygally on the north-east coast. Strong tidal streams will disperse disturbed sediment rapidly and it is expected that sublittoral sands and gravel habitat would be largely unaffected by small amounts of deposited sediment in tide swept areas. Smothering impacts will be localised to the immediate vicinity of the seabed disturbing activities during installation, however as this will potentially impact Annex I habitats of European importance, this is potentially a significant adverse impact.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (such as gravity bases). Potential effects on unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negative - Negligible**
Benthic and Intertidal Ecology	**Contamination – from sediment disturbance**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negligible**	Tidal rapids and maerl habitat are highly sensitive to contamination. Both are present in or adjacent Tidal Resource Zone 3. However the dredged material present at the disposal sites in the zone is unlikely to contain high levels of contamination, and due to the high tidal currents in the area any disturbed sediment is likely to rapidly disperse with negligible effect.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (such as gravity bases). Avoidance of areas of known potential contamination for seabed disturbing works. Potential effects on areas of unknown benthic habitat will need to be assessed through site survey at the project stage.	**Negligible**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Tidal Resource Zone 3 contains tidal rapid habitats and nearby maerl habitats that are of high sensitivity to contamination. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on benthic ecology would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan). Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
	Changes in tidal flow	Operation	Devices that extract energy generated by tidal currents	**Tidal**	**Significant adverse**	Maerl beds, tidal rapid and reef habitats are all highly sensitive to changes in tidal current regime. The entire zone is overlapped by a potential Annex I rocky reef area. Changes in tidal flow regimes could influence the structure of tidal swept sand and gravel habitats although impacts would be localised. Given the presence of these priority habitats in this tidal resource area, the effects could potentially be of adverse significance.	Avoidance of these important habitats though careful site selection would reduce the potential effects of energy extraction. It may not be possible for the sensitive habitats to be avoided completely. Site specific benthic survey would be needed to determine the extent of the sensitive habitats in this zone. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Unknown**

Table 11.10: Maiden Islands (Tidal Resource Zone 3) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	All benthic communities can be expected to be sensitive to removal of their habitat. The long term loss of substratum due to the presence of devices that are attached to the seabed will therefore have a potentially significant adverse effect on any rare or important benthic habitats, such as those listed in the UKBAP and protected under the Habitats Directive. The entire zone is overlapped by a potential Annex I rocky reef area.	Effects on benthic ecology from substratum loss can be reduced either through avoidance (careful site selection) or using devices that have a smaller footprint on the seabed e.g. anchored devices, or clump weights. It may not be possible for the sensitive habitats to be avoided completely. Site specific benthic survey would be needed to determine the extent of the sensitive habitats in this zone. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Significant adverse - negative**
Fish and Shellfish	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative**	Tidal Resource Zone 3 contains populations of scallops, *Nephrops,* and native oysters, which can also be found in Larne Lough. Spawning areas for sprat, which lay their eggs in or on the seabed are also believed to overlap with this zone. These species range from low to high sensitivity to smothering, although this impact will be localised to the immediate vicinity of seabed disturbing activities and limited to during installation.	For devices that require piling, and cable trenching, potential effects could be mitigated by avoiding installation during the spawning season and nursery periods and avoidance of key shellfish areas.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	High levels of noise such as during pile installation may cause physiological or displacement effects to marine fish although the extent to which this may occur is unknown. In particular, herring and cod are known to be highly sensitive to noise and may be able to detect piling noise up to 80km. Both species are present in the study area and therefore may be present Tidal Resource Zone 3, although herring generally only occurs in coastal waters (0 to 20m). It is expected that noise levels from piling and the removal of piled devices will be greater than those generated by operational devices, and although pile driving only occurs during installation the effects may last for longer than the piling activities as fish may not immediately return to the area. There is potential for noise from operational devices to lead to longer term species displacement which could increase pressures on fish populations in other locations and force fish into predator habitats.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive spawning periods.	**Negligible to negative**
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**		No specific mitigation measures have been identified	**Unknown**
	Collision risk	Operation	Turbines/moving part of devices / mooring chains and cables	**Tidal**	**Unknown**	There is potential risk that all mobile fish species could collide with turbines or moving parts of submerged devices. Larger animals (such as basking sharks (UKBAP species)), and pelagic species are considered to be of greater risk. Basking shark and other pelagic fish species are present throughout the study area, and therefore are likely to be present within Tidal Resource Zone 3. However, due to uncertainties with data and knowledge on the interactions between fish and devices, the potential significance of collision risk effects is unknown.	Potential effects associated with collision risk and fish could be reduced through device design e.g. use of protective nets or grids. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**Unknown**
	Hydraulic injury	Operation	Shrouded devices (i.e. venturi devices)	**Tidal**	**Unknown**	There is potential risk that mobile fish could suffer injury or mortality through pressure changes occurring within the turbine as water is sucked through it. This effect is only relevant for shrouded tidal devices such as venturi devices, which use shrouding to constrict the flow, thus leading to a pressure low after the constriction. This effect is likely to be more significant for smaller species. Larger species sucked through the turbine would be more likely to suffer collision impacts.	Possible impacts associated with shrouded turbines can be addressed by using screens to prevent marine organisms from entering the device. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**No impact**
Fish and Shellfish	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Small spillages are likely to have a negligible impact. Large spillages, particularly where they impinge on the coastline or enter Lough Larne could have a significant adverse impact.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**

Table 11.10: Maiden Islands (Tidal Resource Zone 3) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Tidal**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. In terms of demersal species this effect would only apply to devices using seabed foundations. For pelagic species the position of submerged devices in the water column and the proportion of the water column occupied would be most relevant. Due to the vast number of variables associated with device types and the types of fish that could be affected it is not possible to determine the potential significance of this effect. The presence of tidal arrays may also have a positive effect on fish populations through fish stock recovery, should certain types of fisheries be excluded from the array.	No specific mitigation identified	**Unknown**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative**	Tidal Resource Zone 3 contains populations of scallops, *Nephrops* and native oysters can also be found in Larne Lough. Spawning areas for sprat, which lay their eggs on the seabed. These species range from low to high sensitivity to smothering, although this impact will be localised to the immediate vicinity of seabed disturbing activities and limited to during installation.	The potential effects of substratum loss on shellfish and benthic spawners could be reduced by avoiding sensitive areas e.g. key spawning grounds and or using devices that use less intrusive seabed attachment such as gravity bases.	**Negligible**
Fish and shellfish	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown - negligible**	Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical renewable array power cable, but the field would not cause an avoidance reaction. Atlantic salmon, eels and Sea Trout are believed to be sensitive to magnetic fields. However, the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables. There is no evidence to indicate that existing cables have caused any significant effect on migration patterns of these species. However, the significance of potential effects cannot be adequately quantified on the basis of current information.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown - negligible**
Marine Birds	**Physical disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Significant adverse - Negative**	Physical disturbance is of particular importance in terms of breeding colonies as high levels of physical disturbance could lead to species displacement (short-term to long-term). Physical disturbance is also important in terms of foraging and loafing at sea. Whilst there are no SPAs which overlap with Tidal Resource Zone 3. The Larne Lough SPA are within 10km on the adjacent mainland coastline. These areas are designated for their importance for migratory species and Annex I species respectively, and seabirds from these sites may therefore be present foraging and loafing. Impacts such as noise and physical disturbance from installation vessels and equipment are potentially of significant adverse effect for breeding colonies, and negative significance for feeding and loafing areas which extend beyond the SPA boundaries.	Effects on breeding bird colonies could be reduced by avoiding sensitive sites e.g. SPAs and to restricting installation to avoid the most -sensitive seasons e.g. breeding. In some parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and or loafing areas and to aid site selection.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Tidal**	**Negative**	Based on studies of bird behaviour on land it is evident that they have acute hearing. Noise disturbance impacts are possible both during installation and operation. The noisiest activity associated with tidal device installation is piling of monopole foundations. However, there is limited understanding of birds ability to hear underwater. Therefore, it is not possible to determine the level of significance of operational noise effects on marine birds.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive periods such as breeding or moulting.	**Negligible**
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**		No specific mitigation identified	**Unknown**
	Collision risk	Installation Operation Decom	Installation and decommissioning vessels; Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown**	Whilst there are no SPAs which overlap with Tidal Resource Zone 3, the adjacent coastline is protected by the Antrim Hills SPA and Larne Lough SPA. These areas are designated due to their importance for migratory birds and Annex I species. Furthermore, the adjacent coastline has been identified as an IBA. As such, the zone identified is likely to be important for marine birds, using the area for foraging and loafing. All species of marine birds present within the zone are potentially sensitive to collision impacts. Of these, the divers and pursuit divers are considered to be the most sensitive. Due to limitations in knowledge on the interactions between marine birds and devices with moving parts it is difficult to determine the potential significance of this effect which potentially has implications for all surface and diving birds.	During construction appropriate mitigation includes avoidance of sensitive sites and seasons; increasing vessel visibility; avoiding night working. During operation, visibility of above water and below water structures could be increased. In many parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and to aid site selection. Potential effects associated with collision risk could also be reduced through device design e.g. use of protective nets or grids.	**Unknown**

Table 11.10: Maiden Islands (Tidal Resource Zone 3) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Marine Birds	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. All surface birds are sensitive to hydraulic fluid contamination, and in particular auks (regularly occurring migratory birds – Article 4.2 Birds Directive) and divers (Annex 1 – Birds Directive) are highly sensitive to this effect. Whilst there are no SPAs which overlap with the tidal 3 zone of interest, the adjacent coastline is protected by the Antrim Hills SPA and Larne Lough SPA, which are important areas for migratory birds and Annex I species. Furthermore, the adjacent coastline has been identified as an IBA. These birds are likely to use the zone for foraging and loafing. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine birds would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures.	**Negligible**
Marine Birds	**Habitat exclusion**	Operation	Devices that occupy water surface and water column	**Tidal**	**Negative**	Locating devices in areas used for foraging and loafing could result in habitat exclusion and possible species displacement. There is limited information on precise foraging and loafing "hotspots" for different species of marine birds. Birds could be displaced from an area wider than the array site due to their potential avoidance responses. Although birds are mobile and could therefore avoid devices, the potential effects of increasing competitive pressures on adjacent populations and energetic costs of site avoidance also need to be considered. Given the distance from Larne Lough SPA, this could potentially have a negative effect, especially during the breeding season.	Effects on breeding bird colonies could be reduced by avoiding sensitive sites e.g. SPAs and areas close to seabird colonies. However, it may not be possible to avoid interactions with feeding and loafing birds present outside of the designated sites. In some parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and or loafing areas and to aid site selection.	**Negligible**
Marine Mammals	**Physical Disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Negative**	Harbour porpoise (Annex II –Habitats Directive) are frequently sighted in this area. Increased boat traffic will also increase ambient noise in the area and may disturb marine mammals, although, as described below, collisions are unlikely given the speed at which construction vessels will be moving.	The relative importance of this area for seals and cetaceans is unknown therefore monitoring surveys would be required to design a suitable mitigation plan. The effects of installation activities on seal colonies could be reduced by avoiding the breeding and moulting seasons. Cable routing should be planned to avoid impacting on seal breeding colonies or haul out sites.	**Negligible - negative**
Marine Mammals	**Marine Noise**	Installation	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	Piling generates high levels of noise. Studies at wind farms have demonstrated an effect on porpoise distribution during construction with animals displaced up to 15km. Noise can mask signals used by cetaceans to navigate, locate prey, and communicate effectively. Seals and cetaceans can detect piling noise up to a distance of 80km. Behavioural responses and physiological impacts such as temporary or permanent threshold shift in hearing could occur at closer distances. It is also quite possible that these noise sources mask biological relevant signals within the zone of audibility. The potential for noise from piling to affect these marine mammals is therefore considered to be "significant adverse". It is possible that minke whales detect wind farm related noise at considerable distances, (tens of km) during pile driving. Increased shipping associated with installation will raise ambient noise levels in the area.	At sea distribution data for seals is unknown for this area. Also cetacean abundance and habitat usage is unknown therefore dedicated marine mammal surveys would be required to identify the most appropriate site for development and to design adequate mitigation measures The use of gravitational concrete foundations is an alternative to piling but is only suitable in certain conditions. Seasonal or area restrictions could also be imposed so piling activities would be timed not to coincide with sensitive times such as seal moulting or pupping and porpoise breeding seasons. To mitigate for noise disturbance during piling there are a range of measures including the use of Marine Mammal Observers, exclusion zones, passive acoustic monitoring, pingers, soft starts/ramp up and/or bubble curtains. The efficacy of many of these procedures has not been proven to date.	**Negative- Significant Adverse**
Marine Mammals	**Marine Noise**	Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**	Effects of operational noise from tidal energy devices are unknown and may vary substantially with device design. There may be cumulative effects when many devices are operating together or when combined with other noise sources such as operational noise from other nearby tidal arrays.	Operational noise from operating tidal energy devices are unknown and are likely to vary according to device design. Mitigation measures will need to be device specific and as yet proven techniques are unknown.	**Unknown**

Table 11.10: Maiden Islands (Tidal Resource Zone 3) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	**Characteristic**	**Type**				
Marine Mammals	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**negligible**	Marine mammals can potentially collide with vessels and equipment used during installation. Increased shipping activity transiting to the area during installation will increase this risk. Generally most fatal injuries arise with collisions with ships travelling over 14kts. Vessels associated with construction activities would usually not be travelling at these speeds.	Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals both during construction activities and in transit to the construction area if entering areas of high animal abundance.	**Negligible**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown – significant adverse**	Collision risk with tidal energy devices is unknown for seals and cetaceans and the level of risk would depend on device design. However, for turbines with moving parts there is a clear collision risk for marine mammals, which could potentially be significant adverse for tidal devices, although further study is needed to better understand this impact. Collision with moving parts and fixed cables may also be a concern for baleen whales such as minke which may not detect the presence of these in the water and do not have the manoeuvrability of smaller cetaceans. However, the importance of this area to minke whales is unknown so the collision risk is difficult to quantify.	Collision risk during operation could be minimised through enhancing the visibility of marine devices to marine mammals, to maximise the possibility that the animals could detect it in time to react and avoid it. Consider potential measures to increase the acoustic visibility of undersea cables to marine mammals. New developments in active acoustic technology (e.g. sonar) are currently underway and may provide a potential monitoring and mitigation measure for operating turbines in the future.	**Unknown - negative**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on marine mammal health. Offshore tidal energy devices could present a collision risk to shipping. A collision between ships or a ship and a tidal device could result in fluid spills which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine mammals would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Tidal**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. Devices may exclude mammals from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. It is not possible to determine the potential significance of this effect.	No specific mitigation identified	**Unknown**
	Barrier to movement	Operation	Devices	**Tidal**	**Unknown – significant adverse**	Overall the movement of marine mammals around the coast of Northern Ireland is unknown so barrier effect is difficult to quantify. However development of tidal energy devices in constrained areas e.g. island channels may cause a barrier effect and restrict marine mammal movement. This effect could be relevant for the constrained areas within the Maiden Islands and associated rocky outcrops. Tidal Resource Zone 3 is located about 9 km offshore of the entrance to Lough Larne. Marine mammals entering and leaving the Lough could potentially be affected, although there are unrestricted areas around this zone that could potentially also be used by marine mammals.	The key mitigation measure for the impact is careful site selection to avoid key transit routes in and out of sea Loughs and other constrained areas. These areas are currently not well understood. Detailed study would be required to examine marine mammal distribution around the coast in order to fully understand and mitigate for this risk.	**Unknown - negative**
Marine mammals	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown - negligible**	The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains a complicated, understudied and unproven field of science (Basslink, 2001), with only circumstantial evidence. Cetaceans cross cables constantly, and there is no apparent evidence that existing electricity cables have influenced migration of cetaceans. However further study is thought warranted by the scientific community in this field (Gill *et al*., 2005). It should also be borne in mind that the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown - negligible**
Marine Reptiles	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Unknown**	The importance of the coast of Northern Ireland to marine turtles is unknown but there have been sightings of leatherback and loggerhead turtles. There is no information on the effects of tidal device construction on marine turtles so the risk is difficult to quantify.	Possible mitigation includes planning installation to take place at times when there are fewer turtles present or avoid potential migration routes.	**Unknown**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown**	There is no information on the effects of tidal devices on marine turtles so the risk is difficult to quantify		**Unknown**

Table 11.10: Maiden Islands (Tidal Resource Zone 3) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on turtle health. Tidal energy devices could present a collision risk to shipping. A collision between ships or a ship and a tidal energy device could result in an oil spill which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine reptiles would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Barrier to movement	Operation	Devices	**Tidal**	**Unknown**	The movement of marine turtles around the coast of Northern Ireland is unknown so it is difficult to quantify the level of barrier effect.	Mitigation measures to deal specifically with potential risks to marine turtles from offshore wind developments are unknown.	**Unknown**
Marine and coastal archaeology and wrecks	**Effects on submarine historic environment**	Installation	Piling, dredging, placing structures on seabed, cables, coring	**Tidal**	**Significant adverse to Negative**	There is some archaeological and heritage interest around Tidal Resource Zone 3 with a potential for the presence of prehistoric submarine remains. PMRA protected aircraft wrecks may be present and a number of miscellaneous wrecks have been recorded in the area. There is potential for the installation of tidal devices and export cables to impact submarine archaeology through direct disturbance of known and unknown sites on the seabed, or through changes to sediment movements causing an artefact to become buried and preventing later discovery. There is also a potential positive impact associated with development related seabed survey providing additional data for inclusion in the archaeological record of the area.	Follow NIEA and Crown Estates 2007 JNAPC code of conduct and guidance note for the offshore renewable energy sector. Carry out seabed investigations in preferred site locations prior to device installation. Avoid sites of interest and exclusion zones for protected sites.	**Negligible**
	Effects on coastal and terrestrial historic environment	Installation	Cables, shoreline devices	**Tidal**	**Significant adverse to Negative**	There is some terrestrial archaeological and heritage interest on the shoreline adjacent to the area. Locally and regionally important archaeological remains and sites (NMRS) are present along the coast. Numerous listed buildings are also present. Two scheduled sites of interest are a church and graveyard at Solar and a Motte near Ballyruther. Cable installation in the vicinity of these protected sites could cause direct destruction of archaeologically important features.	The main form of mitigation is to avoid protected and other sites of interest. In addition to desk based studies it will be necessary to carry out field walkovers in preferred site locations to determine need for site investigations (geophysical surveys/trial trenching) in consultation with NIEA and Local Authorities. With respect to cabling there is considerable opportunity to avoid or reduce effects. The siting and design of shoreline devices will be important in determining their residual impact.	**Negligible**
Commercial Fisheries	**Direct disturbance of fishing grounds**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative to Significant adverse**	The key commercial interests in the immediate area are lobster and crab pot fisheries around The Maidens with scallop dredging and pot fishing along the Antrim coast. Tidal Resource Zone 3 coincides directly with the lobster potting areas, but mobile dredging gear for scallops or finfish cannot be operated in the areas of strong tidal energy. Development will therefore have a potentially negative significance effect on lobster potting areas. In terms of commercial fisheries this effect could potentially be of adverse significance.	In terms of direct disturbance to commercial shellfisheries, the main form of mitigation would be to avoid key commercial fishing grounds. The effects could also be minimised by using tidal devices that use less intrusive forms of attachment e.g. gravity bases	**Negative - negligible**
	Temporary displacement from traditional fishing grounds	Installation Decom	Vessels, installation equipment and devices	**Tidal**	**Negative**	Inshore fishing grounds tend to be more constrained than offshore areas. Temporary displacement from these areas may lead to the concentration of fishermen in smaller areas, fishermen being unable to fish for short periods or fishermen being displaced to alternative, possibly less productive fishing grounds. Key commercial shellfish in this general area are lobster, crab and king scallop. Temporary displacement will potentially have a negative significance effect on commercial fisheries.	Effects associated with the temporary displacement of traditional fishing grounds can be reduced by avoiding key commercial fishing grounds or by phasing construction activities to specific areas within Tidal Resource Zone 3. Liaison with the fishing community to keep them informed of installation operations is also key to managing the level of this impact.	**Negative - negligible**
	Long term displacement from traditional fishing grounds	Operation	Devices that occupy water surface, water column and seabed	**Tidal**	**Negative to Significant adverse**	Tidal Resource Zone 3 coincides directly with the lobster potting areas, but mobile dredging gear for scallop and finfish cannot be operated in the areas of strong tidal energy. The effects of long term displacement on inshore lobster potting areas could be of adverse significance. Use of rock armour, if required for cable protection, could introduce an obstruction for scallop dredging activity, but could also create new habitat which could have a positive impact of fish stocks.	The long term displacement of commercial shellfish fisheries could be reduced or avoided by avoiding key fishing grounds.	**Negative - negligible**
Mariculture	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**No effect**	There are no aquaculture developments in or near to Tidal Resource Zone 3 and future development is unlikely due to absence of required physical conditions.	N/A	**No effect**

Table 11.10: Maiden Islands (Tidal Resource Zone 3) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Tidal**	**No effect**	There are no aquaculture developments in or near to Tidal Resource Zone 3 and future development is unlikely due to absence of required physical conditions.	N/A	**No effect**
	Substratum loss	Operation	Devices using seabed foundations e.g. piled devices	**Tidal**	**No effect**	There are no aquaculture developments in or near to Tidal Resource Zone 3 and future development is unlikely due to absence of required physical conditions.	N/A	**No effect**
Ports, Shipping and Navigation	**Displacement of shipping movement**	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Tidal**	**Significant adverse to Negative**	The re-routing of vessels to avoid safety zones (during installation), operational devices and decommissioning activity would result in greater transit time and use of fuel with the associated costs to the vessel operator, and could also lead to an increase in vessel densities in areas that already have moderate vessel densities. This could lead to increased encounter rates and increased risk of collision. Tidal Resource Zone 3 is located directly adjacent to the North Channel shipping lane where shipping intensity is high. Tidal Resource Zone 3 is also directly north of the important ferry port of Larne, a large number of vessels traverse the North Channel in an east-west direction between Larne and ports in Scotland and England. However, the shipping densities within Tidal Resource Zone 3 are moderate to low. Depending on the location of the devices within the zone the effect of re-routing vessels to accommodate tidal devices would be negative to significant adverse.	The potential for these effects to be reduced would depend entirely upon the siting of a device in relation to the key shipping routes. There is potential to reduce or avoid significant adverse effects by siting devices so that they are sufficiently distanced from main shipping channels. The scale of potential effect on navigation should be assessed as part of the EIA and the Navigational Risk Assessment (NRA). The assessment should include: • A survey of vessels in the vicinity of the proposed development • Full NRA of the likely impact of the development on navigation, taking into consideration MGN 371 (MCA 2008), MGN 372 (MCA 2008b) and the DTI Guidance Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (DTI 2005) (also considered relevant for other renewable devices). • Cumulative impact assessment	**Negligible**
		Operation	Tidal devices	**Tidal**	**Significant adverse to Negative**			
	Decreased trade/supply	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Tidal**	**Negligible**	The deployment of installation and maintenance vessels, presence of devices and decommissioning activity could create temporary to long-term reductions in access to ports and harbours. Tidal Resource Zone 3 is near to the port of Larne and reduced access to this port would have a significant effect on goods transport and accessibility. However Tidal Resource Zone 3 is not directly adjacent to the port and so likelihood that Larne would have restricted access is low and therefore negligible.	Site selection for device arrays should take into account the requirement for continued access to port and harbours. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning.	**Negative - negligible**
		Operation	Tidal devices	**Tidal**	**Negligible**			
	Reduced visibility	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Significant adverse**	Vessels and other equipment used during the installation of devices, and the operational devices themselves could obstruct views of other vessels and navigation features such as buoys, lights and the coastline. This is particularly important in areas of high vessel densities, constrained channels or areas where there is particular dependence on visual navigation aids as reduced visibility increases the risk of collision with other ships and other structures in the water (natural and man made). Tidal Resource Zone 3 is located within a constrained channel that contains very high shipping densities as a result the effect of reduced visibility would be significant adverse.	Significant adverse effects associated with reduced visibly could be reduced by siting devices away from areas of high vessel densities. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Any vessels and devices should be lit and marked in accordance with regulations and MCA and Trinity House guidance	**Negligible**
		Operation	Tidal devices	**Tidal**	**Significant adverse**			
	Collision risk	Installation Decom	Vessels and equipment used for installation and Decommissioning	**Tidal**	**Significant adverse**	Collision risk considers the risk of navigating vessels colliding with vessels and equipment used during installation, maintenance and decommissioning, and the devices themselves once operational. Collision risk also considers the increased risk of collision between navigating vessels. In both circumstances the risk of collision is increased in constrained channels and areas with high vessel densities as in the North Channel. Tidal zone 3 is located within the North Channel and so the risk of collision in this area will potentially be significant adverse.	The risk of collision could be reduced by siting devices away from main shipping routes. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning. The scale of potential effect on navigation should be assessed as part of the EIA and NRA as outlined above.	**Negative**
		Operation	Tidal devices	**Tidal**	**Significant adverse**			

Table 11.10: Maiden Islands (Tidal Resource Zone 3) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Recreation and Tourism	Disturbance to Wildlife	Installation Operation Decom	Installation activities including noise, vessel movements, operation of devices, decommissioning activities	**Tidal**	**Negligible**	Effects on local tourism would occur where disturbance and/or exclusion from an area overlaps with the locations frequented by visitors and touring vessels. The east coast of Northern Ireland is not considered to be of particular importance for recreational wildlife watching.	None identified.	**Negligible**
	Safety and Collision Risk	Installation Operation Decom	Presence of new structures in the water	**Tidal**	**Negative**	The key receptor affected is sailing. Cruising routes (medium recreational use) are present in the immediate vicinity of Tidal Resource Zone 3. Tidal developments could therefore potentially have a negative effect on recreational sailing.	Safety measures including lighting and marking and informing users of the locations of devices. Locate devices away from cruising routes. Use alternative devices which lie below the surface of the water to a depth which does not affect sailing.	**Negligible**
	Access Restrictions	Installation Operation Decom	Structures in the sea reducing or excluding access	**Tidal**	**Negative**	The key receptor affected is sailing. Cruising routes (medium recreational use are present in the immediate vicinity of Tidal Resource Zone 3. Tidal developments could therefore potentially have a negative effect on recreational sailing.	Avoid cruising routes. Devices which exclude access to an area will have greater effects than those which allow movement through the array. Use alternative devices which lie below the surface at a depth which does not affect sailing.	**Negligible**
Military Exercise Areas	**Disruption to general activities**	Installation Operation	All tidal devices	**Tidal**	**Significant adverse to Negligible**	The entire area lies within the military practice and exercise area X5527 - Maiden. This area is used by the Navy for submarine exercises, aircraft and H.M ships. Dependent on the extent to which the area is used by the navy, significance of this effect could be considered to be significant adverse to negligible.	Consultation with the MOD will be required to enable appropriate site selection in order to reduce or eliminate the risk of interference associated with non-bylawed practice and exercise areas.	**Negligible**
Disposal Areas	**Disruption to access**	Installation Operation	All Tidal devices	**Tidal**	**No effect**	There are a two disposal sites inshore of Tidal Resource Zone 3, one is close to the adjacent coastline, at a nearest distance of about 4 km from this zone. There are no disposal sites within the zone itself. It is unlikely that access to these will be restricted as a result of activities in this area.	Avoidance of the sites by approximately 500m can mitigate against the possibility of access to the sites in the area being inhibited for users.	**No effect**
Cables and Pipelines	**Direct damage**	Operation Installation	All tidal devices Cables	**Tidal**	**No effect**	There are no cables or pipelines in the study area therefore no impacts are expected.	None required	**No effect**
	Reduced access	Operation Installation	All tidal devices Cables	**Tidal**	**No effect**	There are no cables or pipelines in the study area therefore no impacts are expected.	None required	**No effect**
Aggregate extraction	**Presence of devices**	Operation Installation	All tidal devices	**Tidal**	**Unknown / No effect**	There are no existing or proposed aggregate dredging areas within this area therefore there will be no effects on aggregate extraction. Impacts on possible future aggregate extraction sites, based on aggregate resources that have not yet been identified include restricted access to and sterilisation of possible sites. However these impacts are impossible to quantify at this stage.	None identified	**Unknown / No effect**
Oil and gas resources	**Presence of devices**	Operation	All tidal devices	**Tidal**	**Unknown**	The installation of tidal turbines has the potential to sterilise areas that could have been used for oil and gas exploitation. The Larne Basin which overlaps with this zone is identified as an area with oil and gas potential. However, there is currently insufficient data to establish possible future exploitation of oil and gas from this area. Therefore, whilst no sites are currently under consideration for oil and gas exploitation in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**
Natural Gas and CO_2 storage	**Presence of devices**	Operation	Piled devices	**Tidal**	**Unknown**	The installation of piled tidal devices has the potential to sterilise areas that could have been used for CO2 or natural gas storage. There is currently insufficient data to establish potential for use of the marine environment for storage of CO_2. Therefore, whilst no sites are currently under consideration for natural gas or CO_2 storage in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**

Table 11.10: Maiden Islands (Tidal Resource Zone 3) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Landscape/Seascape	Effects on seascape	Operation	Arrays of surface point structures over 10m above surface	**Tidal**	**Significant Effect (0 to 5km)** **Moderate Effect (between 5 and 15km offshore from coast)** **Slight Effect (beyond 15km offshore from the coast)**	Tidal Zone 3 is located along the east coast of Northern Ireland. The adjacent coastline which includes landscape character areas of Fair Head to Blackhead and Larne Lough (southern extent of this section of coastline) comprise five main seascape types: • 2: 2: Inner sea lough enclosed by narrow mouth with raised hinterland (associated with Larne Lough) – enclosed, sheltered and tranquil character. Views to the open sea are obscured by surrounding topography. • 3: Sounds at mouth of enclosed sea lough with raised hinterlands – intimate character, small coastal settlements and small harbours, enclosed, inward views, sheltered and tranquil rural character. • 5: Narrow coastal strip with raised hinterland – exposed with elevated dramatic open and expansive views out to sea. 6: Complex indented coast, small bays and offshore islands – changing views from enclosed views associated with indented bays and inlets to long expansive views from raised headlands and hinterland. • 7: Plateaus and high cliffs – dramatic seascape with open expansive and elevated views with coastal edge of vertical cliff faces arches and raised plateau. Parts of this coastline are also covered by a number of designations these include: • Antrim Coast and Glens AONB – designated 1998 for its varied and dramatic landscape and seascape predominantly of cliffs, incised and narrow coastal strip with wide bays at the foot of steeply raked glens. Due to their intimate nature and distance from Tidal Zone 3 it is unlikely that there will be any effects on Larne Lough and associated seascape types (2 and 3). Seascapes 5 and 7 are of medium sensitivity to on-surface point tidal devices and seascape 6 is of high sensitivity to these types of devices. Although these do not protrude above the surface to the same extend as offshore wind devices they could reach heights of up to 14m above the water surface. The threshold of visibility (which influences magnitude of change) for tidal devices is also lower than for offshore wind. There is potential for significant adverse effects to occur between 0 and 5km from the coast. However, these effects will reduce to negative between 5 and 15km from the coast and to negligible beyond 15km.	Potential adverse effects on seascape can be reduced through the sensitive siting of tidal device arrays. Key factors to be considered in locating a tidal array include: • Identifying opportunities to deploy submerged devices where possible to avoid adverse effects. • Limit the use of markers (buoys and lights) in highly sensitive areas and recognising the requirements in terms of navigational safety. • Maximising the distance from shore of tidal array developments • Avoid deploying tidal arrays that protrude above the water surface in areas where they appear to block or close the entrance to bays/loughs/ narrows/sounds or where they separate a bay from the open sea • Tidal arrays that protrude above the water surface should reflect the shape of the coastline and align with the dominant coastal edge; • Tidal arrays that protrude above the water surface should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate; • Tidal arrays that protrude above the surface should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement; • Tidal arrays that protrude above the surface should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms.	**Slight Effect**
		Operation	Arrays of submerged structures	**Tidal**	**Moderate Effect (0 to 5km)** **Slight Effect (5 to 15km)** **No effect (beyond 15km offshore)**	It is expected that there would be minimal effects on seascape quality and character from submerged devices although there could be some adverse effects associated with buoys or navigation lights which may be required for safety reasons. Given that this area overlaps with areas of moderate use by vessels, it is likely that there will be a requirement for any submerged devices to be clearly marked with buoys and lights. In the nearshore area (0 to 5km) this could have a negative effect on seascape quality. However this will reduce to negligible offshore.	Limit use of safety lights where appropriate (and providing this does not reduce navigational safety in the area)	**Slight Effect**
Climate	Carbon Impacts	Operation	Wind turbines	**Wind**	**Positive**	It is recognised that development of offshore wind farms will contribute towards achieving the Northern Ireland target for 40% energy to be provided from renewable energy sources. In meeting this target the Northern Ireland Assembly will be working towards the wider national, European and international commitment to combat global climate change and reduce the potential associated adverse environmental effects e.g. changing population distributions, species extinction, sea level rise etc. However, whilst seeking to combat climate change there is also a need to respond to it in terms of: • Protecting the existing environment and increasing its robustness and ability to adapt to climate change • Protecting existing and future infrastructure from effects of climate change e.g. increased storm events , flooding and sea level rise	Ensure that coastal infrastructure is sited in locations that are at lower risk from flooding, sea level rise and storm damage and do not increase the risk of flooding or damage to coastal infrastructure elsewhere. This will require close consultation at the project design stage with the relevant land use planning authority.	**Positive**
	Carbon Storage	Installation Operation	Wind turbines	**Wind**	**No effect**	Based on current available information no existing or proposed carbon or gas storage sites have been identified within this area (Offshore Wind Resource Zone 1) therefore there will be no effect resulting from the development of offshore wind farms.	None required	**No effect**

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Bathymetry	**The information presented in this chapter has been used to inform the results of the assessment. No specific impacts on bathymetry are expected.**							
Geology, geomorphology and sediment processes	**Changes in seabed morphology**	Installation	Export cable trenching Devices using seabed foundations e.g. piled devices	**Tidal**	**Negative to Significant adverse**	The Copeland Islands are a small chain of low lying rocky islands located 2km off the mainland that are separated by sounds. Tidal currents race through the sounds. There are a number of sandy beaches on Copeland Island that is closest to the coast. The islands are surrounded by coarse and fine sediment plains interspersed closer to the islands by rocky reef system. Piling and trenching over the rocky outcrops near to the islands could have a significant adverse impact to the seabed morphology. The piled devices will also induce local scour around the structures if the seabed is composed of sand which is the case for the outer zone surrounding the islands. Local scour effects could negatively impact on the seabed morphology and the local sediment transport regime.	Careful site selection is key to keeping impacts to a minimum. To reduce impacts, devices should be sited away from the rocky outcrops close to the islands. Potential effects of local scour on sediment transport will need to be assessed through morphological site surveys and hydrodynamic/sediment transport modelling at the project stage. Site specific geophysical and geotechnical survey will be required to establish a baseline and inform the impact assessment for individual developments.	**Negative**
	Changes in coastal processes	Operation	Devices using seabed foundations e.g. piled devices Devices using energy generated by waves or tidal currents	**Tidal**	**Negative to Significant adverse**	The physical presence of devices on the seabed, will not only induce local scour but also alter the pattern of flow and the dynamics of the flow regime by removing the tidal energy. It is estimated that such changes will extend up to 50 m from devices and is therefore localised to the vicinity of the device array, but will be effective for the operational life of the device. Suspended sediment transported into the vicinity of a tidal array by the currents may be locally deposited where there is an appreciable reduction in tidal energy. If located close to the coast, tidal arrays could impact on the coastal processes by removing the tidal energy that would otherwise transport suspended sediment along the coast. The reduction in tidal energy could possibly lead to deposition of sediment in the vicinity of an array while depriving sediment deposition down coast possibly leading to coastal erosion. Tidal Resource Zone 4 extends between 2 km and 10 km from the adjacent mainland, and between 0 and 7 km from the Copeland islands themselves. Development in the areas of the zone closest to the relevant shorelines could therefore potentially lead to significant adverse impacts on the coast.	The degree of potential impacts depends on the process of fixing the structures to the seabed, how closely individual devices are spaced, and how far offshore the plant is located. Careful site selection is key to keeping impacts to a minimum. Impacts at the coastline will be reduced with increasing distance from the shore, subject to more detailed studies and modelling to better understand impacts at the coast. Modelling the effects of device operation on the current and sediment transport regime should form part of pre-project activities to optimise location.	**Negligible**
Seabed Contamination and Water Quality	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Minor (<1 tonne) discharges that do not impact the coastline are unlikely to have a significant effect on water quality as they will rapidly weather and dissipate. There is a possibility that spillages may enter the sheltered waters of Belfast Lough. Larger spillages and spillages which come ashore may have significant adverse impacts.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Disturbance of contaminated sediment	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negligible to Significant adverse**	Active dredging spoil disposal sites are present within and adjacent to Tidal Resource Zone 4. In view of the high tidal flows in this area it is likely that deposited material has already been dispersed, and the dredged material deposited in this area is likely to be relatively uncontaminated. If material in the disposal site is disturbed by device installation activities, it will be rapidly diluted and dissipated. Therefore the effect on water and sediment quality is likely to be negligible. Munitions migrated from Beauforts dyke munitions disposal site or relict from wartime activities (e.g. wrecks or minelaying) may be encountered. Disturbance could result in significant adverse effects.	Effects on water quality due to the disturbance of contaminated sediment can be reduced through avoidance of potentially contaminated seabed areas (500m buffer). Identification and avoidance of areas of munitions contamination through site survey at the project stage. If munitions are encountered Crown Estates 2006 (Dealing with munitions in marine aggregates) should be followed.	**Negligible**

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Protected Sites and Species	**Impacts on protected sites**	Installation Operation	Marine devices	**Tidal**	**Significant adverse**	Within Tidal Resource Zone 4, there are a number of protected areas. Areas identified as potential Annex I habitat for rocky reef occurs over a large proportion of the zone. There are also small patches of potential Annex I habitat of sandy sediment in <20m water depth. Part of the zone is currently under consideration for designation as a marine SAC and/or Marine Conservation Zone. The Copeland Islands are also protected as AONB, and support several seabird colonies. In the vicinity of the tidal zone, the coastline of the Outer Ards is also extremely important. It is protected under Ramsar, is an SPA and also an ASSI. As such, the impacts of installation of marine devices could impact directly on the site (through physical disturbance such as habitat loss or loss of substratum) and indirectly through smothering or increased suspended sediment and turbidity. Given the ecological sensitivity of this zone, these impacts are considered to have significant adverse effect on the area.	There is limited potential to avoid the PAIH rocky reef habitat through site selection. Site specific benthic surveys would be required to characterise the benthic communities occupying this potential site. Should the site be confirmed as a marine SAC / MCZ for benthic communities then possibilities for mitigating impacts would be primarily associated method of attachment to the seabed and minimising seabed disturbance, and timing installation to avoid sensitive periods, if appropriate. However, it is likely that impact significance could not be reduced any further than to negative.	**Significant adverse to negative**
	Impacts on protected species	Installation Operation	Marine device	**Tidal**	**Significant adverse**	Although there are no protected sites designated for species within Tidal Resource Zone 4, the Outer Ards SPA and Ramsar site, and Belfast Lough SPA (designated for important bird species) are in close proximity with the zone. In addition, marine mammals, seals, seabirds and fish are found throughout the region, as are important benthic species. The impacts on these receptors are discussed in the relevant sections of the table below.	See sections below on benthic ecology, fish and shellfish, seabirds and marine mammals.	**Negative to Negligible**
Benthic and Intertidal Ecology	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenches	**Tidal**	**Significant adverse**	Tidal Resource Zone 4 contains a potential Annex I rocky reef habitat, and may also contain tidal rapid habitat, which will be sensitive to smothering resulting from seabed disturbance. However, strong tidal streams will disperse disturbed sediment rapidly and it is expected that sublittoral sands and gravel habitat would be largely unaffected by small amounts of deposited sediment in tide swept areas. Smothering impacts will be localised to the immediate vicinity of the seabed disturbing activities during installation, however as this will potentially impact Annex I habitats of European importance, this is potentially a significant adverse impact.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (gravity bases). Potential effects on unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
Benthic and Intertidal Ecology	**Contamination – from sediment disturbance**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negligible**	Tidal rapid, reef habitats and sublittoral sand and gravel habitat are highly sensitive to contamination. These habitats are likely to be present in or adjacent to Tidal Resource Zone 4. However the dredged material present at the disposal sites in this zone is unlikely to contain high levels of contamination, and due to the high tidal currents in the area any disturbed sediment is likely to rapidly disperse with negligible effect.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (such as gravity bases). Avoidance of areas of known potential contamination for seabed disturbing works. Potential effects on areas of unknown benthic habitat will need to be assessed through site survey at the project stage.	**Negligible**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. This area contains tidal rapid habitats and potential reef and sublittoral sand and gravel habitat that are of high sensitivity to contamination. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on benthic ecology would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan). Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Changes in tidal flow	Operation	Devices that extract energy generated by tidal currents	**Tidal**	**Significant adverse**	Tidal rapid habitats are highly sensitive to changes in tidal current regime. Changes to tidal flow regimes could influence the structure of tidal swept sand and gravel habitats although impacts would be localised. Given the presence of these priority habitats in this zone, the effects could potentially be of adverse significance.	Avoidance of these important habitats though careful site selection would reduce the potential effects of energy extraction, although it may not be possible for these effects to be removed completely. Site specific benthic survey would be needed to determine the extent of the sensitive habitats in this zone. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Unknown**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	All benthic communities can be expected to be sensitive to removal of their habitat. The long term loss of substratum due to the presence of devices that are attached to the seabed will therefore have a potentially significant adverse effect on any rare or important benthic habitats, such as those listed in the UKBAP and protected under the Habitats Directive. Much of Tidal Resource Zone 4 is overlapped by a potential Annex I rocky reef area.	Effects on benthic ecology from substratum loss can be reduced either through avoidance (careful site selection) or using devices that have a smaller footprint on the seabed e.g. gravity bases. It may not be possible for the sensitive habitats to be avoided completely. Site specific benthic survey would be needed to determine the extent of the sensitive habitats in this zone. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Significant adverse - Negative**
Fish and Shellfish	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative**	Tidal Resource Zone 4 contains key shellfish areas including *Nephrops,* scallops and queen scallops. Lobster, edible crab and velvet crab are also present In this zone. In addition, Belfast Lough supports whelks and mussels. These species live on, near or in the bottom sediments of the seabed, and are therefore sensitive to smothering impacts. Sprat are also known to spawn on the seabed in this area. These species range from low to high sensitivity to smothering, although this impact will be localised to the immediate vicinity of seabed disturbing activities and limited to during installation.	For devices that require piling, and cable trenching, potential effects could be mitigated by avoiding installation during the spawning and nursery seasons, and by avoiding key shellfish areas.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	High levels of noise such as during pile installation may cause physiological or displacement effects to marine fish although the extent to which this may occur is unknown. In particular, herring and cod are known to be highly sensitive to noise and may be able to detect piling noise up to 80km. Both species are present in the study area and therefore may be present Tidal Resource Zone 4, although herring generally only occurs in coastal waters (0 to 20m). It is expected that noise levels from piling and the removal of piled devices will be greater than those generated by operational devices, and although pile driving only occurs during installation the effects may last for longer than the piling activities as fish may not immediately return to the area. There is potential for noise from operational devices to lead to longer term species displacement which could increase pressures on fish populations in other locations and force fish into predator habitats.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive spawning periods.	**Negative - negligible**
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**		No specific mitigation measures have been identified	**Unknown**
	Collision risk	Operation	Turbines/moving part of devices / mooring chains and cables	**Tidal**	**Unknown**	There is potential risk that all mobile fish species could collide with turbines or moving parts of submerged devices (e.g. turbines). Larger animals (such as basking sharks (UKBAP species)), and pelagic species are considered to be of greater risk. Basking shark and other pelagic fish species are present throughout the study area, and will be present within Tidal Resource Zone 4. However, due to uncertainties with data and knowledge on the interactions between fish and devices, the potential significance of collision risk effects is unknown.	Potential effects associated with collision risk and fish could be reduced through device design e.g. use of protective nets or grids. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**Unknown**
	Hydraulic injury	Operation	Shrouded devices (i.e. venturi devices)	**Tidal**	**Unknown**	There is potential risk that mobile fish could suffer injury or mortality through pressure changes occurring within the turbine as water is sucked through it. This effect is only relevant for shrouded tidal devices such as venturi devices, which use shrouding to constrict the flow, thus leading to a pressure low after the constriction. This effect is likely to be more significant for smaller species. Larger species sucked through the turbine would be more likely to suffer collision impacts.	Possible impacts associated with shrouded turbines can be addressed by using screens to prevent marine organisms from entering the device. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**No impact**

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Fish and Shellfish	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Small spillages are likely to have a negligible impact. Large spillages, particularly where they impinge on the coastline or enter Belfast Lough could have a significant adverse impact.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Tidal**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. In terms of demersal species this effect would only apply to devices using seabed foundations. For pelagic species the position of submerged devices in the water column and the proportion of the water column occupied would be most relevant. Due to the vast number of variables associated with device types and the types of fish that could be affected it is not possible to determine the potential significance of this effect. The presence of tidal arrays may also have a positive effect on fish populations through fish stock recovery, should certain types of fisheries be excluded from the array.	No specific mitigation identified	**Unknown**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	Tidal Resource Zone 4 contains key shellfish areas including scallops, *Nephrops*, and queen scallops. Lobster, edible crab and velvet crab are also present in this zone. In addition, Belfast Lough supports whelks and mussels. These species live on, near or in the bottom sediments of the seabed. Sprat are also known to spawn on the seabed in the area. The effect of substratum loss could therefore potentially be of adverse significance. Removal of habitat during installation and operation of tidal turbines could result in the long term removal of the habitat used by these species, although alternative adjacent habitat may be available.	The potential effects of substratum loss on shellfish and benthic spawners could be reduced by avoiding sensitive areas e.g. key shellfish beds and spawning grounds and or using devices that use less intrusive seabed attachment such as gravity bases.	**Negative - negligible**
Fish and Shellfish	**Barrier to movement**	Operation	Devices that occupy the water column	**Tidal**	**Unknown**	Some species, such as Atlantic salmon, trout and eels spend part of their lifecycle in freshwater and part at sea. Migration between these two waterbodies is important for the survival of the species. This zone may be used by these species accessing the river Lagan which flows into Belfast Lough, which is known to contain populations of salmon and sea trout. Installation of tidal devices could present a barrier to migration, although the exact impacts on fish species is unknown.	No specific mitigation identified	**Unknown**
Fish and shellfish	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown - negligible**	Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical renewable array power cable, but the field would not cause an avoidance reaction. Atlantic salmon, eels and Sea Trout are believed to be sensitive to magnetic fields. However, the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables. There is no evidence to indicate that existing cables have caused any significant effect on migration patterns of these species. However, the significance of potential effects cannot be adequately quantified on the basis of current information.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown - negligible**
Marine Birds	**Physical disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Significant adverse - negative**	Physical disturbance is of particular importance in terms of breeding colonies as high levels of physical disturbance could lead to species displacement (short-term to long-term). Physical disturbance is also important in terms of foraging and loafing at sea. Although there are no SPAs which overlap with the zone, a pSPA has been identified, and the presence of seabird colonies and breeding seabirds on the Copeland Islands, and the importance of the Outer Ards coastline for seabirds is a serious consideration. In fact, the Copeland Islands are within the boundary of an area identified as the Outer Ards Peninsula IBA. The Outer Ards is designated as Ramsar and SPA. This area is protected due to presence of Annex I species, migratory populations and over-wintering populations. The close proximity of Tidal Resource Zone 4 to these areas (~1km at the closest point) means that the effect of physical disturbance during installation is considered significant adverse both with regard to breeding colonies and for feeding and loafing areas beyond the boundaries of the SPA and Ramsar sites.	Effects on breeding bird colonies could be reduced by avoiding sensitive sites e.g. SPAs and seabird colonies and to restricting installation to avoid the most -sensitive seasons e.g. breeding. In some parts of this zone, site specific surveys may be required at the project level to identify the presence of key foraging hotspots and or loafing areas and to aid site selection.	**Negative**

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Tidal**	**Negative**	Based on studies of bird behaviour on land it is evident that they have acute hearing. Noise disturbance impacts are possible both during installation and operation. The noisiest activity associated with tidal device installation is piling of monopole foundations. However, there is limited understanding of birds ability to hear underwater. Therefore, it is not possible to determine the level of significance of operational noise effects on marine birds.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive periods such as breeding or moulting.	**Negligible**
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**		No specific mitigation identified	**Unknown**
	Collision risk	Installation Operation Decom	Installation and decommissioning vessels; Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown**	The Copeland Islands support a number of seabird colonies and are important for breeding seabirds (designated as ASSI, and within the Outer Ards Peninsula IBA). In addition the adjacent coastline of the Outer Ards is of high importance for breeding marine birds (Annex I species), migratory populations and over-wintering populations. The Belfast Lough SPA, and Belfast Lough Open Water pSPA is also within the vicinity of Tidal Resource Zone 4. As such, there are likely to be a large number of seabirds using the zone for foraging and loafing. All species of marine birds present within the area are potentially sensitive to collision impacts. Of these, the divers and pursuit divers are considered to be the most sensitive. Due to limitations in knowledge on the interactions between seabirds and devices with moving parts, it is difficult to determine the potential significance of this effect which potentially has implications for all surface and diving birds.	During construction appropriate mitigation includes avoidance of sensitive sites and seasons; increasing vessel visibility; avoiding night working. During operation visibility of above water and below water structures could be increased. In many parts of the development area site specific surveys may be required at the project level to identify the presence of key foraging hotspots and to aid site selection. Potential collision risk effects during device operation could potentially be reduced through device design e.g. use of protective nets or grids.	**Unknown**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. All surface birds are sensitive to hydraulic fluid contamination, and in particular auks (regularly occurring migratory birds – Article 4.2 Birds Directive) and divers (Annex 1 – Birds Directive) are highly sensitive to this effect. Given the importance of the Copeland Islands (designated as ASSI and important for breeding seabirds and waders, and within the Outer Ards Peninsula IBA), and the close proximity of the Outer Ards SPA and Ramsar site and Belfast Lough SPA, and Belfast Lough Open Water pSPA it is likely that a number of auks and divers will be present in the area. Whilst the likelihood of accidental contamination from devices is low, if it were to occur, the potential effects on marine birds would be significant adverse.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
Marine Birds	**Habitat exclusion**	Operation	Devices that occupy water surface and water column	**Tidal**	**Negative to Significant adverse**	Locating devices in areas used for foraging and loafing could result in habitat exclusion and possible species displacement. There is limited information on precise foraging and loafing "hotspots" for different species of marine birds. Birds could be displaced from an area wider than the array site due to their potential avoidance responses. Although birds are mobile and could therefore avoid devices, the potential effects of increasing competitive pressures on adjacent populations and energetic costs of site avoidance also need to be considered. This could potentially have a significant adverse effect during the breeding season and a negative effect on marine birds at other times of the year, especially if it increased population pressures in other locations.	Without a more detailed understanding on the location of key foraging and loafing habitats, it is difficult to identify appropriate mitigation measures other than to avoid sensitive sites. Studies would be needed at the project level to identify the presence of key foraging hotspots and loafing areas in the development area to aid site selection.	**Negligible**
Marine Mammals	**Physical Disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Negative**	Grey seals (Habitats Directive Annex II species) are known to breed on the Copeland Islands, however the overall importance of the area for cetaceans is not well understood. Increased boat traffic will also increase ambient noise in the area and may disturb marine mammals, although, as described below, collisions are unlikely given the speed at which construction vessels will be moving.	The relative importance of this area for cetaceans is unknown therefore monitoring surveys would be required to design a suitable mitigation plan. The effects of installation activities on seal colonies could be reduced by avoiding installation during the breeding and moulting seasons. Cable routing should be planned to avoid impacting on seal breeding colonies or haul out sites.	**Negligible - negative**

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Marine Noise	Installation	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	Piling generates high levels of noise. Studies at wind farms have demonstrated an effect on porpoise distribution during construction with animals displaced up to 15km. Noise can mask signals used by cetaceans to navigate, locate prey, and communicate effectively. Seals and cetaceans can detect piling noise up to a distance of 80km. Behavioural responses and physiological impacts such as temporary or permanent threshold shift in hearing could occur at closer distances. It is also quite possible that these noise sources mask biological relevant signals within the zone of audibility. The potential for noise from piling to affect these marine mammals is therefore considered to be significant adverse. It is possible that minke whales detect wind farm related noise at considerable distances, (tens of km) during pile driving. Increased shipping associated with installation will raise ambient noise levels in the area.	At sea distribution data for seals is unknown for this area. Also cetacean abundance and habitat usage is unknown therefore dedicated marine mammal surveys would be required to identify the most appropriate site for development and to design adequate mitigation measures The use of gravitational concrete foundations is an alternative to piling but is only suitable in certain conditions, and for certain device types. Seasonal or area restrictions could also be imposed so piling activities would be timed not to coincide with sensitive times such as seal moulting or pupping and porpoise breeding seasons. To mitigate for noise disturbance during piling there are a range of measures including the use of Marine Mammal Observers, exclusion zones, passive acoustic monitoring, pingers, soft starts/ramp up and/or bubble curtains. The efficacy of many of these procedures has not been proven to date.	**Negative-Significant Adverse**
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**	Effects of operational noise from tidal energy devices are unknown and may vary substantially with device design. There may be cumulative effects when many devices are operating together or when combined with other noise sources such as operational noise from other nearby installations.	Operational noise from operating tidal energy devices are unknown and are likely to vary according to device design. Mitigation measures will need to be device specific and as yet proven techniques are unknown.	**Unknown**
Marine Mammals	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Negligible**	Marine mammals can potentially collide with vessels and equipment used during installation. Increased shipping activity transiting to the area during installation will increase this risk. Generally most fatal injuries arise with collisions with ships travelling over 14 knots. Vessels associated with construction activities would usually not be travelling at these speeds.	Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals both during construction activities and in transit to the construction area if entering areas of high animal abundance.	**Negligible**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown – significant adverse**	Collision risk with tidal energy devices is unknown for seals and cetaceans and the level of risk would depend on device design. However, for turbines with moving parts there is a clear collision risk for marine mammals, which could potentially be significant adverse for tidal devices, although further study is needed to better understand this impact. Collision with moving parts and fixed cables may also be a concern for baleen whales such as minke which may not detect the presence of these in the water and do not have the manoeuvrability of smaller cetaceans. However, the importance of this area to minke whales is unknown so the collision risk is difficult to quantify.	Collision risk during operation could be minimised through enhancing the visibility of marine devices to marine mammals, to maximise the possibility that the animals could detect it in time to react and avoid it. Consider potential measures to increase the acoustic visibility of undersea cables to marine mammals. New developments in active acoustic technology (e.g. sonar) are currently underway and may provide a potential monitoring and mitigation measure for operating turbines in the future.	**Unknown - negative**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on marine mammal health. Offshore tidal energy devices could present a collision risk to shipping. A collision between ships or a ship and a tidal device could result in fluid spills which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine mammals would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Tidal**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. Devices may exclude mammals from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. It is not possible to determine the potential significance of this effect.	No specific mitigation identified	**Unknown**

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Barrier to movement	Operation	Devices	**Tidal**	**Unknown – significant adverse**	Overall the movement of marine mammals around the coast of Northern Ireland is unknown so barrier effect is difficult to quantify. However, given that development of tidal energy devices in constrained areas such as island channels may cause a barrier effect and restrict marine mammal movement. Tidal Resource Zone **4 is** located around the Copeland Islands and the entrance to Belfast Lough. Therefore the development of tidal arrays in this location could potentially present a barrier to marine mammals transiting between these islands and into Belfast Lough. However, the extent to which marine mammals use these areas is not currently known.	The key mitigation measure for the impact is careful site selection to avoid key transit routes in and out of sea Loughs and other constrained areas. These areas are currently not well understood. Detailed study would be required to examine marine mammal distribution around the coast in order to fully understand and mitigate for this risk.	**Unknown - negative**
Marine Mammals	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown - negligible**	The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains a complicated, understudied and unproven field of science (Basslink, 2001), with only circumstantial evidence. Cetaceans cross cables constantly, and there is no apparent evidence that existing electricity cables have influenced migration of cetaceans. However further study is thought warranted by the scientific community in this field (Gill *et al*., 2005). It should also be borne in mind that the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown - negligible**
Marine Reptiles	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Unknown**	The importance of the coast of Northern Ireland to marine turtles is unknown but there have been sightings of leatherback and loggerhead turtles. There is no information on the effects of tidal device construction on marine turtles so the risk is difficult to quantify.	Possible mitigation includes planning installation to take place at times when there are fewer turtles present or avoid potential migration routes.	**Unknown**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown**	There is no information on the effects of tidal devices on marine turtles so the risk is difficult to quantify		**Unknown**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on turtle health. Tidal energy devices could present a collision risk to shipping. A collision between ships or a ship and a tidal energy device could result in an oil spill which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine reptiles would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Barrier to movement	Operation	Devices	**Tidal**	**Unknown**	The movement of marine turtles around the coast of Northern Ireland is unknown so it is difficult to quantify the level of barrier effect.	Mitigation measures to deal specifically with potential risks to marine turtles from offshore wind developments are unknown.	**Unknown**
Marine and coastal archaeology and wrecks	**Effects on submarine historic environment**	Installation	Piling, dredging, placing structures on seabed, cables, coring	**Tidal**	**Significant adverse to Negative**	There is considerable archaeological and heritage interest in Tidal Resource Zone 4 with a high potential for presence of prehistoric submarine remains. PMRA protected aircraft wrecks may also be present and a large number of miscellaneous wrecks have been reported in the area. There is potential for the installation of tidal devices and export cables to impact submarine archaeology through direct disturbance of known and unknown sites on the seabed, or through changes to sediment movements causing an artefact to become buried and preventing later discovery. There is also a potential positive impact associated with development related seabed survey providing additional data for inclusion in the archaeological record of the area.	Follow NIEA and Crown Estates 2007 JNAPC code of conduct and guidance note for the offshore renewable energy sector. Carry out seabed investigations in preferred site locations prior to device installation. Avoid sites of interest and exclusion zones for protected sites.	**Negligible**

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Effects on coastal and terrestrial historic environment	Installation	Cables, shoreline devices	**Tidal**	**Significant adverse to Negative**	There is some terrestrial archaeological and heritage interest on the shoreline adjacent to Tidal Resource Zone 4. Locally and regionally important archaeological remains and sites (NMRS) are present along the coast. Numerous listed buildings are also present. On Copeland Island there is a Church and graveyard as well as a findspot of flints (possible indication of prehistoric activity) whilst on the nearby mainland coast there are several standing stones as well as a burial ground. The nearest scheduled site is Donaghadee Motte at Donaghadee whilst within Belfast Lough is the historical monument, Carrickfergus Castle. Cable installation in the vicinity of these protected sites could cause direct destruction of archaeologically important features.	The main form of mitigation is to avoid protected and other sites of interest. In addition to desk based studies it will be necessary to carry out field walkovers in preferred site locations to determine need for site investigations (geophysical surveys/trial trenching) in consultation with NIEA and Local Authorities. With respect to cabling there is considerable opportunity to avoid or reduce effects. The siting and design of shoreline devices will be important in determining their residual impact.	**Negative to negligible**
Commercial Fisheries	**Direct disturbance of fishing grounds**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	The key commercial interests in this area are lobster and crab pot fisheries around the Copeland Islands with scallop dredging and whelk potting to the west. In addition there is seed mussel to the south and lobster/ crab potting along the adjacent coastline. Tidal Resource Zone 4coincides directly with the lobster fishing grounds. Development could therefore have a potentially significant adverse effect on lobster potting areas. In terms of commercial fisheries this effect could potentially be of adverse significance.	In terms of direct disturbance to commercial shellfisheries, the main form of mitigation would be to avoid key commercial fishing grounds, and key seasons such as the period of mussel seed settlement (Feb-Apr; Sept). The effects could also be minimised by using tidal devices that use less intrusive forms of attachment e.g. gravity bases.	**Negative - negligible**
	Temporary displacement from traditional fishing grounds	Installation Decom	Vessels, installation equipment and devices	**Tidal**	**Negative**	Inshore fishing grounds tend to be more constrained than offshore areas. Temporary displacement from these areas may lead to the concentration of fishermen in smaller areas, fishermen being unable to fish for short periods or fishermen being displaced to alternative, possibly less productive fishing grounds. Key commercial shellfish in this general area are lobster, crab, king scallop, whelk and seed mussel. Temporary displacement will potentially have a negative significance effect on commercial fisheries.	Effects associated with the temporary displacement of traditional fishing grounds can be reduced by avoiding key commercial fishing grounds or by phasing construction activities to areas within Tidal Resource Zone 4. Liaison with the fishing community to keep them informed of installation operations is also key to managing the level of this impact.	**Negative - negligible**
	Long term displacement from traditional fishing grounds	Operation	Devices that occupy water surface, water column and seabed	**Tidal**	**Negative to Significant adverse**	Tidal Resource Zone 4 coincides directly with the lobster potting areas, but mobile dredging gear for scallop and finfish cannot be operated in the areas of strong tidal energy. The effects of long term displacement on inshore lobster potting areas could be of adverse significance. Use of rock armour, if required for cable protection, could introduce an obstruction for scallop and seed mussel dredging activity, but could also create new habitat which could have a positive impact of fish stocks.	The long term displacement of commercial shellfish fisheries could be reduced or avoided by avoiding key fishing grounds.	**Negative - negligible**
Mariculture	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negligible**	Belfast Lough is a major area for shellfish production, notably bottom grown mussel, there is a key area for seed mussel inshore of the Copeland Islands. Any significant and prolonged rise in suspended solids could have a significant adverse on mussel growing areas. However, increases in suspended sediment is expected to be short term and localised to the immediate vicinity of the seabed disturbing works. Intrusion of sediment plumes into the Lough would therefore only result if the export cables were routed in the immediate vicinity. It is therefore considered there could be a negligible impact from wind energy development.	Should cable trenching work be undertaken within the Lough, impacts could also be reduced by using procedures that minimise the mobilisation of suspended solids such as plough installation.	**Negligible**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	Shellfish are highly sensitive to reductions in water quality caused by hydraulic fluids or tainting from other chemical substances. There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Therefore, although the likelihood of accidental contamination from devices is low, the potential effects any significant intrusion of hydraulic fluids into Belfast Lough could be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, and contingency measures for device failure/component failures. It should be noted that the quantity of hydraulic fluid in devices is likely to be very small, reducing the potential for significant environmental effects. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Substratum loss	Operation	Devices using seabed foundations e.g. piled devices	Tidal	Significant adverse	Tidal Resource Zone 4 does not overlap with shellfish production areas. Should cables be routed through marine fish farms this would be an effect of adverse significance.	The key mitigation measure in terms of reducing effects on shellfish farms is avoidance. In practice, consent is unlikely to be achievable to site renewable energy arrays or cables within existing fish farms.	Negligible
Ports, Shipping and Navigation	Displacement of shipping movement	Installation Decom	Safety zones around areas of installation and decommissioning activity	Tidal	Significant adverse	The re-routing of vessels to avoid safety zones (during installation), operational devices and decommissioning activity would result in greater transit time and use of fuel with the associated costs to the vessel operator, and could also could lead to an increase in vessel densities in areas that already have moderate vessel densities. This could lead to increased encounter rates and increased risk of collision. Tidal Resource Zone 4 is located within the North Channel, a recognised international shipping lane, and directly adjacent to the entrance to the Port of Belfast, consequently shipping densities within Tidal 4 are very high. Tidal Resource Zone 4 is also constrained by the Copeland Islands. The effect of re-routing vessels to accommodate tidal devices would therefore potentially be significant adverse, as vessels would be displaced into already high vessel density areas.	The potential for these effects to be reduced would depend entirely upon the ability to site devices in relation to key shipping routes. There is limited potential to reduce significant adverse effects by careful site selection. The scale of potential effect on navigation should be assessed as part of the EIA and the Navigational Risk Assessment (NRA). The assessment should include: • A survey of vessels in the vicinity of the proposed development • Full NRA of the likely impact of the development on navigation, taking into consideration MGN 371 (MCA 2008), MGN 372 (MCA 2008b) and the DTI Guidance Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (DTI 2005) (also considered relevant for other renewable devices). • Cumulative impact assessment	Significant adverse - Negative
		Operation	Tidal devices	Tidal	Significant adverse			
	Decreased trade/supply	Installation Decom	Safety zones around areas of installation and decommissioning activity	Tidal	Negative	The deployment of installation and maintenance vessels, presence of devices and decommissioning activity could create temporary to long-term reductions in access to ports and harbours. Tidal Resource Zone 4 is located directly adjacent to the entrance to Belfast Lough, inside which several ports and harbours are located. Although the Tidal Resource Zone 4 does not totally obstruct access to the ports within the Lough the installation of devices in this location may reduce access which would have a negative impact on trade and supply.	Site selection for device arrays should take into account the requirement for continued access to port and harbours. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning.	Negligible
		Operation	Tidal devices	Tidal	Negative			
	Reduced visibility	Installation Decom	Vessels and equipment used for installation and decommissioning	Tidal	Significant adverse	Vessels and other equipment used during the installation of devices, and the operational devices themselves could obstruct views of other vessels and navigation features such as buoys, lights and the coastline. This is particularly important in areas of high vessel densities, constrained channels or areas where there is particular dependence on visual navigation aids as reduced visibility increases the risk of collision with other ships and other structures in the water (natural and man made). Tidal Resource Zone 4 is in a constrained area with very high vessel densities. The effect of reduced visibility will potentially be significant adverse.	Significant adverse effects associated with reduced visibly can be reduced by avoiding areas of high vessel densities and areas constrained by land e.g. island channels. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Any vessels and devices should be lit and marked in accordance with regulations and MCA and Trinity House guidance	Negligible
		Operation	Tidal devices	Tidal	Significant adverse			
	Collision risk	Installation Decom	Vessels and equipment used for installation and Decommissioning	Tidal	Significant adverse	Collision risk considers the risk of navigating vessels colliding with vessels and equipment used during installation, maintenance and decommissioning, and the devices themselves once operational. Collision risk also considers the increased risk of collision between navigating vessels. In both circumstances the risk of collision is increased in constrained channels and areas with high vessel densities. Tidal Resource Zone 4 is in a constrained area with very high vessel densities directly adjacent to the mouth of a Lough containing several ports. The risk of collision in this area will potentially be significant adverse.	There is limited potential to reduce significant adverse effects by careful site selection within this zone. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning. The scale of potential effect on navigation should be assessed as part of the EIA and NRA as outlined above.	Significant adverse - Negative
		Operation	Tidal devices	Tidal	Significant adverse			

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Recreation and Tourism	Disturbance to Wildlife	Installation Operation Decom	Installation activities including noise, vessel movements, operation of devices, decommissioning activities	**Tidal**	**Negligible**	Effects on local tourism would occur where disturbance and/or exclusion from an area overlaps with the locations frequented by visitors and touring vessels. The east coast of Northern Ireland is not considered to be of particular importance for recreational wildlife watching	None identified.	**Negligible**
	Safety and Collision Risk	Installation Operation Decom	Presence of new structures in the water	**Tidal**	**Negative**	The key receptor affected is sailing. Cruising routes (medium recreational use) are present in the immediate vicinity of Tidal Resource Zone 4. Tidal developments in this zone could potentially have negative effects on recreation sailing.	Safety measures including lighting and marking and informing users of the locations of devices. Locate devices away from cruising routes. Use alternative devices which lie below the surface of the water to a depth which does not affect sailing.	**Negligible**
	Access Restrictions	Installation Operation Decom	Structures in the sea reducing or excluding access	**Tidal**	**Negative**	The key receptor affected is sailing. Cruising routes (medium recreational use) are present in the immediate vicinity of Tidal Resource Zone 4. Tidal developments in this zone could potentially have negative effects on recreation sailing.	Avoid cruising routes. Devices which exclude access to an area will have greater effects than those which allow movement through the array. Use alternative devices which lie below the surface at a depth which does not affect sailing.	**Negligible**
Military Exercise Areas	**Disruption to general activities**	Installation Operation	All tidal devices	**Tidal**	**Significant adverse to Negligible**	The entire zone lies within military practice and exercise area X5407 - Magee. The area is used by the Navy for submarine exercises, aircraft and H.M. Ships. Dependent on the extent to which the Navy undertake exercises in this area, the significance of this effect could be considered to be significant adverse to negligible.	Consultation with the MOD will be required to enable appropriate site selection in order to reduce or eliminate the risk of interference associated with non-bylawed practice and exercise areas.	**Negligible**
Disposal Areas	**Disruption to access**	Installation Operation	All Tidal devices	**Tidal**	**Significant adverse**	There is one harbour spoil disposal site within the boundaries of Tidal Resource Zone 4. It is possible the construction and presence of |Tidal devices in this area could restrict access to this site with Significant adverse impact. A further site adjacent to Tidal Resource Zone 4.is unlikely to be affected.	Avoidance of the site by approximately 500m can mitigate against the possibility of access to the sites in the area being inhibited for users.	**Negligible**
Cables and Pipelines	**Direct damage**	Operation Installation	All tidal devices Cables	**Tidal**	**No effect**	There are no cables or pipelines in the study area therefore no impacts are expected.	None required	**No effect**
	Reduced access	Operation Installation	All tidal devices Cables	**Tidal**	**No effect**	There are no cables or pipelines in the study area therefore no impacts are expected.	None required	**No effect**
Aggregate extraction	**Presence of devices**	Operation Installation	All tidal devices	**Tidal**	**Unknown / No effect**	There are no existing or proposed aggregate dredging areas within this area therefore there will be no effects on aggregate extraction. Impacts on possible future aggregate extraction sites, based on aggregate resources that have not yet been identified include restricted access to and sterilisation of possible sites. However these impacts are impossible to quantify at this stage.	None identified	**Unknown / No effect**
Oil and gas resources	**Presence of devices**	Operation	All tidal devices	**Tidal**	**Unknown**	The installation of tidal turbines has the potential to sterilise areas that could have been used for oil and gas exploitation. The Larne Basion which overlap with this zone is identified as an area with oil and gas potential. However, there is currently insufficient data to establish possible future exploitation of oil and gas from this area. Therefore, whilst no sites are currently under consideration for oil and gas exploitation in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**
Natural Gas and CO_2 storage	**Presence of devices**	Operation	Piled devices	**Tidal**	**Unknown**	The installation of piled tidal devices has the potential to sterilise areas that could have been used for CO2 or natural gas storage. There is currently insufficient data to establish potential for use of the marine environment for storage of CO_2. Therefore, whilst no sites are currently under consideration for natural gas or CO_2 storage in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**

Table 11.11: Copeland Islands (Tidal Resource Zone 4) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Landcape/Seascape	**Effects on seascape**	Operation	Arrays of surface point structures over 10m above surface	**Tidal**	**Moderate Effect (0 to 10km)** **Slight Effect (beyond 10km offshore from the coast)**	Tidal Zone 4 is located around the Copeland Islands which are situated off the east coast of Northern Ireland opposite Belfast Lough. The adjacent coastline is characterised as seascape type 1: • 1: Large open or partially open sea lough with raised hinterlands – large scale sea lough with associated low lying coastal plain, raised hinterlands and headlands. Tidal mudflats present at lough mouth. Dense urban development concentrated around lough mouth and head. Hinterlands are more rural settlement patterns. Large ports and harbours and busy shipping lanes. Large scale open views. Smaller scale views framed by headlands. High scenic value in areas where there is no urban development. There are no designations along in this part of the coastline. Seascape type 1 is of medium sensitivity to on-surface point tidal devices. Based on the threshold of visibility (which influences magnitude of change) for tidal devices and the sensitivity of seascape type 1 potential negative effects could occur between 0 and 5km from the coast. However, these effects will reduce to negligible with distance from the coast (beyond 10km).	Potential adverse effects on seascape can be reduced through the sensitive siting of tidal device arrays. Key factors to be considered in locating a tidal array include: • Identifying opportunities to deploy submerged devices where possible to avoid adverse effects. • Limit the use of markers (buoys and lights) in highly sensitive areas and recognising the requirements in terms of navigational safety. • Maximising the distance from shore of tidal array developments • Avoid deploying tidal arrays that protrude above the water surface in areas where they appear to block or close the entrance to bays/loughs/ narrows/sounds or where they separate a bay from the open sea • Tidal arrays that protrude above the water surface should reflect the shape of the coastline and align with the dominant coastal edge; • Tidal arrays that protrude above the water surface should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate; • Tidal arrays that protrude above the surface should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement; • Tidal arrays that protrude above the surface should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms.	**Slight Effect**
		Operation	Arrays of submerged structures	**Tidal**	**Moderate Effect (0 to 5km)** **Slight Effect (5 to 15km)** **No effect (beyond 15km offshore)**	It is expected that there would be minimal effects on seascape quality and character from submerged devices although there could be some adverse effects associated with buoys or navigation lights which may be required for safety reasons. Given that this area overlaps with areas of high use by vessels, it is likely that there will be a requirement for any submerged devices to be clearly marked with buoys and lights. In the nearshore area (0 to 5km) this could have a negative effect on seascape quality. However this will reduce to negligible offshore.	Limit use of safety lights where appropriate (and providing this does not reduce navigational safety in the area)	**Slight Effect**
Climate	Carbon Impacts	Operation	Wind turbines	**Wind**	**Positive**	It is recognised that development of offshore wind farms will contribute towards achieving the Northern Ireland target for 40% energy to be provided from renewable energy sources. In meeting this target the Northern Ireland Assembly will be working towards the wider national, European and international commitment to combat global climate change and reduce the potential associated adverse environmental effects e.g. changing population distributions, species extinction, sea level rise etc. However, whilst seeking to combat climate change there is also a need to respond to it in terms of: • Protecting the existing environment and increasing its robustness and ability to adapt to climate change • Protecting existing and future infrastructure from effects of climate change e.g. increased storm events , flooding and sea level rise	Ensure that coastal infrastructure is sited in locations that are at lower risk from flooding, sea level rise and storm damage and do not increase the risk of flooding or damage to coastal infrastructure elsewhere. This will require close consultation at the project design stage with the relevant land use planning authority.	**Positive**
	Carbon Storage	Installation Operation	Wind turbines	**Wind**	**No effect**	Based on current available information no existing or proposed carbon or gas storage sites have been identified within this area (Offshore Wind Resource Zone 1) therefore there will be no effect resulting from the development of offshore wind farms.	None required	**No effect**

Table 11.12: Strangford Narrows (Tidal Resource Zone 5) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Bathymetry	**The information presented in this chapter has been used to inform the results of the assessment. No specific impacts on bathymetry are expected.**							
Geology, geomorphology and sediment processes	**Changes in seabed morphology**	Installation	Export cables	**Tidal**	**Significant adverse**	Strangford Narrows is a 9km long narrow channel, that separates Strangford Lough from the Irish Sea. Tidal currents are unidirectional in the Narrows and reach very high velocities . The Narrows is littered with exposed rock outcrops and underwater ridges of rock that produce a highly turbulent environment especially during ebb flow. There is very little sand deposits on the seabed in the narrows due to the very fast currents preventing deposition. The presence of a commercial scale array, coupled with strong currents, could also potentially induce local sediment scour at the seabed around the structure by creating turbulent wakes. Scour will only occur where the seabed is composed of sediment that is readily mobilised into suspension. Scour effects could alter the seabed morphology. Trenching and piling activities for a commercial scale array is likely to cause a significant adverse impact to the seabed morphology on the rocky seabed.	Due to the limited amount of space available within Strangford Narrows for a commercial scale array, there is very limited potential to avoid impacts through careful site selection. Potential effects of local scour on sediment transport would need to be assessed through morphological site surveys and hydrodynamic/sediment transport modelling at the project stage. Site specific geophysical and geotechnical survey will be required to establish a baseline and inform the impact assessment for individual developments.	**Significant adverse**
	Changes in coastal processes	Operation	Devices using energy generated by waves or tidal currents	**Tidal**	**Significant adverse**	Tidal current energy devices have the potential to modify the tidal and sediment transport dynamics by removing and/or modifying the tidal energy and wave regime. Such extraction or modification of tidal energy could result in changes with respect to tidal flow and direction which could alter the sediment transport pathways upstream of the Strangford Narrows and within the Strangford Lough. Alteration to the sediment transport regime could alter the distribution of the sediments to the Lough and potentially modify the morphology of the inter tidal mud/sand flats within the Lough.	Due to the limited amount of space available within Strangford Narrows for a commercial scale array, there is very limited potential to avoid impacts through careful site selection. Modelling the effects of device operation on the current and sediment transport regime should form part of pre-project activities to optimise location.	**Significant adverse**
Seabed Contamination and Water Quality	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. This zone is Tidally linked with Strangford Lough increasing the potential harm from minor spillages. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects in this area would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Disturbance of contaminated sediment	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	There are no open spoil disposal sites within Tidal Resource Zone 5. Military munitions may be present as a result of migration from Beaufort's Dyke disposal site, or relict from wartime activities. Disturbance of munitions could have a significant adverse effect.	Identification and avoidance of areas of munitions contamination through site survey at the project stage. If munitions are encountered Crown Estates 2006 (Dealing with munitions in marine aggregates) should be followed.	**Negligible**
	Restriction of water exchange	Operation	Devices	**Tidal**	**Significant adverse**	Restriction of exchanges of water between Strangford Lough and the open sea has the potential to promote eutrophication.	Effects on water quality associated with restricted water flows can be minimised by careful design and siting of the devices.	**Negligible**
Protected Sites and Species	**Impacts on protected sites**	Installation Operation	Marine devices	**Tidal**	**Significant adverse**	Tidal Resource Zone 5.is an area of very high importance for nature conservation, reflected by the number of designations. It is designated as NNR, MNR, Ramsar site, SPA, SAC and AONB. Furthermore, within the zone there are a couple of areas of potential Annex I habitat for rocky reef and also for sandy sediment in <20m water. The potential impacts from installation and operation of marine devices include direct impacts such as physical disturbance, habitat loss and loss of substratum, as well as indirect impacts such as smothering, increase in suspended sediment and turbidity, and noise impacts on species in the area. Given the importance of the area and high sensitivity, the potential effects are considered to be of adverse significance.	There is no potential to avoid the marine nature conservation designations, which overlap with the entire zone. Possible mitigation measures to reduce impacts on the interest features of the site include turning off the tidal turbines when seals are present in the immediate vicinity. Careful site selection could be employed to avoid the areas containing the important marine habitats for which the site is designated. However, for a commercial scale array there is vary limited potential to mitigate this impact.	**Significant adverse**
	Impacts on protected species	Installation Operation	Marine device	**Tidal**	**Significant adverse**	The Strangford Narrows are extremely important for seabirds, reflected in their designation as a Ramsar Site and SPA, for Annex I species, migratory species and seabird assemblages. In addition, marine mammals, seals (including pupping sites), and fish are found throughout the region, as are important benthic species. The impacts on these receptors are discussed in the relevant sections of the table below.	See sections below on benthic ecology, fish and shellfish, seabirds and marine mammals.	**Unknown to significant adverse**

Table 11.12: Strangford Narrows (Tidal Resource Zone 5) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Benthic and Intertidal Ecology	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenches	**Tidal**	**Significant adverse**	Tidal Resource Zone 5 almost completely overlaps with Strangford Lough SAC, which contains a range of priority habitats, including *Modiolus modiolus* (horse mussel) beds that are highly sensitive to smothering resulting from seabed disturbance. Smothering impacts will be localised to the immediate vicinity of the seabed disturbing activities during installation. In addition, fast tidal streams will prevent the build-up of disturbed fine sediment in the tidal rapids in Strangford Narrows so smothering for extended periods is unlikely. However as this will potentially impact Annex I habitats of European importance, this is potentially a significant adverse impact.	The potential effects on benthic ecology can be reduced either through avoidance (careful site selection) or using devices that use less intrusive seabed attachments (such as gravity bases). Potential effects on unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
Benthic and Intertidal Ecology	**Contamination – from sediment disturbance**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negligible**	Tidal rapids (Annex I – Habitats Directive) and *Modiolus modiolus* (horse mussel) are highly sensitive to contamination, both of which are present in Tidal Resource Zone 5. There are no dredging disposal sites, or other sites of known sediment contamination in the zone, and this impact is therefore considered to be negligible.	Potential effects on areas of unknown benthic habitat will need to be assessed through site survey at the project stage.	**Negligible**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. This area contains tidal rapids and *Modiolus modiolus* that are of high sensitivity to contamination. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on benthic ecology would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan). Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
	Changes in tidal flow	Operation	Devices that extract energy generated by tidal currents	**Tidal**	**Significant adverse**	Tidal rapids habitat in Strangford Narrows and tidal-swept sublittoral sand and gravel habitat at the north end of the Narrows and the entrance to Strangford Lough will be sensitive to changes in tidal current regime, although impacts would be localised. It is not expected tidal flow would be affected in areas of *Modiolus modiolus* habitat and more sheltered deep sea mud habitat. Given the presence of these UKBAP habitats in this resource zone, the effects could potentially be of adverse significance.	Avoidance of these important habitats though careful site selection would reduce the potential effects of energy extraction. However it may not be possible for these effects to be removed completely. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negative**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	All benthic communities can be expected to be sensitive to removal of their habitat. The long term loss of substratum due to the presence of devices that are attached to the seabed will therefore have a potentially significant adverse effect on any rare or important benthic habitats, such as those listed in the UKBAP and protected under the Habitats Directive.	Effects on benthic ecology from substratum loss may be reduced either through avoidance (careful site selection) or using devices that have a smaller footprint on the seabed e.g. gravity bases. However it may not be possible for these effects to be removed completely. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Significant adverse**
Fish and Shellfish	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative**	Tidal Resource Zone 5 contains key shellfish areas for lobster, *Nephrops,* edible crab and velvet crab. Strangford Lough is also known to contain cockles and whelks, whilst scallops and queen scallops can be found outside the entrance to the Lough. These species live on, near or in the bottom sediments of the seabed. Sprat are also known to spawn in the area. These species range from low to high sensitivity to smothering, although this impact will be localised to the immediate vicinity of seabed disturbing activities and limited to during installation.	For devices that require piling, and cable trenching, potential effects could be mitigated by avoiding installation during the spawning and nursery seasons of the species mentioned, and by avoiding key shellfish areas.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	High levels of noise such as during pile installation may cause physiological or displacement effects to marine fish although the extent to which this may occur is unknown. In particular, herring and cod are known to be highly sensitive to noise and may be able to detect piling noise up to 80km. Both species are	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive spawning periods.	**Negligible - negative**

Table 11.12: Strangford Narrows (Tidal Resource Zone 5) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
		Operation	Turbines/flexing joints/device components	**Tidal**	**Unknown**	present in the study area and therefore may be present in Tidal Resource Zone 5, although herring generally only occurs in coastal waters (0 to 20m). It is expected that noise levels from piling and the removal of piled devices will be greater than those generated by operational devices, and although pile driving only occurs during installation the effects may last for longer than the piling activities as fish may not immediately return to the area. There is potential for noise from operational devices to lead to longer term species displacement which could increase pressures on fish populations in other locations and force fish into predator habitats.	No specific mitigation measures have been identified	**Unknown**
	Collision risk	Operation	Turbines/moving part of devices / mooring chains and cables	**Tidal**	**Unknown**	There is potential risk that all mobile fish species could collide with turbines or moving parts of submerged devices. Larger animals (such as basking sharks (UKBAP species)), and pelagic species are considered to be of greater risk. Basking shark and other pelagic fish species are present throughout the study area, and will be present within Tidal Resource Zone 5. However, due to uncertainties with data and knowledge on the interactions between fish and devices, the potential significance of collision risk effects is unknown.	Potential effects associated with collision risk and fish could be reduced through device design e.g. use of protective nets or grids. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**Unknown**
	Hydraulic injury	Operation	Shrouded devices (i.e. venturi devices)	**Tidal**	**Unknown**	There is potential risk that mobile fish could suffer injury or mortality through pressure changes occurring within the turbine as water is sucked through it. This effect is only relevant for shrouded tidal devices such as venturi devices, which use shrouding to constrict the flow, thus leading to a pressure low after the constriction. This effect is likely to be more significant for smaller species. Larger species sucked through the turbine would be more likely to suffer collision impacts.	Possible impacts associated with shrouded turbines can be addressed by using screens to prevent marine organisms from entering the device. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**No impact**
Fish and Shellfish	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Small spillages are likely to have a negligible impact. Large spillages, particularly where they impinge on the coastline or enter Strangford Lough could have a significant adverse impact.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Tidal**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. In terms of demersal species this effect would only apply to devices using seabed foundations. For pelagic species the position of submerged devices in the water column and the proportion of the water column occupied would be most relevant. Due to the vast number of variables associated with device types and the types of fish that could be affected it is not possible to determine the potential significance of this effect. The presence of tidal arrays may also have a positive effect on fish populations through fish stock recovery, should certain types of fisheries be excluded from the array.	There is no potential to avoid the SPA within Strangford Narrows, as the entire zone is within the protected site.	**Unknown**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Significant adverse**	The zone contains shellfish areas for lobster, *Nephrops*, edible crab and velvet crab. Strangford Lough is also known to contain cockles and whelks, whilst scallops and queen scallops can be found outside the entrance to the Lough. These species live on, near or in the bottom sediments of the seabed. Sprat are also known to spawn in the area. Removal of habitat during installation and operation of tidal turbines could result in the long term removal of the habitat used by these species, although alternative adjacent habitat may be available.	The potential effects of substratum loss on shellfish and benthic spawners could be reduced by avoiding sensitive areas e.g. key spawning grounds and or using devices that use less intrusive seabed attachment such as anchors or clump weights.	**Negative**
Fish and shellfish	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown - negligible**	Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical renewable array power cable, but the field would not cause an avoidance reaction. Atlantic salmon, eels and Sea Trout are believed to be sensitive to magnetic fields. However, the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables. There is no evidence to indicate that existing cables have caused any significant effect on migration patterns of these species. However, the significance of potential effects cannot be adequately quantified on the basis of current information.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown - negligible**

Table 11.12: Strangford Narrows (Tidal Resource Zone 5) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Marine Birds	Physical disturbance	Installation Decom	Vessels and equipment used for installation and decommissioning	Tidal	Significant adverse	Physical disturbance is of particular importance in terms of breeding colonies as high levels of physical disturbance could lead to species displacement (short-term to long-term). Physical disturbance is also important in terms of foraging and loafing. The Strangford Narrows is an area of high importance in terms of seabirds and waterfowl. Designated as SPA and Ramsar, the area supports large numbers of Annex I species, migratory species and breeding and over-wintering populations. It is also important for seabird assemblages, supporting over 60,000 waterfowl over winter, and has been identified as an IBA. The effect of physical disturbance caused by vessels and equipment is considered of adverse significance for breeding colonies and also for any birds foraging and loafing in the areas which extend beyond the boundary of the SPA but still within the delineation of the tidal zone.	There is no potential to avoid the SPA within Strangford Narrows, as the entire zone is within the protected site.	Significant Adverse
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	Tidal	Negative	Based on studies of bird behaviour on land it is evident that they have acute hearing. Noise disturbance impacts are possible both during installation and operation. The noisiest activity associated with tidal device installation is piling of monopole foundations. However, there is limited understanding of birds ability to hear underwater. Therefore, it is not possible to determine the level of significance of operational noise effects on marine birds.	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive periods such as breeding or moulting.	Negligible
		Operation	Turbines/flexing joints/device components	Tidal	Unknown		No specific mitigation identified	Unknown
	Collision risk	Installation Operation Decom	Installation and decommissioning vessels; Turbines/moving parts of device; mooring chains and cables	Tidal	Unknown	Tidal Resource Zone 5 is considered to be of high importance for marine seabirds, as demonstrated by the SPA and Ramsar designations for breeding, wintering populations and migratory species, to include Annex I species, and the fact that the area has been identified as an IBA. All species of marine birds present within the zone identified are potentially sensitive to collision impacts. Of these, the divers and pursuit divers are considered to be the most sensitive. Due to limitations in knowledge on the interactions between marine birds and devices with moving parts it is difficult to determine the potential significance of this effect which potentially has implications for all surface and diving birds.	There is no potential to avoid the SPA within Strangford Narrows, as the entire zone is within the protected site.	Unknown
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	Tidal	Significant adverse	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. All surface birds are sensitive to hydraulic fluid contamination, and in particular auks (regularly occurring migratory birds – Article 4.2 Birds Directive) and divers (Annex 1 – Birds Directive) are highly sensitive to this effect. The Strangford Narrows is a very important area for seabirds (designated as SPA and Ramsar and identified as an IBA). As such, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine birds would be significant adverse.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	Negligible
Marine Birds	Habitat exclusion	Operation	Devices that occupy water surface and water column	Tidal	Significant adverse	Locating devices in areas used for foraging and loafing could result in habitat exclusion and possible species displacement. There is limited information on precise foraging and loafing "hotspots" for different species of marine birds. Birds could be displaced from an area wider than the array site due to their potential avoidance responses. Although birds are mobile and could therefore avoid devices, the potential effects of increasing competitive pressures on adjacent populations and energetic costs of site avoidance also need to be considered. As the area is of high importance for marine birds (breeding populations, migratory and over-wintering populations), this could potentially have a significant adverse effect.	Without a more detailed understanding on the location of key foraging and loafing habitats, it is difficult to identify appropriate mitigation measures other than to avoid sensitive sites (SPAs). In the Strangford Narrows an SPA and Ramsar area cover the entire zone identified, and even outside of the protected areas, birds will still use the area for foraging and loafing. For this reason whilst studies could be undertaken at the project level to identify the presence of key foraging hotspots and loafing areas in the development area are, it is thought that mitigation measures would be insufficient to reduce the impact significantly.	Significant adverse
Marine Mammals	Physical Disturbance	Installation Decom	Vessels and equipment used for installation and decommissioning	Tidal	Significant adverse	Strangford Lough is an SAC and both grey and common seals (Annex II – Habitats Directive) use the area. Harbour porpoises (Annex II) also are known to use the Lough. Increased boat traffic will increase ambient noise in the area and may disturb marine mammals, although, as described below, collisions are unlikely given the speed at which construction vessels will be moving.	The relative importance of this area for seals and cetaceans is known due to studies carried out during the installation of a tidal turbine at Strangford Narrows. The effects of installation activities on seal colonies could be reduced by avoiding the breeding and moulting seasons. Cable routing should be planned to avoid impacting on seal breeding colonies or haul out sites.	Negative-Significant Adverse

Table 11.12: Strangford Narrows (Tidal Resource Zone 5) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Marine Noise	Installation	Devices using seabed foundations e.g. piled devices	Tidal	Significant adverse	Piling generates high levels of noise. Studies at wind farms have demonstrated an effect on porpoise distribution during construction with animals displaced up to 15km. Noise can mask signals used by cetaceans to navigate, locate prey, and communicate effectively. Seals and cetaceans can detect piling noise up to a distance of 80km. Behavioural responses and physiological impacts such as temporary or permanent threshold shift in hearing could occur at closer distances. It is also quite possible that these noise sources mask biological relevant signals within the zone of audibility. The potential for noise from piling to affect these marine mammals is therefore considered to be "significant adverse". It is possible that minke whales detect wind farm related noise at considerable distances, (tens of km) during pile driving. Increased shipping associated with installation will raise ambient noise levels in the area.	At sea distribution data for seals is known for this area. However cetacean abundance and habitat usage is largely unknown so dedicated marine mammal surveys would be required to identify the most appropriate site for development and to design adequate mitigation measures The use of gravitational concrete foundations is an alternative to piling but is only suitable in certain conditions. Seasonal or area restrictions could also be imposed so piling activities would be timed not to coincide with sensitive times such as seal moulting or pupping and porpoise breeding seasons. To mitigate for noise disturbance during piling there are a range of measures including the use of Marine Mammal Observers, exclusion zones, passive acoustic monitoring, pingers, soft starts/ramp up and/or bubble curtains. The efficacy of many of these procedures has not been proven to date.	Negative-Significant Adverse
		Operation	Turbines/flexing joints/device components	Tidal	Unknown	Effects of operational noise from tidal energy devices are unknown and may vary substantially with device design. There may be cumulative effects when many devices are operating together or when combined with other noise sources such as operational noise from nearby installations.	Operational noise from operating tidal energy devices are unknown and are likely to vary according to device design. Mitigation measures will need to be device specific and as yet proven techniques are unknown.	Unknown
Marine Mammals	Collision Risk	Installation Decom	Vessels and equipment used for installation and decommissioning	Tidal	Negligible	Marine mammals can potentially collide with vessels and equipment used during installation. Increased shipping activity transiting to the area during installation will increase this risk. Generally most fatal injuries arise with collisions with ships travelling over 14 knots. Vessels associated with construction activities would usually not be travelling at these speeds.	Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals both during construction activities and in transit to the construction area if entering areas of high animal abundance.	Negligible
		Operation	Turbines/moving parts of device; mooring chains and cables	Tidal	Unknown – significant adverse	Collision risk with tidal energy devices is unknown for seals and cetaceans and the level of risk would depend on device design. However, there is a clear risk that turbines with moving parts run the risk of colliding with marine mammals. Collision with fixed cables may also be a concern for baleen whales such as minke which may not detect the presence of these in the water and do not have the manoeuvrability of smaller cetaceans. However, the importance of this area to minke whales is unknown so the collision risk is difficult to quantify.	Collision risk during operation could be minimised through enhancing the visibility of marine devices to marine mammals, to maximise the possibility that the animals could detect it in time to react and avoid it. Consider potential measures to increase the acoustic visibility of undersea cables to marine mammals. New developments in active acoustic technology (e.g. sonar) are currently underway and may provide a potential monitoring and mitigation measure for operating turbines in the future.	Unknown – significant adverse
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	Tidal	Significant adverse	A spillage of diesel, oil lubricants, hydraulic fluids pollutants could have an effect on marine mammal health. Offshore tidal energy devices could present a collision risk to shipping. A collision between ships or a ship and a tidal device could result in fluid spills which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine mammals would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	Negligible
	Habitat exclusion	Operation	Devices that occupy seabed/water column	Tidal	Negative-Significant Adverse	The presence of devices in the water could lead to habitat exclusion. Devices may exclude mammals from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. It is not possible to determine the potential significance of this effect.	No specific mitigation identified	Unknown
	Barrier to movement	Operation	Devices	Tidal	Unknown - Significant Adverse	Marine mammals are known to use the Lough, which contains qualifying seal populations, and will therefore use Strangford Narrows for entering and leaving the Lough. Due to the constrained nature of Strangford Narrows it is considered likely that installing a commercial scale tidal array within the narrows would present a significant barrier to movement of marine mammals in and out of the Lough.	Due to the available space within the narrows, careful site selection / avoidance may not be possible to mitigate any potential barrier effects. Detailed study would be required to examine marine mammal distribution around the coast in order to fully understand and mitigate for this risk.	Unknown - Significant Adverse

Table 11.12: Strangford Narrows (Tidal Resource Zone 5) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details: Phase	Device Details: Characteristic	Device Details: Type	Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
Marine Mammals	**EMF impacts**	Operation	Inter-turbine and export cables	**Tidal**	**Unknown - negligible**	The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains a complicated, understudied and unproven field of science (Basslink, 2001), with only circumstantial evidence. Cetaceans cross cables constantly, and there is no apparent evidence that existing electricity cables have influenced migration of cetaceans. However further study is thought warranted by the scientific community in this field (Gill *et al.*, 2005). It should also be borne in mind that the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown - negligible**
Marine Reptiles	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Unknown**	The importance of the coast of Northern Ireland to marine turtles is unknown but there have been sightings of leatherback and loggerhead turtles. Turtles have been seen near Strangford Lough. There is no information on the effects of tidal device construction on marine turtles so the risk is difficult to quantify.	Possible mitigation includes planning installation to take place at times when there are fewer turtles present or avoid potential migration routes.	**Unknown**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Tidal**	**Unknown**	There is no information on the effects of tidal devices on marine turtles so the risk is difficult to quantify		**Unknown**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Tidal**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on turtle health. Tidal energy devices could present a collision risk to shipping. A collision between ships or a ship and a tidal energy device could result in an oil spill which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine reptiles would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Barrier to movement	Operation	Devices	**Tidal**	**Unknown**	The movement of marine turtles around the coast of Northern Ireland is unknown so it is difficult to quantify the level of barrier effect.	Mitigation measures to deal specifically with potential risks to marine turtles from offshore wind developments are unknown.	**Unknown**
Marine and coastal archaeology and wrecks	**Effects on submarine historic environment**	Installation	Piling, dredging, placing structures on seabed, cables, coring	**Tidal**	**Significant adverse to Negative**	There is considerable archaeological and heritage interest in this area with a very high potential for presence of prehistoric submarine remains. PMRA protected aircraft wrecks may be present and numerous miscellaneous wrecks have been recorded in the area. Burial of remains within Strangford Lough may increase; however, this is likely to favour long term preservation. There is potential for the installation of tidal devices and export cables to impact submarine archaeology through direct disturbance of known and unknown sites on the seabed, or through changes to sediment movements causing an artefact to become buried and preventing later discovery. There is also a potential positive impact associated with development related seabed survey providing additional data for inclusion in the archaeological record of the area.	Follow NIEA and Crown Estates 2007 JNAPC code of conduct and guidance note for the offshore renewable energy sector. Carry out seabed investigations in preferred site locations prior to device installation. Avoid sites of interest and exclusion zones for protected sites.	**Negligible**
	Effects on coastal and terrestrial historic environment	Installation	Cables, shoreline devices	**Tidal**	**Significant adverse to Negative**	As would be expected there is considerable terrestrial archaeological and heritage interest on the shoreline adjacent to the area, with ancient structures associated with the use of the waterway. Locally and regionally important archaeological remains and sites (NMRS) are present along the coast. Numerous listed buildings are also present. There are also protected remains of various defensive structures along the sides of the Lough, including Strangford Castle and the historical monument of Portaferry Castle as well as numerous other recorded sites of prehistoric human occupation. Cable installation in the vicinity of these protected sites could cause direct destruction of archaeologically important features.	The main form of mitigation is to avoid protected and other sites of interest. In addition to desk based studies it will be necessary to carry out field walkovers in preferred site locations to determine need for site investigations (geophysical surveys/trial trenching) in consultation with NIEA and Local Authorities. With respect to cabling there is considerable opportunity to avoid or reduce effects. The siting and design of shoreline devices will be important in determining their residual impact.	**Negative to negligible**
Commercial Fisheries	**Direct disturbance of fishing grounds**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negative to Significant adverse**	The key commercial interests in the general area are lobster and crab pot fisheries in Strangford Lough with scallop dredging and lobster/crab potting immediately outside the Lough. The eastern part of the area of potential development overlaps with these fishing grounds immediately outside the Lough. The potential effect of tidal developments on commercial fisheries in this area is likely to be of negative to significance adverse significance.	Avoidance of the area immediately outside the Lough will reduce or remove the potential for any impact on the fishing grounds.	**Negligible**

Table 11.12: Strangford Narrows (Tidal Resource Zone 5) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Temporary displacement from traditional fishing grounds	Installation Decom	Vessels, installation equipment and devices	**Tidal**	**Negative to Significant adverse**	Key commercial fisheries in this general area are lobster, crab and king scallop. The eastern part of Tidal Resource Zone 5 overlaps with these fishing grounds immediately outside the Lough. At this point the impact on commercial fisheries is likely to be of negative to significance adverse significance.	Avoidance of the area immediately outside the Lough will reduce or remove the potential for any temporary impact on commercial fishing activity.	**Negligible**
	Long term displacement from traditional fishing grounds	Operation	Devices that occupy water surface, water column and seabed	**Tidal**	**Negative to Significant adverse**	Tidal Resource Zone 5coincides directly with the lobster/crab potting areas immediately outside the lough, but mobile dredging gear for scallop cannot be operated in the areas of strong tidal energy. The effects of long term displacement on pot fishing could be of adverse significance.	The long term displacement of commercial shellfish fisheries could be reduced or avoided by restricting development to the inner (western) part of the area thereby avoiding long term impacts on commercial fishing outside the Lough.	**Negligible**
Mariculture	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal**	**Negligible**	Strangford Lough is an important area for shellfish production, notably Pacific oyster. Any significant and prolonged rise in suspended solids could have a significant adverse on shellfish production sites. However, increases in suspended sediment is expected to be short term and localised to the immediate vicinity of the seabed disturbing works. Intrusion of sediment plumes into the Lough would therefore only result if the export cables were routed in the immediate vicinity. It is therefore considered there could be a negligible impact from tidal developments.	Should device installation or cable trenching work be undertaken within the Lough, impacts could also be reduced by using procedures that minimise the mobilisation of suspended solids such as plough installation, or less intrusive mooring methods such as gravity bases.	**Negligible**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Tidal**	**Significant adverse**	Shellfish are highly sensitive to reductions in water quality caused by hydraulic fluids or tainting from other chemical substances. There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Therefore, although the likelihood of accidental contamination from devices is low, the potential effects any significant intrusion of hydraulic fluids into Strangford Lough could be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, and contingency measures for device failure/component failures. It should be noted that the quantity of hydraulic fluid in devices is likely to be very small, reducing the potential for significant environmental effects. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Substratum loss	Operation	Devices using seabed foundations e.g. piled devices	**Tidal**	**Significant adverse**	Tidal Resource Zone 5 does not overlap with shellfish production areas. Should cables be routed through marine fish farms this would be an effect of adverse significance.	The key mitigation measure in terms of reducing effects on shellfish farms is avoidance. In practice, consent is unlikely to be achievable to site renewable energy arrays or cables within existing fish farms.	**Negligible**
Ports, Shipping and Navigation	**Displacement of shipping movement**	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Tidal**	**Significant adverse**	The re-routing of vessels to avoid safety zones (during installation), operational devices and decommissioning activity would result in greater transit time and use of fuel with the associated costs to the vessel operator, and could also lead to an increase in vessel densities in areas that already have high vessel densities. This could lead to increased encounter rates and increased risk of collision. Vessels densities within Tidal Resource Zone 5 are likely to be low as there are no major fishing or commercial ports within Strangford Lough although there is a regular ferry crossing between Strangford and Portaferry, across the narrows. However, Tidal Resource Zone 5 is located within a channel highly constrained by landforms and so the effect of re-routing vessels in this area would be Negative.	The potential for these effects to be reduced would depend entirely upon the siting of a device in relation to areas shipping/ferry routes and constrained areas. There is potential to reduce or avoid significant adverse effects within this zone by siting devices outside of the most heavily constrained areas. The scale of potential effect on navigation should be assessed as part of the EIA and the Navigational Risk Assessment (NRA). The assessment should include: • A survey of vessels in the vicinity of the proposed development • Full NRA of the likely impact of the development on navigation, taking into consideration MGN 371 (MCA 2008), MGN 372 (MCA 2008b) and the DTI Guidance Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (DTI 2005) (also considered relevant for other renewable devices). • Cumulative impact assessment	**Negligible**
		Operation	Tidal devices	**Tidal**	**Negative**			
	Decreased trade/supply	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Tidal**	**Significant adverse**	The deployment of installation and maintenance vessels, presence of devices and decommissioning activity could create temporary to long-term reductions in access to ports and harbours. There is a ferry service between the ports of Strangford and Portaferry which are inside Tidal Resource Zone 5. The zone spans the entrance to Strangford Lough and so could affect access to settlements within, including the Killyleagh. Reduced access to these harbours could have a significant adverse effect on goods transport and accessibility.	Site selection for device arrays should take into account the requirement for continued access to port and harbours. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning.	**Negligible**
		Operation	Tidal devices	**Tidal**	**Significant adverse**			

Table 11.12: Strangford Narrows (Tidal Resource Zone 5) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Reduced visibility	Installation Decom	Vessels and equipment used for installation and decommissioning	**Tidal**	**Negative**	Vessels and other equipment used during the installation of devices, and the operational devices themselves could obstruct views of other vessels and navigation features such as buoys, lights and the coastline. This is particularly important in areas of high vessel densities, constrained channels or areas where there is particular dependence on visual navigation aids as reduced visibility increases the risk of collision with other ships and other structures in the water (natural and man made). The effect of reduced visibility will potentially be significant adverse in Strangford Narrows due to the constrained nature of the area.	Significant adverse effects associated with reduced visibly can be reduced by avoiding areas of high vessel densities and areas constrained by land. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Any vessels and devices should be lit and marked in accordance with regulations and MCA and Trinity House guidance	**Negligible**
		Operation	Tidal devices	**Tidal**	**Negative**			
	Collision risk	Installation Decom	Vessels and equipment used for installation and Decommissioning	**Tidal**	**Negative**	Collision risk considers the risk of navigating vessels colliding with vessels and equipment used during installation, maintenance and decommissioning, and the devices themselves once operational. Collision risk also considers the increased risk of collision between navigating vessels. In both circumstances the risk of collision is increased in constrained channels and areas with high vessel densities. Despite relatively low vessel densities Tidal Resource Zone 5 is highly constrained by land. The risk of collision in this area will potentially be significant adverse.	The risk of collision could be reduced by avoiding the most highly constrained areas or regularly used regularly used shipping routes (e.g. Strangford Lough ferry route). In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning. The scale of potential effect on navigation should be assessed as part of the EIA and NRA as outlined above.	**Negligible**
		Operation	Tidal devices	**Tidal**	**Negative**			
Recreation and Tourism	Disturbance to Wildlife	Installation Operation Decom	Installation activities including noise, vessel movements, operation of devices, decommissioning activities	**Tidal**	**Significant adverse**	As Northern Ireland's only Marine Nature Reserve Strangford Lough is very popular for wildlife watching, such as for the Loughs seal populations. Development of commercial scale arrays in the narrows could potentially create a barrier effect to seals using the area, with a knock on effect on seal related tourism. Visual impacts within the Lough are also relevant to wildlife tourist's enjoyment of the site, and are described further in the landscape section.	Mitigation measures aimed at reducing or avoiding disturbance to wildlife including sea mammals and birds are set out in the relevant parts of this table. Due to the constrained nature of the resource in this area, there is limited potential to significantly reduce impacts through avoidance of key areas.	**Significant adverse**
	Safety and Collision Risk	Installation Operation Decom	Presence of new structures in the water	**Tidal**	**Significant adverse**	Strangford Lough is identified as a general sailing area, and a race sailing area. An RYA cruising route of heavy recreational runs through Strangford Narrows into the Lough. Navigational hazards include strong tidal streams through the entrance to the Lough and ferry traffic. The presence of a commercial scale array in this area would therefore be expected to cause a significant adverse effect on safety of recreational yachting in this zone.	Available safety measures including lighting and marking and informing users of the locations of devices. Although there is limited potential to significant reduce the level of impact for surface piercing devices, due to the space restriction issue here. Use of alternative devices which lie below the surface of the water to a depth which does not affect sailing may reduce the impact significance to negative.	**Significant adverse / negative**
	Access Restrictions	Installation Operation Decom	Structures in the sea reducing or excluding access	**Tidal**	**Significant adverse**	Strangford Lough is identified as a general sailing area, and a race sailing area. A n RYA cruising route of heavy recreational runs through Strangford Narrows into the Lough. The presence of a commercial scale array in this area would therefore be expected to significantly reduce the access to the area for use by recreational yachting in the Lough.	Use of alternative devices which lie below the surface of the water to a depth which does not affect sailing may reduce the impact significance to negative.	**negative**
Military Exercise Areas	**Disruption to general activities**	Installation Operation	All tidal devices	**Tidal**	**Negative**	The military practice and exercise area X5402-Ardglass is present immediately adjacent to the zone, with a small overlap at the entrance to the Lough. The site is used by the navy for submarine exercises, aircraft and H.M. ships. As there is only a small overlap with the exercise area, the significance of this effect could be considered to be negative.	Consultation with the MOD will be required to enable appropriate site selection in order to reduce or eliminate the risk of interference associated with non-bylawed practice and exercise areas.	**Negligible**
Disposal Areas	**Disruption to access**	Installation Operation	All Tidal devices	**Tidal**	**No effect**	There are no disposal sites with or adjacent to Tidal Resource Zone 5 are therefore no impacts are expected.	None required.	**Negligible**
Cables and Pipelines	**Direct damage**	Operation Installation	All tidal devices Cables	**Tidal**	**Significant adverse**	Potential for direct damage to existing export cable associated with the MCT seaGen device currently located in Strangford Narrows.	A 500 m avoidance zone should be employed (in accordance with ICPC guidelines) and crossing agreements with existing infrastructure should be adhered to.	**No effect**
	Reduced access	Operation Installation	All tidal devices Cables	**Tidal**	**Significant adverse**	Potential for restrictions to maintenance access existing export cable associated with the MCT SeaGen device currently located in Strangford Narrows.	A 500 m avoidance zone should be employed (in accordance with ICPC guidelines) and crossing agreements with existing infrastructure should be adhered to.	**Negligible**

Table 11.12: Strangford Narrows (Tidal Resource Zone 5) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details: Phase	Device Details: Characteristic	Device Details: Type	Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
Aggregate extraction	**Presence of devices**	Operation Installation	All tidal devices	**Tidal**	**Unknown** / **No effect**	There are no existing or proposed aggregate dredging areas within this area therefore there will be no effects on aggregate extraction. Impacts on possible future aggregate extraction sites, based on aggregate resources that have not yet been identified include restricted access to and sterilisation of possible sites. However these impacts are impossible to quantify at this stage.	None identified	**Unknown** / **No effect**
Existing renewable energy development	**Removal of tidal energy**	Operation	All tidal devices	**Tidal**	**Unknown – significant adverse**	Placement of commercial arrays in Strangford Narrows depending on their location and orientation could potentially reduce the available tidal energy currently exploited by the MCT SeaGen device.	Careful site selection taking into account resource assessment and modelling to determine if and how commercial scale arrays could coexist with the existing turbine.	**Unknown - negligible**
	Reduced access	Operation Installation	All tidal devices Cables	**Tidal**	**Significant adverse**	Potential for restrictions to maintenance access to the existing MCT SeaGen device currently located in Strangford Narrows.	An avoidance zone of at least 500 m should be employed, in consultation with MCT.	**No effect**
Natural Gas and CO_2 storage	**Presence of devices**	Operation	Piled devices	**Tidal**	**Unknown**	The installation of piled tidal devices has the potential to sterilise areas that could have been used for CO2 or natural gas storage. There is currently insufficient data to establish potential for use of the marine environment for storage of CO_2. Therefore, whilst no sites are currently under consideration for natural gas or CO_2 storage in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**
Landscape/Seascape	Effects on seascape	Operation	Arrays of surface point structures over 10m above surface	**Tidal**	**Significant Effect (0 to 5km from coast)** **Moderate Effect (5 to 15km)**	Tidal Zone 5 is located within Strangford Lough. The adjacent coastline (with the Ards Peninsula to the North and Portavogie to the south) includes the following seascape types: • 2: Inner sea lough enclosed by narrow mouth with raised hinterland (associated with Larne Lough) – enclosed, sheltered and tranquil character. Views to the open sea are obscured by surrounding topography. • 3: Sounds at mouth of enclosed sea lough with raised hinterlands – intimate character, small coastal settlements and small harbours, enclosed, inward views, sheltered and tranquil rural character. • 4: Low lying coastal plain – rural, diverse and changeable, large to medium scale, very flat and exposed coastal plains and lowlands with expansive views out to sea. Sandy beaches and curved bays. • 6: Complex indented coast, small bays and offshore islands – changing views from enclosed views associated with indented bays/ inlets to long expansive views from raised headlands and hinterland. Parts of this coastline are also covered by a number of designations including: • Strangford Lough AONB – designated for its sheltered rolling meadows and woodlands with a drowned drumlin landscape creating a network of small islands. • Strangford Lough Marine Nature Reserve – designated for its wetland importance and for the purpose of conserving marine flora, fauna and geological features of special interest and providing opportunities for the scientific study of marine systems and sub-tidal areas. • Lecale Coast AONB – designated in 1967 for its rolling landscape around the great expanse of Dundrum Bay which contrasts dramatically with the steep Mourne Mountains to the south. Seascapes 3 and 6 are of high sensitivity to on-surface point tidal devices and seascapes 2 and 4 of medium sensitivity. Given that the main tidal resource is located within the Strangford Narrows it is likely that any development will occur within or around the 0 to 5km visibility threshold. Based on the sensitivity of the landscape in this area any potential effects are likely to be of adverse significance.	Potential adverse effects on seascape can be reduced through the sensitive siting of tidal device arrays. Key factors to be considered in locating a tidal array include: • Identifying opportunities to deploy submerged devices where possible to avoid adverse effects. • Limit the use of markers (buoys and lights) in highly sensitive areas and recognising the requirements in terms of navigational safety. • Maximising the distance from shore of tidal array developments • Avoid deploying tidal arrays that protrude above the water surface in areas where they appear to block or close the entrance to bays/loughs/ narrows/sounds or where they separate a bay from the open sea • Tidal arrays that protrude above the water surface should reflect the shape of the coastline and align with the dominant coastal edge; • Tidal arrays that protrude above the water surface should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate; • Tidal arrays that protrude above the surface should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement; • Tidal arrays that protrude above the surface should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms.	**Moderate to Slight Effect**
		Operation	Arrays of submerged structures	**Tidal**	**Moderate Effect (0 to 5km)** **Slight Effect (5 to 15km)** **No effect (beyond 15km offshore)**	It is expected that there would be minimal effects on seascape quality and character from submerged devices although there could be some adverse effects associated with buoys or navigation lights which may be required for safety reasons.	Limit use of safety lights where appropriate (and providing this does not reduce navigational safety in the area)	**Slight Effect**

Table 11.12: Strangford Narrows (Tidal Resource Zone 5) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Climate	Carbon Impacts	Operation	Wind turbines	**Wind**	**Positive**	It is recognised that development of offshore wind farms will contribute towards achieving the Northern Ireland target for 40% energy to be provided from renewable energy sources. In meeting this target the Northern Ireland Assembly will be working towards the wider national, European and international commitment to combat global climate change and reduce the potential associated adverse environmental effects e.g. changing population distributions, species extinction, sea level rise etc. However, whilst seeking to combat climate change there is also a need to respond to it in terms of: • Protecting the existing environment and increasing its robustness and ability to adapt to climate change • Protecting existing and future infrastructure from effects of climate change e.g. increased storm events , flooding and sea level rise	Ensure that coastal infrastructure is sited in locations that are at lower risk from flooding, sea level rise and storm damage and do not increase the risk of flooding or damage to coastal infrastructure elsewhere. This will require close consultation at the project design stage with the relevant land use planning authority.	**Positive**
	Carbon Storage	Installation Operation	Wind turbines	**Wind**	**No effect**	Based on current available information no existing or proposed carbon or gas storage sites have been identified within this area (Offshore Wind Resource Zone 1) therefore there will be no effect resulting from the development of offshore wind farms.	None required	**No effect**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Bathymetry	**The information presented in this chapter has been used to inform the results of the assessment. No specific impacts on bathymetry are expected.**							
Geology, geomorphology and sediment processes	**Changes in seabed morphology**	Installation	Export cable trenching Devices using seabed foundations e.g. piled devices	**Wind**	**Significant adverse**	The east and south east coast of Northern Ireland experiences low to moderate fetch limited wave energy conditions. The offshore seabed morphology is characterised as a deep water mud basin. Close to the shore, the seabed is composed of coarse and fine sand. The coastline is dominated by dissipative sand beaches with well defined ridge and runnel systems in the intertidal zone. Longshore transport is towards the north east along the coast. Scour effects could alter the seabed morphology. The physical presence of devices on the seabed, could cause localised scour and hydrodynamic changes. It is estimated that such changes will extend up to 50 m from devices and is therefore localised to the vicinity of the device array, but will be effective for the operational life of the device.	Careful site selection is key to keeping impacts to a minimum. Effects of wind turbine bases on the tidal current and wave regime should be model-tested for sediment transport impacts as part of pre-project activities. Site specific geophysical and geotechnical survey will be required to establish a baseline and inform the impact assessment for individual developments.	**Negligible**
	Changes in coastal processes	Operation	Presence of device foundations	**Wind**	**Negligible**	Alteration to the hydrodynamics could potentially interrupt the sediment transport processes along the coastline, possibly inducing deposition in the vicinity of the devices while increasing erosion down coast of the wind farm. Any offshore wind farms located near to the coast could interrupt the sediment transport processes along the coast. This could potentially have a significant adverse impact on the coastal geomorphology further along the coast. Wind Resource Zone 2 is located between 1 and 11km offshore of the coast, and therefore impacts on coastal processes could occur for wind farms sited closest to the coastline.	The degree of potential impacts depends on the process (floating or fixed structures), how closely individual devices are spaced, and how far offshore the devices are located. Careful site selection is key to keeping impacts to a minimum. Impacts at the coastline will be reduced with increasing distance from the shore, subject to more detailed studies and modelling to better understand impacts at the coast. Modelling the effects on coastal processes should form part of pre-project activities to optimise location.	**Negligible**
Seabed Contamination and Water Quality	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids Vessel fuel	**Wind**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Any accidental spillage of slick forming chemicals could be carried into Dundrum Bay, where the effects on water quality will be greater than those in open waters. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects in this area would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan)	**Negligible**
	Disturbance of contaminated sediment	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Negligible to Significant adverse**	There are two active dredging spoil disposal sites within and two immediately adjacent to, Wind Resource Zone 2. These potential areas of contamination could therefore be disturbed by seabed activities. Any contaminated material released is likely to be widely dispersed and diluted and the effect on open sea water quality is likely to be of negligible significance. Munitions migrated from the Beaufort's Dyke dumping ground or relict from wartime activities may be encountered. Disturbance could result in significant adverse effects.	Available mitigation includes avoidance of potentially contaminated seabed areas (dredging areas - 500m buffer). Identification and avoidance of areas of munitions contamination through site survey at the project stage. If munitions are encountered Crown Estates 2006 (Dealing with munitions in marine aggregates) should be followed.	**Negligible**
Protected Sites and Species	**Impacts on protected sites**	Installation Operation	Marine devices	**Wind**	**Negative – significant adverse**	The only protected sites within Wind Resource Zone 2 are the outer Ards ASSI, SPA and Ramsar site. Whilst there are a few areas where potential Annex I habitats for rocky reef and also for sandy sediment in <20m water are found within the zone, no part of the area currently under consideration for designation as a marine SAC. Closer to the coastline, is the Murlough SAC, and also the Outer Ards SPA, Ramsar site and ASSI. Impacts on protected sites could mainly occur as a result of export cable installation, impacts could have a significant adverse effect on protected sites, through physical disturbance and loss of substratum, to impacts upon the species supported in the protected area – of particular importance the seabirds. However, if sensitive areas are avoided, impacts could be negligible on protected sites and species.	Impacts on protected areas could be mitigated by careful site selection avoiding sensitive sites for devices and export cables (i.e. existing and proposed protected sites). Impacts may still arise through indirect impacts on sediment movements during installation and operation, and would need to be assessed in more detail at the project stage. Possible mitigation measures relevant to the specific interest features of the sites and their seasonal and other sensitivities are described elsewhere in this table for the relevant topic areas.	**Negligible**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Impacts on protected species	Installation Operation	Marine device	**Wind**	**Significant adverse**	Wind Resource Zone 2 overlaps partly with the Murlough SAC which is designated to protect fixed dunes, but also contains Annex II species, seals. The zone also borders areas important for seabirds, as shown by their designation as SPA and Ramsar sites. In addition, marine mammals, fish and shellfish are found throughout the region, as are important benthic species. The potential effects on these receptors are discussed in the relevant sections of the table below.	See sections below on benthic ecology, fish and shellfish, seabirds and marine mammals.	**Negative to Negligible**
Benthic and Intertidal Ecology	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenches	**Wind**	**Negative**	Wind Resource Zone 2 is located across an area of sublittoral sand and gravel habitat which grades into deep sea mud habitat further offshore. Disturbed sediments should be dispersed rapidly especially in areas with higher tidal flow with only localised impacts associated with displaced sediment. Many of the benthic species associated with this habitat will be adapted to living in a perturbed environment. Smothering impacts will be localised to the immediate vicinity of the seabed disturbing activities during installation.	The potential effects on benthic ecology can be reduced through avoidance (careful site selection) . Potential effects on unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
Benthic and Intertidal Ecology	**Contamination – from sediment disturbance**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Negligible**	There is a potential for contaminated sediment from spoil dumping sites to be remobilised during seabed disturbing installation works. It is likely that any habitats with the potential to be adversely affected by contamination from these sites have already been subject to disturbance during the original dredging and deposition of material. Furthermore dredged sediment deposited at disposal sites in the area is thought to be relatively uncontaminated. Fine contaminated material will be diluted and dispersed, settling over a wide area with negligible effect on the benthic and intertidal ecology. Coarse material will be rapidly redeposited within the immediate area of installation operations.	The potential effects on benthic ecology can be reduced through avoidance (careful site selection) . Avoidance of areas of known potential contamination for seabed disturbing works. Potential effects on areas of unknown benthic habitat will need to be assessed through site survey at the project stage.	**Negligible**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids Vessel fuel	**Wind**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. The water depth is such that small spillages (< 1tonne) are unlikely to affect the benthos. Similarly small spillages from wind 1 are unlikely to come ashore. Large spillages have the potential to have a significant adverse effect, particularly on the intertidal ecology of the adjacent shoreline coastline, including within Strangford Lough, Dundrum Bay and Carlingford Lough. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on benthic and intertidal ecology would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan). Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negligible**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Tidal Wave Wind**	**Significant adverse**	All benthic communities can be expected to be sensitive to removal of their habitat. The long term loss of substratum due to the presence of devices that are attached to the seabed will therefore have a potentially significant adverse effect on any rare or important benthic habitats, such as those listed in the UKBAP and protected under the Habitats Directive.	Effects on benthic ecology from substratum loss can be reduced through avoidance (careful site selection). However, it may not be possible for this impact to be significantly reduced at this location. Potential effects on areas of unknown benthic habitats will need to be assessed through site survey at the project stage.	**Negative – significant adverse**
Fish and Shellfish	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Negative**	Wind Resource Zone 2 contains shellfish populations of lobster, edible crab, *Nephrops* and velvet crab. Strangford Lough itself is also known to contain cockles and whelks, whilst scallops are distributed throughout the Wind Resource Zone 2. These species live on, near or in the bottom sediments of the seabed. Sprat is also known to spawn in the area. These species range from low to high sensitivity to smothering, although this impact will be localised to the immediate vicinity of seabed disturbing activities and limited to during installation.	For devices that require piling, and cable trenching, potential effects could be mitigated by avoiding installation during the spawning and nursery seasons of the species mentioned, and by avoiding key shellfish areas.	**Negative**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Wind**	**Unknown**	High levels of noise such as during pile installation may cause physiological or displacement effects to marine fish although the extent to which this may occur is unknown. In particular, herring and cod are known to be highly sensitive to noise and may be able to detect piling noise up to 80km. Both species are	The potential effects of noise from piling could be reduced through undertaking studies to determine site specific noise effects, and/or avoiding piling activities during sensitive spawning periods.	**Unknown**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
		Operation	Turbines/flexing joints/device components			present in the study area and therefore may be present Wind Resource Zone 2, although herring generally only occurs in coastal waters (0 to 20m). It is expected that noise levels from piling and the removal of piled devices will be greater than those generated by operational devices, and although pile driving only occurs during installation the effects may last for longer than the piling activities as fish may not immediately return to the area. There is potential for noise from operational devices to lead to longer term species displacement which could increase pressures on fish populations in other locations and force fish into predator habitats.	No specific mitigation measures have been identified	**Unknown**
	Collision risk	Operation	Turbines/moving part of devices / mooring chains and cables	**Wind**	**Unknown**	There is potential risk that all mobile fish species could collide with turbines or moving parts of submerged devices. Larger animals (such as basking sharks (UKBAP species)), and pelagic species are considered to be of greater risk. Basking shark and other pelagic fish species are present throughout the study area, and will be present within Wind Resource Zone 2. However, due to uncertainties with data and knowledge on the interactions between fish and devices, the potential significance of collision risk effects is unknown.	Potential effects associated with collision risk and fish could be reduced through device design e.g. use of protective nets or grids. Devices could also be sited to avoid sensitive areas e.g. migration routes, spawning and nursery grounds.	**Unknown**
Fish and Shellfish	**Accidental Contamination (hydraulic fluids or vessel cargo/fuel)**	Installation Operation	Hydraulic fluids	**Wind**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Small spillages are likely to have a negligible impact. Large spillages, particularly where they impinge on the coastline or enter Strangford Lough could have a significant adverse impact.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Wind**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. Devices may exclude fish from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. It is not possible to determine the potential significance of this effect. The presence of offshore wind arrays may also have a positive effect on fish populations through fish stock recovery, should certain types of fisheries be excluded from the array.	No specific mitigation identified	**Unknown**
	Substratum loss	Installation Operation	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Significant adverse**	The area contains key shellfish areas for lobster, edible crab and velvet crab. Strangford Lough itself is also known to contain cockles and whelks, whilst scallops are distributed throughout Wind Resource Zone 2. These species live on, near or in the bottom sediments of the seabed. Sprat, cod and *Nephrops* are also known to spawn in the area, whilst nursery areas for *Nephrops*, haddock, whiting and herring and cod overlap with the Wind 2 zone. The effect of substratum loss could therefore potentially be of adverse significance.	The potential effects of substratum loss on shellfish and benthic spawners could be reduced by avoiding sensitive areas e.g. key shellfish grounds or spawning grounds	**Negative - Negligible**
Fish and Shellfish	**Barrier to movement**	Operation	Device foundations	**Wind**	**Unknown**	Some species, such as Atlantic salmon, trout and eels spend part of their lifecycle in freshwater and part at sea. Migration between these two waterbodies is important for the survival of the species. The zone may be used by these species accessing the rivers Moneycarragh and Shimna, located on the adjacent coastline, which are known to contain populations of salmon and sea trout. The presence of wind devices could present a barrier to migration, although the exact impacts on fish species is unknown.	No specific mitigation identified	**Unknown**
Fish and Shellfish	**EMF impacts**	Operation	Inter-turbine and export cables	**Wind**	**Unknown - negligible**	Current research indicates that certain species of elasmobranchs are likely to be able to detect the level of electric field that will be generated by a typical renewable array power cable, but the field would not cause an avoidance reaction. Atlantic salmon, eels and Sea Trout are believed to be sensitive to magnetic fields. However, the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables. There is no evidence to indicate that existing cables have caused any significant effect on migration patterns of these species. However, the significance of potential effects cannot be adequately quantified on the basis of current information.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown - negligible**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Marine Birds	**Physical disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wind**	**Significant adverse to Negative**	Physical disturbance is of particular importance in terms of breeding colonies as high levels of physical disturbance could lead to species displacement (short-term to long-term). Physical disturbance is also important in terms of foraging and loafing at sea. Wind Resource Zone 2 is important for seabirds, as The Outer Ards SPA and Ramsar site has a component site within the zone identified, and Strangford Lough SPA is in close proximity. For this reason, birds will be using the area for foraging and loafing. The effect of physical disturbance has been assessed as negligible significance for breeding colonies and negative significance for feeding and loafing areas which extend beyond the delineation of the SPA protection.	Effects on breeding bird colonies could be reduced by avoiding sensitive sites e.g. SPAs and to restricting installation to avoid the most sensitive seasons e.g. breeding and moulting. In some parts of the zone site specific surveys may be required at the project level to identify the presence of key foraging hotspots and or loafing areas and to aid site selection.	**Negligible**
	Marine noise	Installation Decom	Devices using seabed foundations e.g. piled devices	**Wind**	**Unknown**	Based on studies of bird behaviour on land it is evident that they have acute hearing. However, there is limited understanding of birds ability to hear underwater. Therefore, it is not possible to determine the level of significance of noise effects on marine birds.	No specific mitigation identified	**Unknown**
		Operation	Turbines/flexing joints/device components					
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Wind**	**Significant adverse**	There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. All seabirds are sensitive to hydraulic fluid and fuel oil contamination. In addition wading birds within the Strangford Lough SPA, and Outer Ards SPA and Ramsar site may experience negative effects. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine birds would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Collision risk	Installation Operation Decom	Installation and decommissioning vessels; Turbines/moving parts of device; mooring chains and cables	**Wind**	**Significant Adverse**	The coastline adjacent to Wind Resource Zone 2 is considered to be sensitive for marine breeding birds as in addition to the Outer Ards SPA and Ramsar site (important for breeding Annex I species and migratory species) and the Strangford Lough SPA (also important for Annex I breeding species, migratory species, and a seabird assemblage of ~60,000 birds). There are also several seabird colonies in the vicinity of Wind Resource Zone 2. In addition, the area has been identified as an IBA. Anticipated impacts from siting an offshore wind farm array in an area known to be important for seabirds include direct impacts such as disturbance, habitat loss and collision. Given the proximity of Wind Resource Zone 2 with the SPAs and Ramsar, impacts during installation could be an issue, disturbing habitats and bird species in the area. These impacts would decrease the further offshore the array was sited. However, regardless of where within Wind Resource Zone 2 a offshore wind farm was developed, there is still the issue of collision impacts which would be an impact on any species of seabird using the study area for foraging or loafing, outside of the boundary of the SPA, Ramsar or seabird areas. Collision impacts could be a significant risk if located on a major migration route. However, there is some indication that wind turbines themselves may be barriers to bird movement – instead of flying around the turbines, birds fly around the outside of the cluster, i.e. displaying avoidance behaviour. However this avoidance behaviour could lead to other effects including disruption to ecological links between feeding, breeding and roosting areas. For these reasons, the impact and operation of wind development is considered negative.	During construction appropriate mitigation includes avoidance of sensitive sites and seasons; increasing vessel visibility; avoiding night working Other recommendations include the siting of turbines close together to minimise the area accommodated by a wind farm; grouping turbines so as to avoid alignment perpendicular to main flight paths; and providing corridors (up to a few kilometres wide) between groups of turbines to allow passage by birds.	**Negative – negligible**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Marine Birds	**Habitat exclusion**	Operation	Devices that occupy water surface and water column	**Wind**	**Negative to Significant adverse**	Locating devices in areas used for foraging and loafing could result in habitat exclusion and possible species displacement. There is limited information on precise foraging and loafing "hotspots" for different species of marine birds. Birds could be displaced from an area wider than the array site due to their potential avoidance responses. Although birds are mobile and could therefore avoid devices the potential effects of increasing competitive pressures on adjacent populations and energetic costs of site avoidance also need to be considered. This could potentially have a significant adverse effect during the breeding season and a negative significant effect on marine birds at other times of the year, especially if it increased population pressures in other locations.	Without a more detailed understanding on the location of key foraging and loafing habitats, it is difficult to identify appropriate mitigation measures other than to avoid sensitive sites. Studies would be needed at the project level to identify the presence of key foraging hotspots and loafing areas in the development area to aid site selection.	**Significant adverse - negative**
Marine Mammals	**Physical Disturbance**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wind**	**Unknown**	Wind Resource Zone 2 is located offshore of Strangford Lough and Murlough SACs, designated for both grey and common seals use the area. Seals from these SACs may therefore be present in the zone of interest. Harbour porpoises and bottlenose dolphins have also been recorded in the area. These are all Annex II species. Increased boat traffic will also increase ambient noise in the area and may disturb marine mammals.	The relative importance of this area for seals and cetaceans is unknown therefore monitoring surveys would be required to design a suitable mitigation plan. The effects of installation activities on seal colonies could be reduced by avoiding the breeding and moulting seasons. Cable routing should be planned to avoid impacting on seal breeding colonies or haul out sites.	**Unknown**
	Marine Noise	Installation	Devices using seabed foundations e.g. piled devices	**Wind**	**Significant adverse**	Piling generates high levels of noise. Studies at wind farms have demonstrated an effect on porpoise distribution during construction with animals displaced up to 15km. Noise can mask signals used by cetaceans to navigate, locate prey, and communicate effectively. Seals and cetaceans can detect piling noise up to a distance of 80km. Behavioural responses and physiological impacts such as temporary or permanent threshold shift in hearing could occur at closer distances. It is also quite possible that these noise sources mask biological relevant signals within the zone of audibility. The potential for noise from piling to affect these marine mammals is therefore considered to be "significant adverse". It is possible that minke whales detect wind farm related noise at considerable distances, (tens of km) during pile driving. Increased shipping associated with installation will also raise ambient noise levels in the area.	At-sea distribution data for seals is unknown for this area. Also cetacean abundance and habitat usage is unknown there fore dedicated marine mammal surveys would be required to identify the most appropriate site for development and to design adequate mitigation measures Seasonal or area restrictions could also be imposed so piling activities would be timed not to coincide with sensitive times such as seal moulting or pupping and porpoise breeding seasons. To mitigate for noise disturbance during piling there are a range of measures including the use of Marine Mammal Observers, exclusion zones, passive acoustic monitoring, pingers, soft starts/ramp up and/or bubble curtains.	**Negative-Significant Adverse**
		Operation	Turbines	**Wind**	**Unknown**	During operation the turbine can produce low frequency noise and vibrations that can pass into the water column and noise from operational devices can potentially affect seals and cetaceans ability to navigate, locate prey and communicate. Operational noise from wind turbines may be heard by seals and porpoises up to 200m and whilst may not cause hearing damage may affect behaviour. There may be cumulative effects when many turbines are operating together or when combined with operational noise from other renewable devices. Due to lack of baseline data the effect of this is unknown.	Noise from operating turbines can be reduced by using isolators. However this has not been tested over long term and to account for cumulative effects.	**Unknown**
Marine Mammals	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wind**	**Negligible**	Marine mammals can potentially collide with vessels and equipment used during installation. Increased shipping activity transiting to the area during installation will increase this risk. Generally most fatal injuries arise with collisions with ships travelling over 14kts. Vessels associated with construction activities would usually not be travelling at these speeds.	Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals both during construction activities and in transit to the construction area if entering areas of high abundance.	**Negligible**
		Operation	Turbines	**Wind**	**Unknown - negative**	Collision with wind turbines is negligible for seals and small cetaceans however collision may be a concern for baleen whales such as minkes which may not detect the presence of these in the water and do not have the manoeuvrability of smaller cetaceans. The importance of this area to minke whales is unknown so the collision risk is difficult to quantify.	Consider measures to make turbine foundations more visible to marine mammals could reduce further the risk of collisions.	**Unknown - negative**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Wind**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids during installation could have an effect on marine mammal health. Offshore wind farms could present a collision risk to shipping. A collision between ships or a ship and a turbine could result in fluid spills which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine mammals would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Habitat exclusion	Operation	Devices that occupy seabed/water column	**Wind**	**Unknown**	The presence of devices in the water could lead to habitat exclusion. Devices may exclude mammals from a suitable feeding habitat by providing a physical or perceptual barrier, or producing noise that results in avoidance behaviour. It is not possible to determine the potential significance of this effect.	No specific mitigation identified	**Unknown**
	Barrier to movement	Operation	Devices	**Wind**	**Unknown - Significant adverse**	Development of wind farms in front of either Murlough or Strangford Lough may cause a barrier effect and restrict marine mammal movement in and out of the Lough. Although Strangford Lough is designated for its seal populations (grey and common) the importance of the wider area for marine mammals is largely unknown. Overall, the movement of marine mammals around the coast of Northern Ireland is unknown so barrier effect is difficult to quantify.	Development should be planned not to reduce potential restrictions to potential movement of animals into or out of sea loughs. However, detailed study would be required to examine marine mammal distribution around the coast in order to fully understand and mitigate for this risk.	**Unknown - Significant adverse**
Marine Mammals	**EMF impacts**	Operation	Inter-turbine and export cables	**Wind**	**Unknown - negligible**	The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains a complicated, understudied and unproven field of science (Basslink, 2001), with only circumstantial evidence. Cetaceans cross cables constantly, and there is no apparent evidence that existing electricity cables have influenced migration of cetaceans. However further study is thought warranted by the scientific community in this field (Gill *et al.*, 2005). It should also be borne in mind that the level of impact associated with inter-turbine arrays will be more concentrated than those for export cables.	Cable burial, where possible to minimise field effect at the seabed. Cable configuration and orientation can reduce field strength	**Unknown - negligible**
Marine Reptiles	**Collision Risk**	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wind**	**Unknown**	The importance of the coast of Northern Ireland to marine turtles is unknown but there have been sightings of leatherback and loggerhead turtles. Turtles have been seen near Strangford Lough. There is no information on the effects of wind farm construction on marine turtles so the risk is difficult to quantify.	Possible mitigation includes planning installation to take place at times when there are fewer turtles present or avoid potential migration routes.	**Unknown**
		Operation	Turbines/moving parts of device; mooring chains and cables	**Wind**	**Unknown**	There is no information on the effects of wind farm operation on marine turtles so the risk is difficult to quantify.		**Unknown**
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Wind**	**Significant adverse**	A spillage of diesel, oil lubricants, hydraulic fluids could have an effect on turtle health. Offshore wind farms could present a collision risk to shipping. A collision between ships or a ship and a turbine could result in an oil spill which could have serious environmental consequences. Therefore, although the likelihood of accidental contamination from devices is low, should it occur, the potential effects on marine reptiles would be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, contingency measures for device failure/component failures. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negative**
	Barrier to movement	Operation	Devices	**Wind**	**Unknown**	The movement of marine turtles around the coast of Northern Ireland is unknown so it is difficult to quantify the level of barrier effect.	Mitigation measures to deal specifically with potential risks to marine turtles from offshore wind developments are unknown.	**Unknown**
Bats	**Collision Risk**	Operation	Turbines	**Wind**	**Unknown**	The presence of bats in offshore locations (off the east coast of Northern Ireland) is unknown. The potential interactions between bats and wind turbines and associated potential effects is also unknown due to a lack of data and research in this area	Unknown	**Unknown**
Marine and coastal archaeology and wrecks	**Effects on submarine historic environment**	Installation	Piling, dredging, placing structures on seabed, cables, coring	**Wind**	**Significant adverse to Negative**	Dundrum Bay and the adjacent waters are in a depositional zone and preservation of archaeological sites by burial is favoured under these conditions. There also are numerous recorded wreck sites along the adjacent coastline and within Wind Resource Zone 2. There is potential for the installation of wind devices and export cables to impact submarine archaeology through direct disturbance of known and unknown sites on the seabed, or through changes to sediment movements causing an artefact to become buried and preventing later discovery. There is also a potential positive impact associated with development related seabed survey providing additional data for inclusion in the archaeological record of the area.	Follow NIEA and Crown Estates 2007 JNAPC code of conduct and guidance note for the offshore renewable energy sector. Carry out seabed investigations in preferred site locations prior to device installation. Avoid sites of interest and exclusion zones for protected sites.	**Negligible**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Effects on coastal and terrestrial historic environment	Installation	Cables, shoreline devices	**Wind**	**Significant adverse to Negative**	There are a large number of terrestrial sites of archaeological and heritage interest in this area including scheduled sites of coastal defences and sites of prehistoric human occupation. Locally and regionally important archaeological remains and sites (NMRS) are present along the coast and within Strangford Lough. Numerous listed buildings are also present on the coastline adjacent to the area, including the historical monuments Dundrum Castle, located within Dundrum Bay and Jordan's Castle which is located at Ardglass. Cable installation in the vicinity of these protected sites could cause direct destruction of archaeologically important features.	The main form of mitigation is to avoid protected and other sites of interest. In addition to desk based studies it will be necessary to carry out field walkovers in preferred site locations to determine need for site investigations (geophysical surveys/trial trenching) in consultation with NIEA and Local Authorities. With respect to cabling there is considerable opportunity to avoid or reduce effects. The siting and design of shoreline devices will be important in determining their residual impact.	**Negative to negligible**
Commercial Fisheries	**Direct disturbance of fishing grounds**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Negative to Significant adverse**	Commercial shellfish areas are most sensitive to direct disturbance as shellfish are generally much less mobile than fin fish. Inshore finfish grounds are also sensitive to direct disturbance as these are generally exploited by small vessels which are less able to exploit alternative grounds. Key commercial species in Wind Resource Zone 2 are *Nephrops*, king scallop, lobster, crab, herring, cod, haddock and whiting. There is also an important seed mussel area adjacent to the Ards peninsula at Skullmartin. Wind Resource Zone 2 coincides directly with the main trawling areas for *Nephrops* and whitefish, and overlaps to some degree with scallop dredging, lobster/crab potting and herring drift netting areas. Development will therefore have a potentially negative significant effect on these fishing grounds. In terms of commercial fisheries this effect could potentially be of adverse significance.	In terms of direct disturbance to commercial shellfisheries and fin fisheries, the effects could be minimised by avoiding key commercial fishing grounds, and key seasons such as the period of mussel seed settlement (Feb-Apr; Sept). The effects could also be minimised by using procedures and structures that minimise the area of seabed disturbed for turbine foundations.	**Negative - negligible**
	Temporary displacement from traditional fishing grounds	Installation Decom	Vessels, installation equipment and devices	**Wind**	**Negative**	Inshore fishing grounds tend to be more constrained than offshore areas. Temporary displacement from these areas may lead to the concentration of fishermen in smaller areas, fishermen being unable to fish for short periods or fishermen being displaced to alternative, possibly less productive fishing grounds. Key commercial species in Wind Resource Zone 2 are *Nephrops*, king scallop, lobster, crab, herring, cod, haddock and whiting. Temporary displacement will potentially have a negative significance effect on commercial fisheries.	Effects associated with the temporary displacement of traditional fishing grounds can be reduced by avoiding key commercial fishing grounds or by phasing construction activities to specific areas within Wind Resource Zone 2. Liaison with the fishing community to keep them informed of installation operations is also key to managing the level of this impact.	**Negative - negligible**
	Long term displacement from traditional fishing grounds	Operation	Devices that occupy water surface, water column and seabed	**Wind**	**Negative to Significant adverse**	All types of commercial fisheries could be affected by long term displacement from traditional fishing grounds. The potential effects could be of adverse significance for spatially constrained inshore fisheries and for bottom trawl and dredge fisheries which may be restricted by cable routes. Conversely, long term exclusion of mobile gear from the area could be of benefit to fish stocks in the wider area. The key bottom trawl fisheries in Wind Resource Zone 2 are *Nephrops*, cod, haddock and whiting. King scallops are exploited by mechanical dredging gear; lobster and crab by static potting gear. The effects of long term displacement on inshore fisheries (see above) could be of adverse significance. The effects of long term displacement of offshore and beam trawler/dredging fisheries could be of negative significance. Use of rock armour, if required for cable protection, could introduce an obstruction for trawling activity, but could also create new habitat which could have a positive impact of fish stocks.	The long term displacement of commercial fisheries (shellfish and fin fish) could be reduced or avoided by avoiding key commercial fishing grounds or by spacing of turbines at wide enough intervals to permit use of mobile fishing gear.	**Significant adverse - negligible**
Mariculture	**Smothering**	Installation Decom	Devices using seabed foundations e.g. piled devices Cable trenching	**Wind**	**Negligible**	Carlingford Lough, Strangford Lough and Dundrum Bay are important areas for shellfish production, notably bottom grown mussel and Pacific oyster. The Ards peninsula at Skullmartin is a key area for seed mussel. Any significant and prolonged rise in suspended solids could have a significant adverse on these areas. However, increases in suspended sediment is expected to be short term and localised to the immediate vicinity of the seabed disturbing works. Intrusion of sediment plumes into aquaculture areas would therefore only result if the export cables were routed in the immediate vicinity. There could therefore be a negligible impact from wind energy development.	Should cable trenching work be undertaken within these areas, impacts could also be reduced by using procedures that minimise the mobilisation of suspended solids such as plough installation.	**Negligible**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	**Characteristic**	**Type**				
	Accidental Contamination (hydraulic fluids or vessel cargo/fuel)	Installation Operation	Hydraulic fluids	**Wind**	**Significant adverse**	Shellfish are highly sensitive to reductions in water quality caused by hydraulic fluids or tainting from other chemical substances. There is potential for accidental contamination from devices and vessels to occur as a result of collision, storm damage or device failure. Therefore, although the likelihood of accidental contamination from devices is low, the potential effects any significant intrusion of hydraulic fluids into aquaculture production areas could be of adverse significance.	Effects associated with contamination from devices could be reduced through careful design, and contingency measures for device failure/component failures. It should be noted that the quantity of hydraulic fluid in devices is likely to be very small, reducing the potential for significant environmental effects. Effects associated with contamination from fuel oil spills could be reduced through good practice and implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	**Negligible**
	Substratum loss	Operation	Devices using seabed foundations e.g. piled devices	**Wind**	**Significant adverse**	Wind Resource Zone 2 does not overlap with shellfish production areas. Should cables be routed through marine fish farms this would be an effect of adverse significance.	The key mitigation measure in terms of reducing effects on shellfish farms is avoidance. In practice, consent is unlikely to be achievable to site renewable energy arrays or cables within existing fish farms.	**Negligible**
Ports, Shipping and Navigation	**Displacement of shipping movement**	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Wind**	**Significant adverse**	The re-routing of vessels to avoid safety zones (during installation), operational devices and decommissioning activity would result in greater transit time and use of fuel with the associated costs to the vessel operator, and could also lead to an increase in vessel densities in areas that already have moderate vessel densities. This could lead to increased encounter rates and increased risk of collision. High densities of shipping operate in much of the area, and there are only small areas where intensity is low. The northern section of Wind Resource Zone 2 is located adjacent to the North Channel where shipping intensity is very high. As a result there are a significant number of vessels transiting the zone with large numbers of vessels also travelling to and from the commercial ports of Belfast and Warrenpoint. In addition there will be a significant number of vessels travelling to or from the major fishing ports of Kilkeel, Ardglass and Portavogie. The patterns in shipping density imply the use of distinct shipping routes. Placement of devices in areas of high shipping density could therefore displace shipping into adjacent areas, and would potentially be of adverse significance.	The potential for these effects to be reduced would depend entirely upon the ability to site devices in relation to key routes for shipping. Potentially significant adverse effects could be reduced or avoided by siting devices away from areas of high vessel densities. Much of the Wind 2 zone is utilised for shipping however there may be potential for siting devices away from areas of high shipping activity. The scale of potential effect on navigation should be assessed as part of the EIA and the Navigational Risk Assessment (NRA). The assessment should include: • A survey of vessels in the vicinity of the proposed development • Full NRA of the likely impact of the development on navigation, taking into consideration MGN 371 (MCA 2008), MGN 372 (MCA 2008b) and the DTI Guidance Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (DTI 2005) • Cumulative impact assessment	**Negative**
		Operation	Wind turbines	**Wind**	**Significant adverse**			
	Decreased trade/supply	Installation Decom	Safety zones around areas of installation and decommissioning activity	**Wind**	**Significant adverse**	The deployment of installation and maintenance vessels, presence of devices and decommissioning activity could create temporary to long-term reductions in access to ports and harbours. There are three major fishing ports (Kilkeel, Ardglass and Portavogie) adjacent to Wind Resource Zone 2. This zone also extends across the entrance to Carlingford Lough, at the head of which the commercial port of Warrenpoint is located. Reduced access to these harbours could have a significant adverse effect on goods transport and accessibility.	Site selection for device arrays should take into account the requirement for continued access to port and harbours. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning.	**Negligible**
		Operation	Wind turbines	**Wind**	**Significant adverse**			
	Reduced visibility	Installation Decom	Vessels and equipment used for installation and decommissioning	**Wind**	**Negative to Significant adverse**	Vessels and other equipment used during the installation of devices, and the operational devices themselves could obstruct views of other vessels and navigation features such as buoys, lights and the coastline. This is particularly important in areas of high vessel densities, constrained channels or areas where there is particular dependence on visual navigation aids as reduced visibility increases the risk of collision with other ships and other structures in the water (natural and man made). The effect of reduced visibility will potentially be significantly adverse in Wind Resource Zone 2 due to the high vessel densities and the adjacent entrances to Loughs and ports.	Significant adverse effects associated with reduced visibly can be reduced by avoiding areas of high vessel densities and areas constrained by land e.g. adjacent to the entrances of ports and Loughs. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Any vessels and devices should be lit and marked in accordance with regulations and MCA and Trinity House guidance	**Negative - Negligible**
		Operation	Wind turbines	**Wind**	**Negative to Significant adverse**			

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
	Collision risk	Installation Decom	Vessels and equipment used for installation and Decommissioning	**Wind**	**Significant adverse**	Collision risk considers the risk of navigating vessels colliding with vessels and equipment used during installation, maintenance and decommissioning, and the devices themselves once operational. Collision risk also considers the increased risk of collision between navigating vessels. In both circumstances the risk of collision is increased in constrained channels and areas with high vessel densities. Wind Resource Zone 2 is not located in a constrained channel but where there are distinct shipping routes and high vessel densities the risk of collision will potentially be significant adverse. Collision risk is also increased in the vicinity to the entrances of ports. The significance of the impact will also increase dependent on the number of arrays which could potentially be present on either side of the channel, restricting potential for vessels using the main shipping lanes to re-route in emergencies.	The risk of collision could be reduced by avoiding areas of high shipping densities and regularly used shipping routes. In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning.	**Significant adverse - Negligible**
		Operation	Wind turbines	**Wind**	**Significant adverse**			
Recreation and Tourism	Disturbance to Wildlife	Installation Operation Decom	Installation activities including noise, vessel movements, operation of devices, decommissioning activities	**Wind**	**Negligible**	Effects on local tourism would occur where disturbance and/or exclusion from an area overlaps with the locations frequented by visitors and touring vessels. The east coast of Northern Ireland is not considered to be of particular importance for recreational wildlife watching.	None identified.	**Negligible**
	Safety and Collision Risk	Installation Operation Decom	Presence of new structures in the water	**Wind**	**Negative**	The key receptor affected is sailing. Cruising routes of light, medium and heavy recreational use are present in the immediate vicinity of Wind Resource Zone 2. Offshore wind farm developments in this zone could potentially have negative effects on recreational sailing.	Safety measures including lighting and marking and informing users of the locations of devices. Locate devices away from cruising routes. Use alternative devices which lie below the surface of the water to a depth which does not affect sailing.	**Negligible**
	Access Restrictions	Installation Operation Decom	Structures in the sea reducing or excluding access	**Wind**	**Negative**	The key receptor affected is sailing. Cruising routes of light, heavy, and medium recreational use are present in the immediate vicinity of the zone, Offshore wind farm developments in this zone could potential have negative effects on recreational sailing.	Avoid cruising routes. Devices which exclude access to an area will have greater effects than those which allow movement through the array. Use alternative devices which lie below the surface at a depth which does not affect sailing.	**Negligible**
Aviation Radar	**Radar Interference**	Operation	Wind turbines	**Wind**	**Significant adverse**	Approximately 150km^2 of Wind Resource Zone 2 lies within an NERL "potential to interfere" area and as such there is potential for negative effects on aviation. 4km^2 of the zone at the southern most extent lies within the 30km consultation area surrounding Belfast City airport. There is likely to be a negative impact on aviation either from intermittent detections of turbines by air traffic controllers or from "shadowing" where radar signals become weaker behind turbines. In this area there is likely to be a significantly adverse effect on aviation.	Consultation with the CAA and NATS will be required as well as consultations with Belfast City airport. The location of wind turbines should be supplied to Belfast City so it can be plotted on there radar and any signals received from that area will not be confused with aeroplanes.	**Negligible**
Military Exercise Areas	**Disruption to general activities**	Installation Operation	Wind turbines	**Wind**	**Significant adverse to Negligible**	Most of Wind Resource Zone 2 excluding the southern portion lies within the military practice and exercise area X5402 Ardglass. This area is used by the Navy for submarine exercises, aircraft and H.M ships. Dependent on the extent to which the area is used by the navy, significance of this effect could be considered to be significant adverse to negligible.	Consultation with the MOD will be required to enable appropriate site selection in order to reduce or eliminate the risk of interference associated with non-bylawed practice and exercise areas.	**Negligible**
Disposal Areas	**Disruption to access**	Installation Operation	All Wind turbines	**Wind**	**Significant adverse**	There are four harbour spoil disposal sites within Wind Resource Zone 2. Construction operations and the presence of wind devices have the potential to restrict normal access to these sites.	Avoidance of the sites by approximately 500m can mitigate against the possibility of access to the sites in the area being inhibited for users.	**Negligible**
Cables and Pipelines	**Direct damage**	Operation Installation	All wind devices Cables	**Wind**	**Significant adverse**	The Manx-Northern Ireland telecommunications cable runs through the centre of the area for 13km. There is also a telecommunications cable (Lanis 2) operated by C&W which runs through the northern edge of the area for 3km. Direct damage to an existing cable would be most likely to occur during installation of device arrays and cables but also could occur maintenance phases. The impact is considered to be significant adverse (should it occur) as domestic and international telecommunications could be seriously disrupted.	A 500m avoidance zone should be employed when selecting sites for marine renewable energy developments (in accordance with ICPC guidelines) and crossing agreements with existing infrastructure should be adhered to. These mitigation measures will eliminate or significantly reduce significance and likelihood of impacts on cables.	**No effect**
	Reduced access	Operation Installation	All wind devices Cables	**Wind**	**Significant adverse**	There is potential that the presence of devices in waters close to existing cables could restrict access to the cables for maintenance purposes. The potential significance of this effect could be significant adverse.	A 500m avoidance zone should be employed when selecting sites for marine renewable energy developments (in accordance with ICPC guidelines) and crossing agreements with existing infrastructure should be adhered to. These mitigation measures will eliminate or significantly reduce significance and likelihood of effects on cables.	**Negligible**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Aggregate extraction	Reduced access	Operation Installation	Wind turbines	**Wind**	**Unknown** / **Negligible**	There are no existing aggregate dredging areas within Wind Resource Zone 2 however, twoareas have been provisionally accepted by the Crown Estate which lie 10nm off of Kilkeel and within the area. There is potentially a negative impact from wind turbine installation restricting access to dredging grounds. However, if dredging does take place the impact is seen to be negligible. Impacts on possible future aggregate extraction sites, based on aggregate resources that have not yet been identified include restricted access to and sterilisation of possible sites. However these impacts are impossible to quantify at this stage.	A 500m avoidance zone should be employed when selecting sites for marine renewable energy developments (in accordance with ICPC guidelines).	**No effect**
	Changes to sediment regime	Operation Installation	Wind turbines	**Wind**	**Unkonwn** / **Negative**	There are no existing aggregate dredging areas within Wind Resource Zone 2 however, two areas have been provisionally accepted by the Crown Estate which lie 10nm off of Kilkeel and within the area. There is potentially a negative impact from dredging areas causing sediment regime changes around turbines. If dredging of this area does take place the impact is deemed negative as sediment changes can affect the structural integrity of turbines and could cause exposure of export cables. Impacts on possible future aggregate extraction sites, based on aggregate resources that have not yet been identified include restricted access to and sterilisation of possible sites. However these impacts are impossible to quantify at this stage.	A 500m avoidance zone should be employed when selecting sites for marine renewable energy developments (in accordance with ICPC guidelines). Scour protection could be utilised around turbines to avoid uncovering of pilings or cables linked to the turbines.	**Unkonwn** / **No effect**
Natural Gas and CO_2 storage	**Presence of devices**	Operation	Wind turbines	**Wind**	**Unknown**	The installation of piled turbines has the potential to sterilise areas that could have been used for CO2 or natural gas storage. There is currently insufficient data to establish potential for use of the marine environment for storage of CO_2. Therefore, whilst no sites are currently under consideration for natural gas or CO_2 storage in this area, the significance of this possible future impact is unknown.	None identified	**Unknown**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Landscape/Seascape	Effects on seascape	Operation	Wind turbine arrays of up to 140 m blade height	**Wind**	**Significant Effect to Moderate Effect (between 0 and 15km offshore from the coast)** **Moderate Effect (between 15km and 26km from the coast)**	Offshore Wind Zone 2 extends along the south east coast of Northern Ireland from the Ards Peninsula in the north to Killkeel in the south. The seascape types associated with this stretch of the coastline include: • Inner sea lough enclosed by narrow mouth with raised hinterland (associated with Larne Lough) – enclosed, sheltered and tranquil character. Views to the open sea are obscured by surrounding topography. • 3: Sounds at mouth of enclosed sea lough with raised hinterlands – intimate character, small coastal settlements and small harbours, enclosed, inward views, sheltered and tranquil rural character. • 4: Low lying coastal plain – rural, diverse and changeable, large to medium scale, very flat and exposed coastal plains and lowlands with expansive views out to sea. Sandy beaches and curved bays. • 5: Narrow coastal strip with raised hinterland – exposed with elevated dramatic open and expansive views out to sea. 6: Complex indented coast, small bays and offshore islands – changing views from enclosed views associated with indented bays/ inlets to long expansive views from raised headlands and hinterland. • 8: Large bay – distinct seascape comprising very large long sweeping bay with sand dunes backed by flat agricultural land. This rises steeply to the mountain landscape (Mourne Mountains) with plantation forestry to the south. Vast scale landscape with very long open views across the bay and out to sea. Parts of this coastline are also covered by a number of designations including:: • Strangford Lough AONB – designated for its sheltered rolling meadows and woodlands with a drowned drumlin landscape creating a network of small islands. • Strangford Lough Marine Nature Reserve – designated for its wetland importance and for the purpose of conserving marine flora, fauna and geological features of special interest and providing opportunities for the scientific study of marine systems and sub-tidal areas. • Lecale Coast AONB – designated in 1967 for its rolling landscape around the great expanse of Dundrum Bay which contrasts dramatically with the steep Mourne Mountains to the south. • Mourne AONB – designated in 1986 the Mourne Mountains are a national landmark and include Sieve Donard, Northern Ireland's tallest mountain. Area has been proposed as a National Park. Very distinctive landscape of mountains and open flat coastal plain. Given the varied landscape and seascape types within this area and the varying levels of sensitivity to offshore wind farm developments from medium to high the potential effects in certain locations within 0 to 15km from the coast, could range from significant adverse to negative depending on where wind farms are sited. For example locating an offshore wind farm off the Outer Ards Peninsula, Ballyquintin and Lecale Coast, Tyrella Dunes and Killkeel Coast which are seascape types 4 may only have negative effect whereas development in areas of more sensitive seascape types are likely to have significant adverse effects. Further offshore (between 15km and 26km), potential effects are likely to be reduced to negative/negligible.	Potential adverse effects on seascape can be reduced through the sensitive siting of offshore wind farms. Key factors to be considered in locating an offshore wind farm include: • Wind farms should not be sited where they appear to block or close the entrance to bays/loughs/narrows/sounds or where they separate a bay from the open sea; • Wind farms should reflect the shape of the coastline and align with the dominant coastal edge; • Wind farms should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate; • Wind farms should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement; • Wind farms should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms; • Consideration should be given to locating devices in already industrialised and developed seascapes;	**Moderate Effect**

Table 11.13: East Coast (Wind Resource Zone 2) - Summary of Potential Effects

Topics where POTENTIAL strategic level negative or significant adverse effects may occur	Description of effect	Device Details			Potential effect significance (without Mitigation)	Key sensitivities and impact description	Mitigation	Residual effect significance (With Mitigation)
		Phase	Characteristic	Type				
Climate	Carbon Impacts	Operation	Wind turbines	**Wind**	**Positive**	It is recognised that development of offshore wind farms will contribute towards achieving the Northern Ireland target for 40% energy to be provided from renewable energy sources. In meeting this target the Northern Ireland Assembly will be working towards the wider national, European and international commitment to combat global climate change and reduce the potential associated adverse environmental effects e.g. changing population distributions, species extinction, sea level rise etc. However, whilst seeking to combat climate change there is also a need to respond to it in terms of: • Protecting the existing environment and increasing its robustness and ability to adapt to climate change • Protecting existing and future infrastructure from effects of climate change e.g. increased storm events , flooding and sea level rise	Ensure that coastal infrastructure is sited in locations that are at lower risk from flooding, sea level rise and storm damage and do not increase the risk of flooding or damage to coastal infrastructure elsewhere. This will require close consultation at the project design stage with the relevant land use planning authority.	**Positive**
	Carbon Storage	Installation Operation	Wind turbines	**Wind**	**No effect**	Based on current available information no existing or proposed carbon or gas storage sites have been identified within this area (Offshore Wind Resource Zone 1) therefore there will be no effect resulting from the development of offshore wind farms.	None required	**No effect**

12 Cumulative Effects: Testing Offshore Renewable Energy Targets

12.1 Introduction

The following chapter looks at the cumulative effects different targets for offshore wind and marine renewable energy development, and the spatial distribution of development across each of the individual resource zones within the Northern Ireland waters study area, would have on the environment and other marine users. Chapter 13 presents the results from the assessment of cumulative effects associated with other marine plans, programmes and developments.

12.2 Identification of the Targets for Offshore Wind and Marine Renewable Energy

In terms of identifying targets to reflect the extent to which offshore wind and marine renewable energy will contribute towards the proposed Northern Ireland target of providing 40% electricity from renewable energy sources, it is necessary to identify the likely levels of development that could occur within the individual resource zones (and wider study area) and how these would affect the marine and coastal environment and other marine users.

These likely levels of development were identified through a series of stages:

5. Identify the potential raw resource within the study area and potential resource zones where the available unconstrained (e.g. no environmental, technical (other than water depth) or economic constraints) resource could be developed based on current technologies (see Chapters 7 and 8).
6. Identify the total electricity demand in Northern Ireland by 2020 and total installed capacity required by 2020 to meet that demand.
7. Identify the targets for renewable electricity generation by 2020.
8. Based on current technologies (Chapter 7) and available resource (Chapter 8) identify 'scenarios' relating to the potential percentage contributions of offshore wind, wave and tidal to the overall renewable energy target for Northern Ireland (without taking into account any constraints on development – see above)
9. Identify the likely levels of development that would be required across the study area in order to achieve the different target contributions (scenarios) of offshore wind, wave and tidal power to the overall renewable energy target for Northern Ireland.
10. Identify the potential capacity of each of the resource zones (e.g. levels of development that could occur within each zone based on technological factors only).

Having identified the potential total capacity of each resource zone in terms of the levels of development that it could accommodate, it is then necessary to assess the potential effects that those different levels of development would have on the environment (cumulative effects). The results from this assessment are then used to identify which of the suggested targets (see section 12.2.3 below) could be achieved without significant adverse effects on the environment or other marine users.

12.2.1 *Resource Zones*

In total eight potential resource zones were identified in the study area. These include five tidal zones which are mainly located along the north and east coast, two offshore wind zones; one to the north of the study area and one to the south off Kilkeel, and one wave zone which is located off the north coast. Details of the criteria used to select these zones are presented in Chapter 8. The results from the initial assessment of the potential effects of the different types of development (offshore wind, wave and tidal) on the environment and other marine users within and adjacent to each of the resource zones are presented in Chapter 11.

12.2.2 *Northern Ireland 2020: Energy Demand, Required Installed Capacity and Renewables Targets*

As identified in the recently published Draft Strategic Energy Framework 2009, the proposed target for renewable electricity generation in Northern Ireland by 2020 is 40%, a proportion of which will come from offshore wind, tidal and wave power. As noted in the Strategic Energy Framework the total electricity demand for Northern Ireland is estimated to reach around 11,000 GWh by 2020, which equates to an installed capacity requirement of approximately 4000 MW. Therefore to meet the target of 40% by 2020, approximately 1,600 MW installed capacity will have to be met from renewable energy sources.

The current target for renewable electricity in Northern Ireland is 12% by 2012. At present around 8% of energy generated in Northern Ireland is from renewables sources, the majority of which is generated from onshore wind. It is expected that onshore wind will continue to be the dominant source of renewable energy in Northern Ireland. However, there is significant potential for other sources of renewable energy to contribute towards achieving the targets, including offshore wind, wave and tidal power.

12.2.3 *Theoretical Development Scenarios*

The development scenarios presented below reflect various theoretical levels of contribution from offshore wind, wave and tidal towards achieving the proposed 40% target for renewable electricity in Northern Ireland. These scenarios reflect the findings from the recent DETI work and take into account the information on development parameters discussed in Chapter 7 of this report and summarised in Table 12.1 below.

Table 12.1: Development Parameters

Development/Operational Parameters		Wind	Tidal	Wave
Average Water Depth		15m to 100m	30 to 70m	Up to 100m
Approximate MW/km^2		10	50	10
Average Turbine/Device Generating Capacity		5 MW	1 MW	0.5 MW to 5 MW
Average Scale of Commercial Development	MW	300 MW	50 MW	30 MW
	Km^2	30km^2	1km^2	3km^2

Based on the information presented in Table 12.1 the following scenarios have been identified in terms of the potential contribution of offshore wind and tidal energy towards achieving the Northern Ireland's proposed target of 40% renewable energy by 2020 and the likely levels of development achieving these targets would involve.

These development scenarios are based on **average sizes** for offshore wind farms (300 MW) and tidal arrays (30 MW) based on the information collected from developers and research and are presented in Chapter 8 and Table 12.1 above. The use of the average sizes of offshore wind and tidal developments reflects the strategic nature of this assessment.

However, it should be noted that at the project development stage the size of wind farms and tidal arrays are likely to vary significantly according to different locations and the use of different devices/technologies.

Table 12.2: Theoretical Development Scenarios for Offshore Wind and Tidal Energy (based on average sizes of offshore wind farms and tidal arrays and development occurring anywhere within the Northern Ireland SEA Study Area (territorial waters))

Total NI energy demand in 2020 = ~ 11,000 GWh					
Installed capacity in NI in 2020 = ~ 4,000 MW					
Renewable energy target for 2020 of 40% = 1,600 MW					
Contribution of offshore wind and tidal energy to achieving proposed NI 40% renewable energy target		**Likely required number of developments to achieve percentage contribution based on the assumption that an average wind farm is 300 MW (see previous development parameters)**		**Likely required number of developments to achieve percentage contribution based the assumption that an average tidal array is 50 MW (see previous development parameters)**	
% Contribution	**Equivalent total MW contribution**				
25%	400 MW	1 wind	300 MW	2 tidal	100 MW
37.5%	600 MW	2 wind	600 MW	0 tidal	0 MW
		1 wind	300 MW	6 tidal	300 MW
50%	800 MW	2 wind	600 MW	4 tidal	200 MW
70%	1200 MW	3 wind	900 MW	6 tidal	300 MW
100%	1600 MW	4 wind	1200 MW	8 tidal	400 MW

12.2.3.1 <u>Wave Energy</u>

Given that there is limited potential resource in terms of wave (only one resource zone) this technology has been excluded from the overall theoretical targets discussed in Table 12.2 above. However, this does not exclude wave from the SEA or inclusion within the SAP. It simply reduces the pressure to deliver significant levels of energy from a technology where the available resource is already fairly limited.

12.2.4 Resource Zone Capacity

The development scenarios presented in Table 12.2 above are based on certain levels of development occurring across the entire NI SEA study area (e.g. for three wind farms and six tidal arrays to be located anywhere within the Northern Ireland SEA study area). However, the majority of exploitable resource is only available within certain locations or 'zones'. Therefore to enable an assessment of the potential cumulative effects that achieving the theoretical targets presented above would have on the environment and other marine users, it is necessary to identify the potential capacity for development within each resource zone.

The potential capacity of each resource zone is based on technological considerations only. **Environmental factors and marine users have NOT been taken into consideration at this point in the assessment.** The potential development capacity of each zone is illustrated in Table 12.3 below in terms of the number of developments that could be accommodated within each zone (based on technological considerations only) and the total number of MW that could be generated. **This is based on the average sizes for offshore wind and tidal arrays presented in Table 12.1.** These averages are likely to change in the future as technologies and devices develop and evolve.

Table 12.3: Resource Zone Capacity (Offshore Wind and Tidal)

Resource Zone Capacity Offshore Wind (excluding environmental factors)			**Resource Zone Capacity Tidal (excluding environmental factors)**		
Zone	**Total No. of developments** (based on average size of offshore wind developments from Table 12.1)	**Total Potential MW** (based on average size of offshore wind developments from Table 12.1)	**Zone**	**Total No. of developments** (based on average size of tidal arrays from Table 12.1)	**Total Potential MW** (based on average size of tidal arrays from Table 12.1)
Zone 1	2	600 MW	**Zone 1**	2 to 3	100 MW/150 MW
Zone 2	3	900 MW	**Zone 2**	4	200 MW
			Zone 3	1 to 2	100 MW
			Zone 4	2	100 MW
			Zone 5	0 to 1	50 MW
Total Offshore Wind		1500 MW	Total Tidal		600 MW
Total Offshore Renewable Energy Capacity (offshore wind and tidal) within the Identified Resource Zones in the NI SEA Study Area					**2100 MW**

12.3 Results from the Assessment of the Varying Levels of Development (Targets)

This section looks at the assessment of the potential effects of varying levels of development within each of the resource zones on the environment (marine and coastal) and other marine users.

The cumulative assessment attempts to take a pragmatic approach to bringing together the findings of the previous sections of the SEA in order to determine, at a strategic level, where arrays could potentially be located within each resource zone. The cumulative assessment takes into account the location of technical resource for each technology type, and the physical and environmental constraints operating within each zone. The potential for development of multiple arrays within each zone (depending on the size of the zone relative to the typical array size for each technology) is considered, and the cumulative impacts are assessed.

The cumulative assessment has assumed that appropriate and realistic mitigation can and will be applied to reduce impacts. However, it has also taken into account where avoidance mitigation may not be possible, and therefore should not be assumed, due to the influence of other constraints. Where fundamental device design characteristics, such as method of seabed attachment, are recommended as possible mitigation measures that developers should consider to reduce seabed impacts, the cumulative assessment has not assumed that such mitigation can be applied, as the applicability of such design criteria will be device specific.

The results of the cumulative assessment are presented in Tables 12.4 to 12.10. For each resource zone, impacts of both single and multiple areas are assessed across all receptors within that zone. An attempt has been made to assign potential effects significance to each in order to compare the possible impacts within each zone. However, in a number of cases uncertainty remains in relation to both the baseline environmental data for that zone, and the level of understanding of interactions between wave, wind and tidal devices and marine wildlife. Cumulative impacts may be further reduced from those described in the tables, dependent on further site study and device design. The tables illustrate where there is the greatest potential for development (offshore wind and tidal) avoiding significant adverse effects.

Table 12.4: Wind Resource Zone 1: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Wind Resource Zone 1: North Coast – Potential Cumulative Effects WITH Mitigation		
		Number of Commercial Offshore Wind Developments		Comments
		1 (300 MW)	2 (600 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Negligible**	**Negligible**	Any effects on coastal processes are likely to be negligible due to distance of the main area of resource from the coast. However, coastal modelling may be required to confirm the exact level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Negative**	**Negative**	Zone is in close proximity to the Skerries pSAC and overlaps with potential Annex I (PAIH) sandy sediment habitat.
	Benthic and Intertidal Ecology	**Negative**	**Negative**	Overlap with potential Annex I (PAIH) sandy sediment.
	Fish and Shellfish	**Negligible**	**Negligible**	There is potential for installation of devices to result in substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. There may be potential positive effect on fish populations through fish stock recovery. However, this is dependent on whether certain types of commercial fishing activities would be excluded from the array.
	Birds	**Negative**	**Significant adverse**	The adjacent coastline contains protected seabird populations and breeding colonies. Birds from these sites may therefore be present feeding or loafing in the offshore resource zone. Likely negative and significant adverse effects include marine noise, physical disturbance, and habitat exclusion and collision risk. The significance of the effect would increase for multiple arrays due to the increased habitat area affected, and increasing risk of barrier effects.
	Marine Mammals	**Negative**	**Significant adverse**	Although marine mammal distribution is not well understood, harbour porpoise are known to use Lough Foyle. There may also be a likely significant adverse effects from noise during the installation of piled foundations, and potential barrier effect at entrance to Lough Foyle. These effects will increase in significance with increasing development.
	Marine Reptiles	**Unknown**	**Unknown**	Turtle populations in NI waters are not well understood.
	Bats	**Unknown**	**Unknown**	The presence of bats in offshore locations and the potential effects of offshore wind farms on bats are not well understood.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Wind Resource Zone 1: North Coast – Potential Cumulative Effects WITH Mitigation		
		Number of Commercial Offshore Wind Developments		Comments
		1 (300 MW)	2 (600 MW)	
Population and Human Health	Commercial Fisheries	**Negligible**	**Negative**	Potential displacement from traditional inshore whitefish trawling and lobster and crab potting grounds. Potential positive effects resulting from stock recovery in areas where fishing is excluded. Actual degree of likely effect is primarily dependent on whether fishing is permitted within arrays.
Population and Human Health	Mariculture	**Negligible**	**Negligible**	Offshore wind development will not have a direct effect on fish farming within Lough Foyle. There is also limited potential for effects from export cables.
	Ports, shipping and navigation	**Negligible**	**Negative**	Close proximity to shipping lanes entering and leaving Lough Foyle increasing the potential for collision risk and displacement. Placement of 2 arrays could introduce restricted areas for shipping on both sides of the Lough Foyle approach channel.
	Recreation and Tourism	**Negligible**	**Negative**	Potential impacts on recreational yachting and marine mammals relevant to wildlife watching in Lough Foyle.
	Radar Interference	**Negligible**	**Negligible**	Zone overlaps with an area of potential for interference with NERL infrastructure. Consultation with CAA/NATS required to confirm level of impact.
	Military Practice Areas	**Negligible**	**Negligible**	Overlap with Skerries exercise area. There is also potential for sites to overlap with the Magilligan firing range. Consultation with MOD required to confirm level of impact.
	Disposal Areas	**Negligible**	**Negligible**	No overlap with disposal sites. Close proximity to Portstewart Bay disposal site.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	Potential interactions with telecoms cable can be managed through good practice.
	Aggregate Extraction	**No effect**	**No effect**	No receptors within zone.
Landscape/ Seascape	Seascape	**Significant Effects**	**Significant Effects**	Significant effects on Giant's Causeway WHS, and adjacent coastline including areas of AONB (Causeway Coast).
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects by helping to reduce carbon emissions at a local and national level and providing a platform for the growth and development of an industry that, at a wider scale, could assist in combating global climate change.
	Carbon and Gas Storage	**No effect**	**No effect**	No receptors within zone.
Cumulative Effects	Cumulative Effects	**Negative**	**Significant adverse/ Significant effects**	Cumulative effects across receptors range from no effect to significant adverse. The significance of effect increases with development of 2 arrays primarily due to the increased barrier effects for mammals accessing Lough Foyle, increased restriction to shipping routes, and possible bird collision impacts. Seascape effects are also considered to be significant for both 1 or 2 arrays due to the possible close proximity to the turbine height and proximity to relatively unspoilt coastline, and Giant's Causeway WHS and Causeway Coast AONB. Further information is needed to fully understand and quantify the potential negative impacts on marine mammals and fish, and potential negligible impacts on birds and benthic ecology.

Table 12.5: Wind Resource Zone 2: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Wind Resource Zone 2: East Coast – Potential Cumulative Effects WITH Mitigation			
		Number of Commercial Offshore Wind Developments			Comments
		1 (300 MW)	2 (600 MW)	3 (900 MW)	
Water and Soil (Sediment)	Bathymetry	**No effect**	**No effect**	**No effect**	No effects on bathymetry are expected.
	Geology, geomorphology and sediment processes	**Negligible**	**Negligible**	**Negligible**	Any potential effects on coastal processes are likely to be negligible due to distance of the main area of resource from the coast. However, coastal modelling may be required to confirm level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Negligible**	**Negligible**	**Negligible**	There is potential for development to overlap with the Murlough SAC. However any significant adverse effects can be avoided by avoiding this site during site selection. There are no currently proposed marine SACs in this zone.
	Benthic and Intertidal Ecology	**Negligible**	**Negligible**	**Negative**	There is potential for development to cause substratum loss which could have a negative effect on the pAIH sub-tidal sandbanks adjacent to Murlough SAC.
	Fish and Shellfish	**Negligible**	**Negligible**	**Negative**	There are potential negative effects from substratum loss in shellfish grounds and spawning areas. Noise, habitat exclusion and collision risks are not well understood. Potential positive effect on fish populations through fish stock recovery although this is dependent on whether certain types of commercial fishing activities would be excluded from the arrays.
	Birds	**Negative**	**Negative**	**Significant adverse**	Marine noise, physical disturbance and collision risk could have potential negative effects on birds. These effects will increase in significance as development increases.
	Marine Mammals	**Negligible**	**Negligible**	**Significant adverse**	Significant adverse effects on marine mammals from noise during installation of piled foundations. Noise from the construction of multiple arrays could act as a barrier to mammal movements adjacent to the coast and along migration routes, although these effects are not well understood.
	Marine Reptiles	**Unknown**	**Unknown**	**Unknown**	Turtle populations in NI waters are not well understood.
	Bats	**Unknown**	**Unknown**	**Unknown**	The presence of bats offshore and impacts of offshore wind farms on bats is not well understood.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.
Population and Human Health	Commercial Fisheries	**Negligible**	**Negative**	**Significant adverse**	Potential long term displacement from traditional grounds for lobster and crab potting, gill netting, scallop dredging and trawling. Actual significance of potential effect is primarily dependent on whether fishing is permitted within arrays.

SEA Topic		Wind Resource Zone 2: East Coast – Potential Cumulative Effects WITH Mitigation			
		Number of Commercial Offshore Wind Developments			Comments
		1 (300 MW)	2 (600 MW)	3 (900 MW)	
Population and Human Health	Mariculture	Negligible	Negligible	Negligible	No direct effects on fish farming within the adjacent sea Loughs. Limited potential for effects from export cables.
	Ports, shipping and navigation	Negligible	Negative	Significant adverse	Zone is in close proximity to shipping routes increasing the potential of collision risk and displacement. Installation of 2-3 arrays could result in wind farms on both sides of a main shipping route, potentially placing a significant physical constraint on the navigation channel.
	Recreation and Tourism	Negligible	Negligible	Negative	Potential access and displacement impacts on recreational yachting.
	Radar Interference	Negligible	Negligible	Negligible	Potential to overlap an area with potential for interference with NERL infrastructure. Consultation with CAA/NATS required to confirm level of potential effect.
	Military Practice Areas	Negligible	Negligible	Negligible	Overlap with Ardglass exercise area. Consultation with MOD required to confirm level of potential effect.
	Disposal Areas	Negligible	Negligible	Negligible	Although the zone is in close proximity to several disposal sites potential effects will be avoided through implementation of good practice and site selection.
Material Assets	Cables and Pipelines	No effect	No effect	No effect	Potential interactions with telecoms cable can be managed through good practice.
	Aggregate Extraction	Negligible	Negligible	Negligible	Two areas within the zone have been identified as containing suitable resource for commercial aggregate extraction. There could be potential negative effects if the aggregate resource is exploited.
Landscape/Seascape	Seascape	Moderate	Moderate	Significant effects	There are areas within this resource zone where offshore wind developments would potentially only have a moderate effect on seascape. However, once these areas are developed the cumulative effects resulting from any further developments in areas of high seascape value could lead to significant effects.
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	Positive	Positive	Positive	Positive effects on wider targets to combat climate change and minimise associated environmental effects.
	Carbon and Gas Storage	No effect	No effect	No effect	No receptors within zone.
Cumulative Effects	Summary	Negligible	Negative	Significant adverse	Cumulative impacts across receptors for development of 1 or 2 arrays are generally negligible to negative. Installation of 3 arrays in this zone may cause significant adverse effects primarily associated with the potential presence of wind farm constraints either side of a very busy shipping channel and seascape impacts. Collision and habitat exclusion impacts on birds, and possible barrier effects to marine mammals moving along the coast could also be of adverse significance. Further information is needed to fully understand and quantify the potential negative impacts on marine mammals and fish, and negligible impacts on birds and benthic ecology.

Table 12.6: Tidal Resource Zone 1: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Tidal Resource Zone 1: North Coast – Potential Cumulative Effects WITH Mitigation		
		Number of Commercial Tidal Array Developments		Comments
		1 (50 MW)	2 (100 MW)	
Water and Soil (Sediment)	Bathymetry	**No effect**	**No effect**	No effects on bathymetry are expected
	Geology, geomorphology and sediment processes	**Negligible**	**Negligible**	Any potential effects on coastal processes are likely to be negligible due to distance of the main area of resource from the coast. However, coastal modelling may be required to confirm level of likely effect.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	Potential effects in relation to contamination can be managed through the adoption of good practice.
Biodiversity, Flora and Fauna	Protected Sites	**Negligible**	**Negligible**	The main area of tidal resource is located within the centre of the zone, 3 km from the stony and bedrock reef PAIH.
	Benthic and Intertidal Ecology	**Negligible**	**Negligible**	No known sensitive/important benthic communities present. Benthic surveys will be required to confirm level of potential effect.
	Fish and Shellfish	**Negative**	**Negative**	Seabed disturbance could have potential negative effects on seabed species such as scallops. The significance of effect is dependent on method of seabed attachment. Noise, habitat exclusion and collision risks are not well understood, but any potential negative effects are likely to increase as the levels of development increase.
	Birds	**Negligible**	**Negligible**	The offshore area associated with this zone has not been identified as an area of importance for breeding seabirds. However there is limited information on location of feeding and loafing areas. Noise, habitat exclusion and collision risks (diving birds) are not well understood. However the site is in open waters offshore and it is considered likely that there will be alternative adjacent habitat available.
	Marine Mammals	**Negative**	**Negative**	Although collision risk effects and marine mammal distributions are not well understood, there is potential for negative effects to occur in relation to tidal turbines. There may be negative short term effects from noise during installation of piled foundations. Barrier effects not likely to be a significant issue in this area.
	Marine Reptiles	**Unknown**	**Unknown**	Turtle populations in NI waters are not well understood.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.
Population and Human Health	Commercial Fisheries	**Negligible**	**Negligible**	Potential for long term displacement from traditional whitefish trawling area and scallop dredging grounds. The tidal resource area only represents a small percentage of overall fishing grounds. The actual degree of potential effect is primarily dependent on whether fishing is permitted within arrays.

SEA Topic		Tidal Resource Zone 1: North Coast – Potential Cumulative Effects WITH Mitigation		
		Number of Commercial Tidal Array Developments		Comments
		1 (50 MW)	2 (100 MW)	
	Mariculture	Negligible	Negligible	There are unlikely to be any direct negative effects on fish farming within Lough Foyle. There is also limited potential for negative effects from export cables.
Population and Human Health	Ports, shipping and navigation	Negligible	Negligible	The tidal resource zone is in close proximity to shipping routes entering and leaving Lough Foyle. However there is low potential for increased collision risk and displacement as the main resource is in open, relatively unconstrained offshore waters.
	Recreation and Tourism	Negligible	Negligible	Low potential effects on recreational yachting and marine mammals relevant to wildlife watching in Lough Foyle, as the zone is in open relatively unconstrained offshore waters.
	Military Practice Areas	Negligible	Negligible	Overlap with Skerries exercise area. Consultation with MOD required to confirm level of effect.
	Disposal Areas	Negligible	Negligible	No disposal areas within zone. Close proximity to Portstewart Bay disposal site. Any potential adverse effects can be avoided through site selection and good practice.
Material Assets	Cables and Pipelines	No effect	No effect	Potential interactions with telecoms cable can be managed through good practice.
	Aggregate Extraction	No effect	No effect	No receptors within zone.
Landscape/Seascape	Seascape	Slight effects	Slight effects	The main tidal zone is located more than 15km offshore and therefore, given that tidal devices do not protrude as much as offshore wind devices above the surface any development is only likely to have a slight effect.
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	Positive	Positive	Positive effects on wider targets to combat climate change and minimise associated environmental effects by helping to reduce carbon emissions at a local and national level and providing a platform for the growth and development of an industry that, at a wider scale, could assist in combating global climate change.
	Carbon and Gas Storage	No effect	No effect	No receptors within zone
Cumulative Effects	Summary	Negative	Negative	Cumulative effects across receptors for development of 1 or 2 arrays are generally negligible to negative. Further information is needed to fully understand and quantify the potential negative effects on marine mammals and fish, and potential negligible effects on birds and benthic ecology.

Table 13.7: Tidal Resource Zone 2: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Tidal Resource Zone 2: Rathlin Island and Torr Head – Potential Cumulative Effects WITH Mitigation				
		Number of Commercial Tidal Array Developments				Comments
		1 (50 MW)	2 (100 MW)	3 (150 MW)	4 (200 MW)	
Water and Soil (Sediment)	Bathymetry	**No effect**	**No effect**	**No effect**	**No effect**	No effects on bathymetry are expected.
	Geology, geomorphology and sediment processes	**Negative**	**Negative**	**Negative**	**Negative**	Tidal arrays could have potential negative effects on important marine landscapes, and due to proximity to the coastline may also effect hydrodynamics and coastal processes. Coastal modelling will be required to confirm level of potential effect and inform array siting.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	**Negligible**	**Negligible**	Contamination can be managed through adopting good practice
Biodiversity, Flora and Fauna	Protected Sites	**Negative**	**Negative**	**Negative**	**Negative**	There is potential for the development of up to 4 arrays avoiding protected sites. There may be potential negative cumulative effects on birds using the nearby SPA.
	Benthic and Intertidal Ecology	**Negligible**	**Negligible**	**Negligible**	**Negligible**	There is potential for development of up to 4 arrays, which avoid existing and known potential protected sites for benthic ecology, including avoidance of the potential SAC and MCZ at Shamrock Reef. Benthic survey required to confirm level of potential effect.
	Fish and Shellfish	**Negative**	**Negative**	**Negative**	**Negative**	There are potential effects on demersal species such as lobster, edible crab, *Nephrops* and velvet crab from seabed disturbance. The significance of the effect is dependent on the method of seabed attachment. Noise, habitat exclusion and collision risks are not well understood, but are likely to increase as the number of arrays in the areas increases.
	Birds	**Negative**	**Negative**	**Negative**	**Negative**	The adjacent coastline is extensively protected for marine seabirds. Whilst development can avoid designated sites, birds from these sites may be present within the array area. There is limited information on location of feeding and loafing areas. Noise, habitat exclusion and collision risks (diving birds) are not well understood. Site specific surveys are recommended to aid site selection.
	Marine Mammals	**Negative**	**Negative**	**Negative**	**Negative**	Collision risk, and marine mammal distribution is not well understood, but there is a potential risk of negative effects in relation to tidal turbines. Adverse short term impacts (noise) during installation of piled foundations. Potential barrier effect in constrained area between Rathlin increases with number of arrays in this zone, however development of up to 4 arrays within resource zone 2 is possible without blocking Rathlin Sound.
	Marine Reptiles	**Unknown**	**Unknown**	**Unknown**	**Unknown**	Turtle populations in NI waters are not well understood.

SEA Topic		Tidal Resource Zone 2: Rathlin Island and Torr Head – Potential Cumulative Effects WITH Mitigation				
		Number of Commercial Tidal Array Developments				Comments
		1 (50 MW)	2 (100 MW)	3 (150 MW)	4 (200 MW)	
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.
Population and Human Health	Commercial Fisheries	**Negligible**	**Negligible**	**Negligible**	**Negative**	There could be potential long term displacement from traditional grounds for lobster and crab potting. However the main tidal resource area only represents a small percentage of overall fishing grounds in this area and the actual degree of impact primarily dependent on whether fishing is permitted within arrays.
	Mariculture	**No effect**	**No effect**	**No effect**	**No effect**	No receptors within zone.
	Ports, shipping and navigation	**Negligible**	**Negligible**	**Negative**	**Negative**	Close proximity to shipping routes within a restricted area. There is scope for array placement in areas of low shipping activity within this zone. Development would also need to avoid disruption/diversion to any key ferry routes that pass through the area.
	Recreation and Tourism	**Negligible**	**Negligible**	**Negligible**	**Negligible**	Low potential impacts on recreational yachting and marine mammals relevant to wildlife watching.
	Military Practice Areas	**Negligible**	**Negligible**	**Negligible**	**Negligible**	Overlap with Rathlin exercise area. Consultation with MOD required to confirm level of potential effect.
	Disposal Areas	**Negligible**	**Negligible**	**Negligible**	**Negligible**	Close proximity to disposal site. No access restrictions are expected.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	**No effect**	**No effect**	Potential interactions with power cable can be managed through good practice and site selection.
	Aggregate Extraction	**No effect**	**No effect**	**No effect**	**No effect**	No receptors within zone.
Landscape/ Seascape	Seascape	**Slight**	**Slight**	**Moderate**	**Moderate**	Submerged tidal arrays and smaller arrays that protrude above the surface are likely to have moderate to slight effects. As most of the tidal resource is located around Rathlin Island it is likely that most development will occur within 0 to 5km from the coast. Four developments could therefore potentially have a significant effect on seascape although these effects could be reduced through careful siting (e.g. away from other development) and array configurations or the use of submerged devices.
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects by helping to reduce carbon emissions at a local and national level and providing a platform for the growth and development of an industry that, at a wider scale, could assist in combating global climate change.

SEA Topic		Tidal Resource Zone 2: Rathlin Island and Torr Head – Potential Cumulative Effects WITH Mitigation				
		Number of Commercial Tidal Array Developments				Comments
		1 (50 MW)	2 (100 MW)	3 (150 MW)	4 (200 MW)	
Climatic Factors	Carbon and Gas Storage	**No effect**	**No effect**	**No effect**	**No effect**	No receptors within zone.
	Cumulative Effects					
Cumulative Effects	Summary	**Negative**	**Negative**	**Negative**	**Negative**	Cumulative effects across receptors for development of 1 or 2 arrays are generally negligible to negative. Potential negative effects increase as the number of arrays increase, mainly due to the greater area of habitat removal for marine species, and possible barrier effects associated with developing more arrays in a relatively constrained area. The possible restriction on shipping also increases with number of arrays as they would be likely to be placed on either side of a busy shipping channel. Further information is needed to fully understand and quantify the potential effects on marine mammals and fish, birds and benthic ecology. Increased number of developments may also have a moderate effect on seascape, although the use of submerged devices and careful siting and configuration of arrays would prevent any significant effects occurring.

Table 12.8: Tidal Resource Zone 3: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Tidal Resource Zone 3: Maiden Islands – Potential Cumulative Effects WITH Mitigation		
		Number of Commercial Tidal Array Developments		Comments
		1 (50 MW)	2 (100 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Negative**	**Negative**	The siting of arrays in close proximity to the Maiden Island coastline could have potential negative effects on hydrodynamics and coastal processes. Coastal modelling will be required to confirm the level of effect and inform array siting.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	Contamination can be managed through adopting good practice and appropriate site selection.
Biodiversity, Flora and Fauna	Protected Sites	**Significant adverse**	**Significant adverse**	The entire resource zone overlaps with stony and bedrock reef PAIH, and the possible Maidens Offshore SAC. Substratum removal associated with the installation of devices may be unavoidable and could have a potential significant adverse effect, although these effects are dependent on the device foundation type.
	Benthic and Intertidal Ecology	**Significant adverse**	**Significant adverse**	The entire resource zone overlaps with stony and bedrock reef PAIH, and possible Maidens Offshore SAC, which is has been identified as a possible SAC on the basis of its benthic ecology. Substratum removal associated with the installation of devices may be unavoidable and could give rise to potential significant adverse effects, although these effects are dependent on the device foundation type.
	Fish and Shellfish	**Negative**	**Negative**	Seabed disturbance could have potential negative effects on demersal species such as scallops, *Nephrops*, and native oysters. The significance of these effects are dependent on method of seabed attachment. Noise, habitat exclusion and collision risks are not well understood, but any negative effects are likely to increase as the amount of development of the available resource increases.
	Birds	**Negligible**	**Negligible**	The adjacent mainland (Larne Lough - 10 km away) contains protected bird populations. Whilst development can avoid designated sites, birds from these sites may be present within the array area. Limited information is available on the location of feeding and loafing areas. Noise, habitat exclusion and collision risks (diving birds) are also not well understood. Surveys are recommended to aid site selection.
	Marine Mammals	**Negligible**	**Negative**	There is potential that tidal turbines could increase the risk collision with marine mammals. There could also be negative effects from noise produced during installation of piled foundations. Potential barrier effects from collision risk and noise on mammals transiting in the constrained area between the Maiden Islands and associated rocky outcrops will potentially increase with number of arrays in this zone.
	Marine Reptiles	**Unknown**	**Unknown**	Turtle populations in NI waters are not well understood.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Tidal Resource Zone 3: Maiden Islands – Potential Cumulative Effects WITH Mitigation		
		Number of Commercial Tidal Array Developments		Comments
		1 (50 MW)	2 (100 MW)	
Population and Human Health	Commercial Fisheries	**Negligible**	**Negligible**	Tidal arrays could lead to the potential long term displacement from traditional grounds for lobster and crab potting. However, the main area of tidal resource only represents a small percentage of overall fishing grounds, therefore effects are likely to be negligible. The actual degree of potential effect is dependent on whether fishing is permitted within arrays.
	Mariculture	**No effect**	**No effect**	No receptors within zone.
	Ports, shipping and navigation	**Negligible**	**Negligible**	Main resource area is about 2.5 km from the busiest adjacent shipping routes.
	Recreation and Tourism	**Negligible**	**Negligible**	Low potential access and displacement impacts on recreational yachting. Main routes are away from the area of greatest tidal resource.
	Military Practice Areas	**Negligible**	**Negligible**	Overlap with Maiden exercise area. Consultation with MOD required to confirm level of potential effect.
	Disposal Areas	**No effect**	**No effect**	No receptors within zone.
Material Assets	Cables and Pipelines	**No effect**	**No effect**	No receptors within zone.
	Aggregate Extraction	**No effect**	**No effect**	No receptors within zone.
Landscape/Seascape	Seascape	**Slight effect**	**Slight effect**	The main area of tidal resource is between 5km and 15km offshore. Therefore it is likely that, with submerged devices or devices that only protrude a small amount above the surface of the water, have a potential slight effect on seascape.
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	**Positive**	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects by helping to reduce carbon emissions at a local and national level and providing a platform for the growth and development of an industry that, at a wider scale, could assist in combating global climate change.
	Carbon and Gas Storage	**No effect**	**No effect**	No receptors within zone.
Cumulative Effects				
Cumulative Effects	Summary	**Significant adverse**	**Significant adverse**	Cumulative effects across receptors for the development of 1 or 2 arrays range from no effect to significant adverse. The Maiden Islands are being considered for designation as an offshore SAC, and therefore significant adverse impacts cannot be ruled out. Negative effects increase as number of arrays increase, mainly due to possible effects on coastal processes, the increased area of habitat removal for marine species, and possible barrier effects associated with developing a large number of arrays in relatively constrained areas. Further information is needed to fully understand and quantify the potential impacts on marine mammals and fish, birds and benthic ecology.

Table 12.9: Tidal Resource Zone 4: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topics		Tidal Resource Zone 4: Copeland Islands – Potential Cumulative Effects WITH Mitigation		
		Number of Commercial Tidal Array Developments		Comments
		1 (50 MW)	2 (100 MW)	
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Negative**	**Negative**	The siting of tidal devices in close proximity to the Copeland Island coastline could have potential negative effects on hydrodynamics and coastal processes. Coastal modelling will be required to confirm the level of potential effect and inform array siting.
	Sediment Contamination and Water Quality	**Negligible**	**Negligible**	Contamination can be managed through adopting good practice and site selection.
Biodiversity, Flora and Fauna	Protected Sites	**Significant adverse**	**Significant adverse**	Almost the entire zone overlaps with stony and bedrock reef PAIH, and the entire zone overlaps with possible Offshore SAC and Marine Conservation Zone (MCZ).
	Benthic and Intertidal Ecology	**Significant adverse**	**Significant adverse**	Almost the entire zone overlaps with stony and bedrock reef PAIH, and the entire zone overlaps with possible offshore SAC and MCZ currently under discussion, based on its benthic communities.
	Fish and Shellfish	**Negative**	**Negative**	Seabed disturbance from the installation of devices could have a potential negative effect on seabed species such as *Nephrops*, scallops, queen scallops, lobster, edible crab and velvet crab. The significance of potential effects is dependent on method of seabed attachment. Effects from noise, habitat exclusion and collision risks are not well understood, but are likely to increase as the level of development within the zone increases.
	Birds	**Negligible**	**Negative**	The adjacent mainland (Outer Ards SPA - 2 km away) contains protected bird populations. Whilst development can avoid designated sites, birds from these sites may be present within the array area. Limited information on location of feeding and loafing areas. Potential effects associated within noise, habitat exclusion and collision risks (diving birds) are not well understood. Site specific surveys are recommended to aid site selection.
	Marine Mammals	**Negligible**	**Negative**	Potential effects associated with tidal turbines and the risk of collision is not well understood. The distribution of marine mammals is also not well understood. There could be potential negative effects from noise created during the installation of piled foundations. There may also be potential barrier effects on mammals transiting in the constrained area between the Copeland Islands and the adjacent coastline, and entering Belfast Lough. The significance of these potential effects is likely to increases with the level of development in this zone.
	Marine Reptiles	**Unknown**	**Unknown**	Turtle populations in NI waters are not well understood.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.
Population and Human Health	Commercial Fisheries	**Negligible**	**Negligible**	No known fishing grounds within the site which is immediately adjacent to / within a main shipping channel

SEA Topics		Tidal Resource Zone 4: Copeland Islands – Potential Cumulative Effects WITH Mitigation		
		Number of Commercial Tidal Array Developments		Comments
		1 (50 MW)	2 (100 MW)	
Population and Human Health	Mariculture	No effect	No effect	No receptors within zone.
	Ports, shipping and navigation	Negative	Significant adverse	Development of 1 array would mean placing devices immediately adjacent to main shipping route, development of 2 arrays would mean that devices are placed within the main shipping channel, with the associated collision risk and displacement impacts.
	Recreation and Tourism	Negligible	Negligible	Potential access and displacement impacts on recreational yachting. Main recreational routes are away from the area of greatest tidal resource.
	Military Practice Areas	Negligible	Negligible	Overlap with Magee exercise area. Consultation with MOD required to confirm level of potential effect.
	Disposal Areas	No effect	No effect	No receptors within zone.
Material Assets	Cables and Pipelines	No effect	No effect	No receptors within zone.
	Aggregate Extraction	No effect	No effect	No receptors within zone.
Landscape/Seascape	Seascape	Slight effect	Slight effect	Potential effects on seascape associated with tidal developments in this zone are likely to be slight due to the lower sensitively of the seascape area to tidal developments and the opportunities for the installation of submerged or predominantly submerged devices.
Climatic Factors	Carbon Cost of Offshore Renewable Energy Developments	Positive	Positive	Positive effects on wider targets to combat climate change and minimise associated environmental effects by helping to reduce carbon emissions at a local and national level and providing a platform for the growth and development of an industry that, at a wider scale, could assist in combating global climate change.
	Carbon and Gas Storage	No effect	No effect	No receptors within zone.
Cumulative Effects	Summary	Significant adverse	Significant adverse	Cumulative impacts across receptors and for development of 1 or 2 arrays range from no effect to significant adverse. The Copeland Islands are being considered for designation as an offshore SAC, and therefore significant adverse impacts cannot be ruled out. Negative impacts increase with number of arrays, mainly due to possible impacts on coastal processes, the increased area of habitat removal for marine species, and possible barrier effects associated with developing more arrays in a relatively constrained area. In addition, the area overlaps with an intensely used shipping area, and development of 2 arrays would necessitate placing devices in busy shipping areas, with significant adverse impacts. Further information is needed to fully understand and quantify the potential impacts on marine mammals and fish, birds and benthic ecology.

Table 13.10: Tidal Resource Zone 5: Results of the Cumulative Assessment (based on likely residual effects INCLUDING MITIGATION)

SEA Topic		Tidal Resource Zone 5: Strangford Narrows	
		Number of Commercial Tidal Array Developments 1 (50 MW)	Comments
Water and Soil (Sediment)	Geology, geomorphology and sediment processes	**Significant adverse**	Due to the close proximity to the coastline, and limited space within the Lough there is potential for significant adverse effects to occur.
	Sediment Contamination and Water Quality	**Negligible**	Contamination can be managed through adopting good practice and site selection.
Biodiversity, Flora and Fauna	Protected Sites	**Significant adverse**	The entire resource zone overlaps with national and international designations (Ramsar, SAC, SPA, NNR, and AONB). Strangford Lough is also the only MNR in NI. Development of tidal arrays in this area is likely to have significant adverse effects.
	Benthic and Intertidal Ecology	**Significant adverse**	Most of zone overlaps with stony and bedrock reef PAIH, and entire zone overlaps with SAC and MNR, designated for its benthic ecology. Development of tidal arrays in this area is likely to have significant adverse effects.
	Fish and Shellfish	**Negative**	Seabed disturbance could potential have a negative effect on seabed species such as lobster, *Nephrops*, edible crab, velvet crab, cockles and whelks. The significance of potential effects is dependent on method of seabed attachment. Effects from noise, habitat exclusion and collision risks are not well understood, but are likely to increase as the level of development within the zone increases.
	Birds	**Significant adverse**	The Narrows are heavily protected for marine birds (containing SPA and Ramsar designations), which completely overlap with the resource zone. Disturbance and displacement resulting from the installation and operation of tidal arrays could potentially have a significant adverse effect on the bird populations present in this area. Potential effects associated within noise, habitat exclusion and collision risks (diving birds) are not well understood. Site specific surveys are recommended to aid site selection.
	Marine Mammals	**Significant adverse**	Potential effects associated with tidal turbines and the risk of collision is not well understood. The distribution of marine mammals is also not well understood. There could be potential negative effects from noise created during the installation of piled foundations. The existing single tidal turbine in Strangford Lough has not been found to effect seal populations in the Lough, although the device is subject to 24 hour monitoring to avoid any risk collision with marine mammals. However, due to the constrained nature of the narrows there is likelihood that a number of devices in this area (associated with an array) could potentially have a significant adverse effect on marine mammals by creating a barrier to the movement of mammals entering or leaving Strangford Lough.
	Marine Reptiles	**Unknown**	Turtle population in NI waters is not well understood.
Cultural Heritage Including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	**Negligible**	Potential effects on wrecks and submerged landscapes can be avoided through site selection and monitoring during installation. Archaeological assessment of survey data can add to archaeological record.

SEA Topic		Tidal Resource Zone 5: Strangford Narrows	
		Number of Commercial Tidal Array Developments	Comments
		1 (50 MW)	
Population and Human Health	Commercial Fisheries	**Negligible**	There are no known fishing grounds within the Lough, although crab and lobster potting occurs at the Lough entrance. Any potential effects are likely to be negligible.
	Mariculture	**Negligible**	There is an existing aquaculture area in Strangford Narrows, but it is likely that this could be avoided through site selection.
	Ports, shipping and navigation	**Negligible**	There is negligible commercial shipping activity in the zone.
	Recreation and Tourism	**Significant adverse**	There is potential that the development of a tidal array in this area could have a significant adverse effect on recreational yachting by restricting access and reduced navigational safety due to the constrained nature of this Lough. The Lough is a general and race sailing area. It is also important for wildlife watching, which could also be significantly affected by the presence of commercial arrays.
	Military Practice Areas	**Negligible**	Overlap with Ardglass exercise area. Consultation with MOD required to confirm level of potential effect.
	Disposal Areas	**No effect**	No receptors within zone
Material Assets	Cables and Pipelines	**No effect**	No receptors within zone
	Aggregate Extraction	**No effect**	No receptors within zone
	Marine renewable development	**Significant adverse**	Removal of tidal energy and potential access restrictions could have significant impacts on the operation and maintenance of the existing MCT SeaGen device in Strangford Narrows
Landscape/Seascape	Seascape	**Significant effect**	Any potential effects of development are likely to be significant due to the narrow nature of the narrows any tidal devices that protrude above the water surface will be highly visible (within 0 to 5km visibility threshold). The area is also a designated AONB. There may be an opportunity to reduce the potential effects on seascape through the deployment of submerged devices.
Climatic Factors	Carbon Cost of Offshore Wind Energy Developments	**Positive**	Positive effects on wider targets to combat climate change and minimise associated environmental effects by helping to reduce carbon emissions at a local and national level and providing a platform for the growth and development of an industry that, at a wider scale, could assist in combating global climate change.
	Carbon and Gas Storage	**No effect**	No receptors within zone.
Cumulative Effects	Summary	**Significant adverse**	Due to the relatively constrained available space and conservation status of the area it is likely that the development of a tidal array in this area will have significant adverse effects on coastal processes, protected sites, benthic ecology, birds, marine mammals, recreation, seascape and the existing SeaGen development.

12.4 Summary of Results

Based on the results presented in Tables 12.4 to 12.10, the following conclusions have been made regarding the potential levels of development that could occur within the identified areas of resource (resource zones) taking into account the potential cumulative environmental effects, and effects on other marine users, associated with offshore wind and marine renewable energy developments.

These conclusions are based on the development of commercial scale offshore windfarms and tidal arrays only. Although test sites and demonstration projects are not excluded from this SEA, they are not included specifically in the cumulative assessment as the main focus for this part of the assessment is to determine the extent to which offshore wind and tidal energy could potentially contribute towards achieving the proposed Northern Ireland target of 40% electricity from renewable sources. This contribution is most likely to come from full scale commercial developments rather than test or demonstration projects, although it is acknowledged that test and demonstration projects could generate electricity that could be fed into the Northern Ireland grid network.

12.4.1 Potential Levels of Development for Offshore Wind

Table 12.11 provides a summary of the main conclusions in terms of the levels of offshore wind development that could occur within Northern Ireland waters taking into account potential cumulative environmental effects and effects on other marine users.

Table 12.11: Levels of Offshore Wind Development Taking into Account Environmental Effects

Zone	Potential levels of development	Total No. of developments (average)	Total Potential MW	Key Environmental Effects/Effects on Other Marine Users
Zone 1	**Without environmental constraints**	2	600 MW	▪ Effects on benthic ecology from substratum loss and disturbance ▪ Important seabird colonies in area ▪ Potential barrier effect on marine mammals from piling noise ▪ Effects on commercial fisheries ▪ Seascape effects on Giant’s Causeway and Causeway Coast. ▪ Positive effects on climate change
	With environmental constraints	1	300 MW	
Zone 2	**Without environmental constraints**	3	900 MW	▪ Effects on benthic ecology from substratum loss and disturbance ▪ Important seabird colonies in area ▪ Potential barrier effect on marine mammals from piling noise ▪ Effects on commercial fisheries ▪ Effects on shipping and navigation ▪ Seascape effects ▪ Positive effects on climate change
	With environmental constraints	2	600 MW	

Based on the results from the cumulative assessment it has been identified that, in total, up to 900 MW of installed capacity could potentially be provided from offshore wind developments in Northern Ireland waters taking into account environmental effects and effects on other marine users. This is based on one 300MW commercial offshore wind development located within Resource Zone 1, the North Coast, and two 300 MW commercial offshore wind developments located in Resource Zone 2.

12.4.1.1 Summary of Development Constraints in Wind Resource Zone 1: North Coast

The cumulative assessment has identified that there are a number of potential environmental constraints and effects on other marine users that would need to be taken into account/ addressed as part of any commercial scale (e.g. 300MW) offshore wind development within Zone 1. These are summarised in Table 12.11 above and relate mainly to:

- Effects on benthic ecology from substratum loss and disturbance from piled foundation and gravity bases.
- The presence of important seabird populations and breeding colonies along the North Coast.
- Potential for piling noise from development located in the vicinity of Lough Foyle to effect marine mammals and fish and potentially cause a barrier to movement of marine mammals in to and out of Lough Foyle.
- There is potential that offshore wind developments in Wind Resource Zone 1 could cause displacement of fishermen from traditional fishing grounds.
- Offshore wind developments in this zone could have a significant effect on the seascape value of the Causeway Coast AONB and Giant's Causeway World Heritage Site (WHS).

For any commercial offshore wind developments to be taken forward in Wind Resource Zone 1 further surveys (e.g. species abundance and distribution) would need to be carried out at the project development stage (to inform the consenting process) to define the likely level of potential effect on benthic ecology, seabirds, marine mammals and marine reptiles in this area. However, from experience and previous studies undertaken elsewhere it is likely that with careful site selection e.g. away from sensitive benthic species and habitats, seabird colonies and bird migration routes and confined areas where noise from piling activities could cause a barrier to the movement of marine mammals, potential effects on seabirds and marine mammals could be reduced.

There may also be a need, at the project development stage to undertake wider consultation with local commercial fisheries to identify the likely effects of offshore wind developments in this resource zone and examine opportunities for minimising any disruption or displacement.

In terms of effects on seascape, these are likely to be greater for commercial offshore wind developments than wave and tidal arrays in all locations due to the fact that a larger proportion of the device (offshore wind turbine) protrudes above the water surface and therefore has much larger visibility thresholds (distances that devices are visible from shore).

With regard to offshore Wind Resource Zone 1, although a large proportion of the north Antrim Coast is of high sensitivity to offshore wind farm developments, there could be a potential opportunity to locate a commercial offshore wind farm in an offshore location within the western section of the resource zone towards Lough Foyle. This would maximise the distance of the development from the Giant's Causeway World Heritage Site (WHS) and the Causeway Coast AONB which have been identified as being of very high sensitivity to offshore wind developments and of very high scenic value within Northern Ireland and Europe.

However, it should be noted that due to the very high sensitivity of the Giant's Causeway WHS it may not be considered appropriate to develop any commercial scale offshore wind farms along the north coast. This would have to be determined through more detailed seascape assessments undertaken as part of the development consent process for individual projects. The implications of potential effects on seascape in terms of the targets for offshore renewable energy are discussed in section 12.5.

12.4.1.2 Summary of Development Constraints in Wind Resource Zone 2: East Coast

The potential environmental constraints and effects on other marine users that need to be taken into account/addressed as part of any commercial offshore wind development within Resource Zone 2: East Coast are similar to those identified for Wind Resource Zone 1: North Coast except that there is a greater potential for development to interact with shipping and navigation activities in the North Channel. The main issues are summarised in Table 12.11 above and include:

- Effects on benthic ecology from substratum loss and disturbance from piled foundations and gravity bases.
- The presence of important seabird populations and breeding colonies along the East Coast in particular in relation to the Strangford Lough SPA and IBA and Outer Ards SPA and IBA.
- Potential for piling noise from development located in the vicinity of Strangford and Carlingford Loughs and to the north of the zone (North Channel) to affect marine mammals, marine reptiles and fish and potentially cause a barrier to movement of marine mammals in to and out of Strangford and Carlingford Loughs (Strangford Lough is a designated SAC for seals).
- There is potential that offshore wind developments in Wind Resource Zone 2 could cause displacement of fishermen from traditional fishing grounds in particular lobster and crab potting areas.
- Wind Resource Zone 2 is located in close proximity to main shipping channels including the North Channel which is a recognised navigation route of international importance. Offshore wind developments in this zone could lead to reduce navigational safety by constraining shipping channels and displacing vessels into areas of higher shipping intensity.
- Offshore wind developments in this zone could affect the seascape value of the east coast, in particular seascapes associated with Kilkeel coast and surrounding Mourne Mountains hinterlands (Mourne AONB).

As with Wind Resource Zone 1, it is recommended that further surveys/monitoring is carried out at the project level (to inform the consenting process) to further assess the potential effects of commercial offshore wind developments in this area on benthic habitats and species, seabirds, marine mammals and marine reptiles. This could include for example surveys into the distribution and abundance of certain species that could be affected by commercial offshore wind developments. Project level surveys would also be required to provide greater resolution on the likely effects of offshore wind developments (single and cumulative) on seascape.

In addition to seabirds, marine mammals and seascape, other constraints that could potentially limit the extent of offshore wind development within Resource Zone 2 include shipping and navigation and commercial fisheries.

The cumulative assessment identified that through the careful siting of developments negative effects associated with one or two commercial offshore wind developments could be avoided or reduced. However, as the area that is available for development reduces the competition for space in these areas will increase. The potential consequence of this increased pressure for space is that there is a greater likelihood of a higher number of commercial offshore wind farms (e.g. 3 or 4) to have adverse effects on commercial fisheries through increased displacement from traditional fishing ground. Increased development may also further constrain shipping channels and therefore increase the risk of collision and reduced navigational safety by displacing a higher number of vessels in to adjacent, higher intensity shipping lanes.

Increased competition for space within Wind Resource Zone 2 can also increase the likelihood of adverse effects on benthic habitats and species, seabirds, marine mammals, marine reptiles and fish as a consequence of reducing the flexibility for siting developments away from sensitive areas.

12.4.2 Potential Levels of Development for Tidal Energy

Table 12.12 provides a summary of the main conclusions in terms of the number of commercial tidal energy developments (arrays) that could occur within Northern Ireland waters taking into account potential cumulative environmental effects.

Table 12.12: Levels of Tidal Energy Development Taking into Account Environmental Effects

Zone	Potential levels of development	Total No. of developments	Total Potential MW	Key Environmental Effects/Effects on Other Marine Users
Zone 1	**Without environmental constraints**	1 to 2	100 MW	▪ No significant adverse effects identified ▪ Limited constraints due to offshore location ▪ Positive effects on climate change
	With environmental constraints	1 to 2	100 MW	
Zone 2	**Without environmental constraints**	4	200 MW	▪ No significant adverse effects identified ▪ Potential negative effects on fish, marine mammals and sea birds (collision risk and noise) ▪ Potential effects on commercial fisheries and navigation ▪ Positive effects on climate change
	With environmental constraints	4	200 MW	
Zone 3	**Without environmental constraints**	1 to 2	100 MW	▪ Zone overlaps possible offshore SAC sites (due to benthic ecology) ▪ Positive effects on climate change
	With environmental constraints	0	0 MW	
Zone 4	**Without environmental constraints**	2	100 MW	▪ Zone entirely with possible offshore SAC and Marine Conservation Zone (MCZ). ▪ Zone located in middle of main North Channel international shipping lane ▪ Positive effects on climate change
	With environmental constraints	0	0 MW	
Zone 5	**Without environmental constraints**	0 to 1	50 MW	▪ Potential significant adverse effects on hydrodynamics and coastal processes ▪ Potential significant adverse effects on Strangford Lough SAC, SPA and Marine Nature Reserve ▪ Effects on seascape and recreation and tourism ▪ Positive effects on climate change
	With environmental constraints	0	0 MW	

Based on the results from the cumulative assessment it has been identified that, in total, up to 300 MW of installed capacity could potentially be provided from commercial tidal array developments in Northern Ireland waters taking into account environmental effects and effects on other marine users. This is based on two 50MW commercial tidal array developments located within Tidal Resource Zone 1, the North Coast and four 50 MW commercial tidal arrays located in Tidal Resource Zone 2: Rathlin Island and Torr Head. Summaries of development constraints on all the tidal resource zones are given below.

12.4.2.1 Summary of Development Constraints in Tidal Resource Zone 1: North Coast

The cumulative assessment has identified that, in comparison to the rest of the tidal resource zones, the number of potential constraints on the development of commercial tidal arrays are fairly limited in this zone. This observation reflects the fact the main area of tidal resource in this zone is located in open water at a distance of more than 12km offshore. Consequently a number of the potential constraints associated with more coastal areas e.g. presence of seabird populations and breeding colonies, potential to cause barrier effects by obstructing or discouraging movement of fish and marine mammals through channels, between islands or into and out of Loughs, and the potential to restrict navigation channels are fairly limited. Similarly potential effects on seascape also reduce with increased distance offshore from the coast.

However, whilst the assessment has identified that there is potential for the development of tidal arrays in this zone and although key sensitive receptors have not been specifically identified within this location this does not imply that they are not present. To ensure that any commercial tidal development in this location does not have adverse effects on the environment it will still be necessary, at the project stage to obtain the necessary information e.g. through surveys, to ascertain whether there are sensitive benthic habitats, species or marine mammals present in the area or whether the area is used by seabirds for foraging or loafing.

Although this zone is further offshore than other tidal resource zones, there is still the potential that the area is located within a key commercial fishing ground. Negative effects on commercial fisheries therefore cannot be discounted at this strategic level of assessment.

12.4.2.2 Summary of Development Constraints in Tidal Resource Zone 2: Rathlin Island and Torr Head

The results from the cumulative assessment indicate that although no significant adverse effects have been identified for Tidal Resource Zone 2, there are a number of likely negative effects that could occur as a result of a number of commercial tidal arrays being deployed in this area. The key likely negative effects that would need to be assessed in greater detail at the project design stage include:

- Effects on benthic ecology from substratum loss and disturbance from piled foundations and gravity bases (Shamrock Pinnacle and Red Bay both identified as potential offshore SACs for benthic ecology).
- The presence of important seabird populations and breeding colonies (Rathlin SPA also designated as an Important Bird Area (IBA) for seabird assemblages).
- Potential for piling and operational noise from tidal developments located around Rathlin Island to affect marine mammals, marine reptiles and fish and potentially cause a barrier to movement of marine mammals and fish around Rathlin Island and through the channel between Rathlin Island and the mainland.
- There is potential that tidal developments could cause displacement of fishermen from traditional fishing grounds in particular scallop, lobster and crab potting areas.
- Parts of the zone are located in close proximity to main shipping channels therefore tidal developments could reduce navigational safety and restrict navigation channels and access to ports. However, there are areas within the zone where shipping activity is fairly low.
- Offshore wind developments in this zone could affect the seascape value of Antrim Coast and Glens AONB.

Although there are a number of potentially sensitive receptors and protected sites located within the Rathlin Island and Torr Head tidal resource zone, the assessment indicates that potential significant adverse effects on these can be avoided or reduced through careful site selection and the implementation of appropriate project level mitigation measures.

However, although the designated sites and known areas of sensitive receptors can be avoided this does not guarantee that commercial scale tidal developments in this location will not have any adverse effects on these receptors. For example, in terms of seabirds, it is recognised that a large proportion of birds forage and loaf in areas outside the designated sites. The exact distances that seabirds will travel beyond site boundaries are currently unknown. Therefore there is the potential that although a designated site has been avoided, the birds that are being protected may actually be present across the entire resource zone.

Similarly, although there are no specific sites designated for the protection of marine mammals in or adjacent to this resource zone, marine mammals associated with other designated sites elsewhere along the Northern Ireland or even Scottish coast may still be present within, or pass through this zone and could therefore still be affected by commercial tidal developments.

Therefore, although no significant adverse effects have been identified, it will still be necessary as part of the project design/development consent stage to carry out surveys and monitoring into seabird, marine mammal, marine reptile (and possibly basking sharks) occurrence within the zone and acquire further information on the likely interaction of these species with tidal arrays.

In particular it will be necessary to examine the potential for the increased risk and collision and noise from the operation of a number of developments in this resource zone to create a barrier to the movement of marine mammals and fish.

Given that there is an opportunity for tidal devices to be fully submerged, the effects of a number of commercial tidal developments (arrays) in this zone on seascape are likely to be negative to negligible. It is also likely that potential effects on shipping and navigation can also be avoided by deploying tidal arrays in areas low shipping activity (e.g. vessel movements). Further consultation may be required at the project design stage to ascertain the precise effect on commercial fisheries.

12.4.2.3 Summary of Development Constraints in Tidal Resource Zone 3: Maiden Islands

The results from the cumulative assessment indicate that the opportunities for developing any commercial tidal array developments in Tidal Resource Zones 3 without any adverse effects on the environment are fairly limited.

The main environmental constraint within this tidal resource zone relates to benthic ecology. The entire zone overlaps with stony and bedrock reef Priority Annex I Habitat (PAIH) and has been identified as the possible Maidens Offshore SAC. Unlike Tidal Resource Zone 2, there is limited potential to avoid this protected habitat and possible future offshore SAC site. It is likely that any commercial development in this zone would results in the removal of substratum which would have a significant adverse effect on the benthic habitat that it supports. On this basis that this likely significant adverse effect would be unavoidable the cumulative assessment identifies that there is no potential for tidal development in this area.

Potential effects on marine mammals and fish, in particular collision risk and noise from the installation and operation of tidal arrays, and the potential for these to create barriers to movement, also limits the potential development opportunities in this resource zone.

12.4.2.4 Summary of Development Constraints in Tidal Resource Zone 4: Copeland Islands

The main constraints in Tidal Resource Zone 4 have been identified as:

- Shipping and navigation
- Protected sites
- Benthic ecology

As with Tidal Resource Zone 3, the cumulative assessment has identified that there are limited opportunities for commercial tidal developments to be located within this tidal resource zone.

Tidal Resource Zone 4 is located within the North Channel shipping lane which is recognised as a route of international importance for navigation and consequently experiences high levels of shipping movements. Whilst there is potential that the use of fully submerged tidal devices in this location would enable the co-existence of shipping and tidal developments, further research is required to determine the depths to which devices must be deployed to avoid any interaction with passing vessels.

However, although there may be opportunities for tidal developments and shipping to coexist in this location, the potential opportunities for commercial tidal array development in this zone are also limited by the presence of important and valuable benthic habitats and seabird populations as illustrated through the existing designations (Outer Ards SPAs) and proposed future designation (offshore SACs and MCZs). As with Tidal Resource Zone 3, the area included within the proposed offshore SAC and MCZ designations cover the majority of the resource zone. It is therefore likely that any significant effects on benthic habitats resulting from the disturbance of the substratum during the deployment of commercial tidal array developments would be unavoidable.

Additionally, in an attempt to avoid significant adverse effects on shipping and navigation by deploying commercial tidal developments in areas that have lower vessel intensities, this could increase the pressure on sensitive habitats and other species that may be present elsewhere in resource zone, further increasing the likelihood of significant adverse effects. The results from the assessment of cumulative effects therefore indicate that there is limited, to no potential, for commercial tidal developments in Tidal Resource Zone 4.

12.4.2.5 Summary of Development Constraints in Tidal Resource Zone 5: Strangford Lough

The main constraints in Tidal Resource Zone 5 have been identified as:

- Geology and geomorphology
- Protected sites
- Benthic ecology
- Birds
- Marine mammals
- Recreation and tourism
- Seascape

Resource Zone 5 is located within the Strangford Narrows. It is recognised that there is a significant tidal resource within this area, some of which is already being exploited by Marine Current Turbines (MCTs) SenGen demonstration tidal device. However, due to its very high nature conservation value, and its importance in terms of recreation and seascape, the cumulative assessment has concluded that any commercial development in this zone is likely to have a significant adverse effect on the environment.

Strangford Lough is the only Marine Nature Reserve (MNR) in Northern Ireland. It is also a designated SAC, SPA, Ramsar, NNR and AONB. These designations illustrate the importance of the marine and coastal habitats, species and geological features in this area. Given the character of the narrows (9km long narrow channel between Strangford Lough and the Irish Sea) the assessment has also indentified that any large scale commercial development is likely to have significant adverse effects on the seascape character of the area which could also have a direct significant adverse effect on local recreation and tourism. Taking these constraints into account, the assessment has identified that there is very limited potential for commercial tidal developments in this zone.

12.5 Potential Targets for Offshore Wind and Tidal Energy

The main focus of this part of the cumulative assessment was to identify targets which would reflect the extent to which offshore wind and tidal energy within Northern Ireland waters could contribute towards the proposed renewable energy target for Northern Ireland of 40% electricity to be provided from renewable sources.

Table 12.2 (section 12.2.3) set out the likely levels of development required to achieve various targets for offshore wind and tidal energy. These targets were based on a percentage contribution of offshore wind and tidal energy to the overall proposed 40% renewable electricity target for Northern Ireland. The range of percentages and associated levels of development (MW) considered included:

- 25% of the 40% (400MW)
- 37.5% of the 40% (600 MW)
- 50% of the 40% (800 MW)
- 70% of the 40% (1200 MW)

In total, based on the results from the cumulative assessment up to 1200 MW of installed capacity could be provided within Northern Ireland waters. This is based on 900 MW from offshore wind and 300 MW from tidal energy. Should this level of development be achieved this would mean the offshore wind and tidal energy could potentially contribute up to 70% of the overall proposed 40% renewable energy target for Northern Ireland. However, it is important to note these estimates are based on the available baseline information which is appropriate to an SEA; project-specific resource assessments, surveys and environmental impact assessment would still be required to refine these estimates.

The assessment results identify that overall achieving a 70% contribution towards the proposed 40% target for renewable energy in Northern Ireland would have a number of positive effects in terms of combating the effects of climate change. These positive effects would be recognised at both a national and global level by assisting Northern Ireland in reducing its CO_2 emissions in line with European targets and providing a platform for the growth and development of an industry that, at a wider scale, could assist in combating climate change at a global level.

However, although there may be the potential to achieve a 70% contribution, it should be noted that this is likely to be a very challenging level of development for a number of reasons:

- Tidal technologies are still relatively new and unproven in terms of their commercial viability.
- Timescales for achieving full scale commercial developments in terms of the renewable electricity targets and the implementation of the SAP by 2020 are relatively tight (10 years).
- There are still a number of uncertainties relating to the distribution, abundance and precise interaction of commercial tidal (and in some cases offshore wind) developments on coastal processes, seabirds, benthic ecology, marine mammals and reptiles, fish species and commercial fishing activities.
- Potential effects of offshore wind developments on the Giant's Causeway WHS would have to be investigated in more detail.

These challenges and uncertainties do make it difficult to be confident that offshore wind and tidal energy will deliver a 70% contribution to the proposed 40% renewable energy target for Northern Ireland within the 2020 timescales set out in the Strategic Energy Framework and the SAP. In particular the potential effects of a commercial offshore wind development in Resource Zone 1 on the Giants Causeway WHS would need to be examined in greater detail.

In conclusion, therefore, it should be noted that whilst the results from this assessment do indicate that there is potential for offshore wind and tidal developments to make a very significant contribution to the wider mix of renewable energy sources available in Northern Ireland, the precise level to which wind and tidal energy will contribute towards the proposed renewable electricity target for Northern Ireland cannot be quantified at this stage.

As onshore wind is the most readily available and currently least costly renewable technology, it is expected that, in particular within the 2020 timescales, the development of onshore wind will continue to make the greatest contribution towards the proposed 40% renewable electricity target for Northern Ireland.

13 Cumulative Effects: Other Plans and Programmes and Developments

13.1 Introduction

The following chapter looks at the potential cumulative environmental effects that could occur as a result of implementing the SAP in respect to the following:

1. Assessment of effects associated with implementation of the SAP in combination with other marine developments implemented through other marine plans and programmes. This part of the assessment will consider:
   - NI waters specific marine developments and plans and programmes e.g. UK and NI Marine Bills and requirements for Marine Spatial Planning (MSP) and the designation of Marine Protected Areas (MPAs)
   - Wider transboundary effects associated with other UK, Scottish, IOM or ROI strategies for marine development and marine renewable (offshore wind, wave and tidal for example DECC Offshore Energy Plan and The Crown Estate (TCE) Round 3 Offshore Wind and the Scottish Government Marine Renewable Strategy.

2. Assessment of effects associated with implementation of the SAP in relation to known environmental issues and problems.

13.2 Cumulative Effects Associated with Varying Levels of Development

There are wide range of plans, programmes and policies (PPP) which have an influence over, either directly or indirectly, and which could have a bearing on the proposals set out in the SAP for offshore wind and marine renewable energy development in Northern Ireland. These plans and programmes are discussed in Chapter 5: Policy Context and Appendix A.

A number of the PPPs are regulatory instruments (International, European, UK and domestic) which the Northern Ireland Assembly is statutorily obliged to implement appropriately e.g. the completion by DETI of this SEA in line with the EU SEA Directive. There are also a number of other regulatory instruments which have to be taken into account in, and may also have a direct influence over, the results of this assessment e.g. the Habitats and Birds Directives. The main environmental objectives of these regulatory instruments and how they influence the SEA and SAP is discussed in Chapter 5 and Appendix A.

In addition to the regulatory instruments there are also a number of plans and programmes that need to be taken into consideration in terms of this SEA and the developing SAP. The plans and programmes discussed below are the ones that have been identified as having a direct influence on/interaction with the SAP either through the management, use and protection of the marine environment or the future development of offshore renewable energy. These plans and programmes include:

- UK Marine and Coastal Access Act 2009 and Northern Ireland Marine Bill Proposals.
- Marine Strategy Framework Directive 2008 (2008/56/EC).
- Habitats Directive 1992 (92/43/EEC).
- Other Offshore Wind and Marine Renewable Energy Strategies:
  - Sustainable Energy Ireland (SEI) Offshore Renewable Energy Development Plan (OREDP) – draft.
  - Scottish Government Marine Energy Policy Statement 2007.
  - Department of Energy and Climate Change (DECC) Energy Plan 2009.

- The Crown Estate (TCE) Offshore Wind Licensing Rounds 1, 2 and 3 including extensions to Rounds 1 and 2.
- The Crown Estate (TCE) Licensing Round for Wave and Tidal Power (Pentland Firth 2009).
- The Crown Estate Offshore Wind Licensing Round in Scottish Waters.
- Welsh Assembly Government (WAG) Ministerial Policy Statement on Marine Energy in Wales July 2009.
- Potential offshore renewable energy developments in Isle of Man waters.

The potential interactions and associated cumulative effects between these plans are discussed below.

13.2.1 *UK Marine and Coastal Access Act 2009*

This introduces a new provision for the creation of a framework for the strategic and sustainable management of marine activities and increased protection of the marine environment. As part of the UK Marine and Coastal Access Act, Northern Ireland is required to contribute to the preparation of the UK Marine Policy Statement. As part of its devolved responsibilities DOE is also responsible for the preparation of a Northern Ireland Marine Bill which will focus specifically on the Northern Ireland territorial waters. Chapter 5 provides further detail on the UK Marine and Coastal Access Act.

13.2.2 *Northern Ireland Marine Bill*

Proposals for the Northern Ireland Marine Bill are being prepared by the DOE. It is expected that this will include provisions for marine planning and conservation. It may also include provisions for further streamlining of marine licensing. The potential interactions with this SEA and marine planning and marine conservation are discussed below.

13.2.2.1 Marine Spatial Planning

The focus of marine spatial planning is to enable a more coordinated and joined up approach to the use, management and protection of the marine environment. This will be achieved through preparation of marine spatial plans. This may include for example a national plan and a series of local plans, or one main marine plan. Marine spatial plans in Northern Ireland could include:

- Identification of key issues currently affecting the marine environment.
- A vision for the marine area covered by the plan.
- Objectives for the management and protection of the marine environment.
- Strategic priorities for growth and development of marine sectors/activities.
- Action plan for delivering strategic priorities.
- Management policies for specific sectors and activities.
- Policies for the protection of the marine environment.
- A framework for decision making in respect of development consent
- Guidance on taking nature conservation measures into account in the decision making process and the implementation of local nature conservation objectives and measures
- Identification of certain areas for development or use by certain sectors/for certain activities
- Links to the land use planning system and other plans

In terms of this SEA and the developing SAP, whilst it is necessary to take into consideration the future proposals for, and likely requirements of, the marine spatial planning process, the regulatory framework (NI Marine Bill), under which the preparation of these plans will become a statutory requirement, currently does not exist. Therefore the requirements for marine spatial planning cannot directly influence the SEA process, its findings or the content of the SAP.

However, it is likely that the findings of the SEA and the content of the SAP will have a direct influence over any future marine spatial plans that are prepared for Northern Ireland waters. In particular how the proposals for the future development of the offshore renewable energy sector can be accommodated within the current environment and how development and growth of this sector can best be managed to minimise adverse effects on other marine sectors and activities.

The SAP provides a strategy for the development of offshore renewable energy within Northern Ireland waters. Although current timescales for the implementation of the SAP (commencing 2009 to 2010) precede the adoption of a Northern Ireland Marine Bill and the subsequent preparation and adoption of statutory marine spatial plans, it is likely that, in the longer term, marine spatial planning will have an important role in the delivery of offshore renewable energy developments.

In particular, as the offshore renewable energy sector in Northern Ireland grows it is likely that there will be much greater emphasis on managing multiple commercial developments in certain locations (e.g. cumulative effects). It will therefore become increasing important to adopt a coordinated and joined up approach to the growth of this sector in a way that recognises, and minimises disruption to, other marine sectors and activities. There is therefore an opportunity for the marine spatial planning process to provide a framework for assisting with the longer term delivery of the SAP.

A number of ways in which this could be achieved include:

- Identification of local level (and wider national etc) issues affecting the commercial scale development of offshore renewable energy developments.
- Examination, at a local level, of potential solutions for resolving overlapping interests to help maximise opportunities for offshore renewable energy developments (possibility multiple) whilst minimising the potential effects on other marine sectors and activities.
- Identification, at a local level, of specific zones for the development of offshore renewable energy taking into account interactions within other marine sectors and activities.
- Set out guidance and advice for developers and decision makers on:
    - Requirements for consultation (based on local, national and European issues)
    - Compliance with environmental management and protection policies
    - Consenting framework within which individual offshore renewable energy development applications would be determined

There is also an opportunity to use the findings from the SEA to assist with the development of marine spatial plans in terms of baseline data collection. Large amounts of baseline data have been collected through the SEA process, some of which will be essential to the preparation of marine spatial plans. The SEA has also identified a number of gaps in the available data and information. It is likely that some of these gaps will need to be filled to inform to development of specific local level environmental management and protection polices and to assist the decision making process.

13.2.2.2 Marine Conservation

The main focus for marine conservation is to improve the protection of the marine environment and the integration of marine conservation and protection measures into the wider management and use of Northern Ireland waters. It is likely that this will be achieved through the designation of new protection areas and revised/increased statutory provisions for the protection of certain species and habitats and through the process of marine planning (see above).

In terms of the likely direct measures, the focus is on the increased protection of sites, species and habitats that are considered to be of national or local importance but are not subject to any statutory protection under the existing framework of nature conservation legislation. These increased protection measures are likely to include for example the designation of certain areas as Marine Conservation Zones (MCZs), which would form part of the wider network of Marine Protected Areas (MPAs) to be implemented under the OSPAR Convention 1992 by 2010.

As with marine planning, in the absence of any statutory requirements for the creation of new nature conservation legislation or the designation of MCZs, there are no formal means by which these requirements can influence the SEA. Consequently, at the time that this SEA was undertaken, there were no designated MCZs, although information on the sites that were being considered as MCZs was available. Where appropriate these candidate MCZ sites were taken into account in the assessment to minimise the risk of any potential future conflicts arising once these sites receive statutory designations. However, it should be noted that the precise boundaries of these sites was unknown and therefore they may be subject to change once this SEA is completed.

Although the current proposals for increased marine conservation under the Northern Ireland Marine Bill have limited influence over the content of this SEA, there are opportunities for this SEA to be used to assist in the future identification and designation of MCZ's and the better integration of marine conservation objectives within the marine spatial planning process. As discussed previously large amounts of baseline data were collected as part of this SEA, and although no specific surveys, monitoring work or additional research studies were undertaken, through the analysis of the available baseline data and the subsequent assessment of potential environmental effects, the SEA has been able to identify where there are data gaps and has given an indication as to the priorities for filling those gaps.

There is the potential that a number of the gaps identified may need to be filled to inform both the designation of MCZs and the preparation of marine spatial plans. Early identification of these data gaps thorough the SEA could help to assist with establishing the necessary mechanisms for acquiring any required additional data e.g. funding sources, data sharing initiatives etc. The SEA also gives a strategic view of data gaps across the whole of Northern Ireland for a range of topics. Through further review of these gaps it may be possible to identify where a number of gaps (either locations or receptor specific or both) could be filled through one specific survey or monitoring work. Further detail on possible actions to address the data and information gaps identified as part of this SEA is included in Chapter 14.

13.2.3 Marine Strategy Framework Directive (MSFD) 2008 (2008/56/EC)

As discussed in Chapter 5, Northern Ireland is obliged, under the MSFD, to 'take the necessary measures to achieve or maintain good environmental status (GES) of the marine environment by 2020 at the latest' and to adopt an ecosystem approach to the management of human activities in the marine environment. In order to meet the requirements of the MSFD, the DOE is required to prepare a strategy for the management of Northern Ireland territorial waters. This strategy includes a number of actions which must be delivered in specific timescales.

As part of this strategy there is a requirement to develop environmental targets and indicators by 2012 and to then implement a monitoring programme based on those targets and indicators by 2014. It is likely that these targets and indicators will be based upon the descriptors of Good Environmental Status (GES) that are set out in the MSFD. The results from the monitoring programme and the GES descriptors will be used to inform the preparation of a programme of measures (management actions) which needs to be developed by 2015 and implemented by 2016.

Although the timescales for these specific actions occur after the SAP has been adopted, they will be implemented within the timescales set out for the delivery of the SAP (by 2020). There is therefore potential that a number of the actions included in the strategy could have a bearing on future offshore renewable energy developments and implementation of the SAP.

In particular, based on the results of the assessment presented in Chapters 10, 11 and 12 of this report, offshore renewable energy developments (offshore wind, wave and tidal) could potentially affect a number of the GES descriptors that would be included in the monitoring programme and programme of measures. These include:

- **GES Descriptor 1: Biological diversity** – this requires the quality and occurrence of habitats and the distribution and abundance of species to be kept in line with prevailing physiographic, geographic and climate conditions. Any potential effect on biological diversity as a result of offshore energy developments e.g. habitat loss, species displacement or barriers to movement from the installation and presence of devices and commercial developments/arrays could potentially effect species distribution and abundance and would need to be taken into account in terms of the obligations of the MSFD and addressed accordingly at the project design and consent stage.
- **GES Descriptor 6: Sea-floor integrity** – this descriptor sets out requirements for the integrity of the seafloor to be maintained to a level that ensures that the structure and function of the ecosystems are safeguarded and benthic ecosystems, in particular, a not adversely affected by a loss in the integrity of the seafloor. As noted in Chapters 10, 11 and 12 there is potential that the installation of devices with piled foundations and cable laying activities could have an adverse effect of the integrity of the seafloor and substratum loss. This could potentially have an adverse effect on benthic habitats and species in the area of development. Devices with gravity bases, whilst they will potential have less of an effect on the actual integrity of the seafloor, they may also lead to the loss or disturbance of important benthic ecology and would therefore also need to be taken into consideration in terms of the Northern Ireland’s obligations under MSFD and addressed accordingly at the project design and consent stage.
- **GES Descriptor 7: Hydrographical conditions** – this descriptor requires that any permanent alterations to the hydrographical conditions do not adversely affect marine ecosystems. The results from the assessment do indicate that there is potential for wave and tidal arrays to extract energy from either the wave or tidal stream regime. This could have a direct effect on ecosystems by affecting certain benthic habitats and species that are sensitive to changes in wave or tidal regimes. There could also be indirect effects on benthic ecosystems resulting from changes in coastal process and sediment transfers. Although potential adverse effects can be avoided through site selection and modelling these effects will still need to be taken into account in the context of MSFD and addressed accordingly at the project design and consent stage.
- **GES Descriptor 8: Concentrations of contaminants** – this descriptor requires that concentrations of contaminants are at levels that do not give rise to pollution effects. The results of the assessment identify that there is potential for the installation devices with piled foundations and cable laying activities to disturb potential contaminants that are present in the area e.g. disposal areas. The release of contaminants could lead to water pollution. Although these potential effects can be avoided through careful site selection they will need to be taken into consideration in the context of MSFD and addressed accordingly at the project design and consent stage.
- **GES Descriptor 11: Introduction of energy –** this descriptor relates to the introduction of energy, including underwater noise, at levels that not adversely affect the marine environment. The assessment results have identified that there is potential for all forms of offshore renewable energy developments to introduce noise into the marine environment, either during the installation stages (e.g. pile driving) or from the operation of devices e.g. noise from the rotation of tidal turbines. There are still levels of uncertainty around the precise effects of noise from offshore renewable energy developments on the marine environment in particular the behaviour and distribution of marine mammals, seabirds and fish. There is potential that the levels of noise generated from large commercial arrays could, depending on the location of the development e.g. at the mouths of loughs or on migration/foraging routes, could cause barriers to movement. This would potentially have a negative effect on species distributions within the area. Although these potential effects can be avoided through careful site selection (avoiding migratory routes and lough mouths etc) and the implementation of appropriate mitigation e.g. avoidance of breeding seasons, they will need to be taken into consideration in the context of MSFD and addressed accordingly at the project design and consent stage.

There are other GES descriptors that could also be affected by offshore renewable energy developments e.g. GES Descriptor 2: Non-indigenous species, GES Descriptor 4: Marine food webs and GES Descriptor 9: Contaminants in fish and other seafood. Although the effects are less direct they will still need to be considered at the project design and consent stage.

13.2.4 European Habitats Directive 1992 (92/43/EEC)

Under the Habitats Directive member states are required to extend onshore and coastal Natura 2000 site designations offshore to increase protection of rare and vulnerable species (Annex I) and habitats (Annex II) and birds protected under Annex I of the European Birds Directive 1979 (79/409/EEC) within the marine environment.

The designation of these offshore marine Natura 2000 sites was ongoing at the time of this SEA. Where information was available on the sites (designated, proposed and candidate) this has been taken into account in the SEA. However, some sites where designations are ongoing may not have been included.

13.2.5 Offshore Wind and Marine Renewable Energy Strategies

The UK and the devolved administrations of Scotland and Wales, the Isle of Man (IOM) and the Republic of Ireland have prepared, or are in the process of preparing, plans/strategies for the development of offshore wind, wave and tidal power within their territorial waters (and the UK Renewable Energy Zone). In addition to this The Crown Estate has recently commenced with its third round of leasing for offshore wind and are progressing with a leasing round for wave and tidal development in the Pentland Firth on the north coast of Scotland.

The focus for all of the strategies is to take forward offshore wind, wave and tidal developments as part of delivering individual Government 2020 targets for renewable energy. Taking this into account, should the suggested levels of development presented within some of the plans be achieved this could potentially give rise to significant adverse cumulative effects. For example in terms of offshore wind alone, DECC in its recent UK Offshore Energy Plan (2009) announced plans to develop a further 25GW of offshore wind energy by 2020, this is in addition to the 8GW of offshore wind energy that has been identified as part of first and second licensing rounds.

Chapter 5 provides further detail on the key proposals presented within each of the strategies and plans discussed above.

Given that the Northern Ireland territorial waters are adjacent to Scottish territorial waters, Irish waters and the UK Renewable Energy Zone (REZ), there is potential for the implementation of the Scottish Marine Renewable Energy Strategy, the draft Offshore Renewable Energy Development Plan (OREDP) currently being prepared by Sustainable Energy Ireland (SEI), the UK Offshore Energy Plan (DECC) and the third round of offshore wind licensing (The Crown Estate) to have possible cumulative effects in respect to the Northern Ireland Strategic Action Plan (SAP).

Due to the proximity to Northern Ireland waters, there is also potential for any plans for offshore renewable energy developments proposed by the Welsh Assembly Government and proposals from the Isle of Man Government to have cumulative effects in relation to the Northern Ireland SAP.

13.2.5.1 <u>Potential Cumulative Effects from Other Plans and Programmes</u>

Based on the information presented in previous sections of this report, the following cumulative effects have been identified as having the potential to occur in relation to the implementation of the SAP and other plans and programmes relating to offshore renewable energy.

- Effects on geomorphology and sediment processes.
- Loss of large areas of benthic and intertidal habitats from occupation of large areas of the seabed with offshore wind and tidal array developments.
- Increased risk of collision from birds (offshore wind farms), marine mammals, fish and diving and pursuit seabirds (tidal devices).
- Increased disturbance and displacement of marine mammals, seabirds and fish due to high levels of marine noise generated from a number of arrays either being installed at the same time (e.g. high frequently of piling noise) or continuous installation of different arrays over

time (steady but increased noise levels) and noise from the operation of a number of separate arrays.

- Increased risk of barriers to movement as a result of increased noise and risk of collision this could cause some species to become disorientate (noise) and affect the ability of species to move between feeding ground and migrate to breeding areas.
- There is potential that increased intensity/high numbers of offshore wind farms in certain locations could have significant adverse cumulative effects on seascape.
- Increased displacement of commercial fisheries – this could lead to increased pressure on resources (fish stocks) in other areas or displacement of fishing activities into less productive or high yielding fishing grounds.
- Increased displacement of shipping – this could lead to the movement of vessels into areas where there are already high intensities of vessel movements (reducing navigational safety)
- Increased risk of collision where arrays impinge on shipping channels, particularly if these channels have moderate to high intensities of shipping movements.
- Radar interference – large numbers of offshore wind farms in adjacent areas could lead to interference with aviation and shipping radar.
- Climate – in delivering the levels of development suggested in some of the plans and programmes the UK and Ireland will be making significant progress towards achieving the 2020 targets for renewable energy. Strategically this would have significant positive effects on the environment by working towards reducing/offsetting the global and local effects of climate change.

13.2.5.2 Results from the Assessment of Cumulative Effects of Other Plans and Programmes

Table 13.1 provides a summary the potential significant adverse cumulative effects associated with other plans and programmes relating to offshore renewable energy.

Table 13.1: Assessment of Cumulative Effects of Other Plans and Programmes

Overview of main proposals within plan/strategy	Potential for significant cumulative effects in relation to the SAP	Comments
SEI Offshore Renewable Energy Development Plan (Draft 2009)		
Set out proposals for developing offshore wind, wave and tidal energy to contribute towards achieving the Republic of Ireland Government target of 40% electricity from renewable sources by 2020. Aims for up to 4,500 MW from offshore wind and 1,500 MW from wave and tidal. This draft plan is now the subject on an SEA.	**Geomorphology and sediment processes (scouring and wave energy reduction)**	The areas of potential offshore wind resource extend along the north and east coasts of NI and Republic of Ireland (either side of land borders). The potential wave resource also extends along the north coast of Ireland and NI. A number of offshore wind developments in these areas could have adverse effects on sediment processes by inducing scour around wind turbine foundations. A number of wave developments along the north coast could affect the wave regime which may have adverse effects on local hydrodynamics. Careful siting of these developments could reduce potential effects.
	Collision risk (seabirds)	A number of offshore wind developments along the north and east coast could significantly increase the risk of collision with seabirds, particularly in key feeding areas and on key migration routes.
	Barriers to movements (through increased noise and collision risk)	Noise generated by piling activities associated with a number of offshore wind developments along the north and east coast could create barriers to movement. Extensive wave developments could also restrict mammal and large fish (e.g. basking shark movements between feeding grounds).

Overview of main proposals within plan/strategy	Potential for significant cumulative effects in relation to the SAP	Comments
	Seascape **Recreation and tourism**	A number of offshore wind developments located along the north and east coast could have significant adverse effects on local seascape quality and visual amenity. This could also have an adverse effect on local recreation and tourism due to the scenic value of these areas.
	Displacement from commercial fishing grounds	A number of developments (offshore wind and wave) along the north and east coast (wind only) could lead to extensive displacement from fishing grounds and possible increased pressure on other resources (fish stocks) in the area.
DECC UK Offshore Energy Plan and The Crown Estate Offshore Wind Round 3 and Extensions to Offshore Wind Rounds 1 and 2		
Targets set out in the UK energy plan are for the development of 25GW offshore wind energy from UK waters including the REZ by 2020. The Crown Estate in its 3rd licensing round has identified a number of zones where these offshore wind developments could occur.	**Barriers to movement (noise from piling)**	The majority of zones identified as part of The Crown Estates 3rd Round are located on the east coast of England and Scotland. However, there is one zone located offshore to the north of the current Round 1 & 2 North Wales Coast and to the west of Liverpool Bay. Although this zone is separated from NI waters by the Irish Channel there is the potential that noise generated by piling activities in this zone (from Round 1, 2 extensions and Round 3 developments) and NI waters (Wind Resource Zone 2 off Kilkeel) combined could affect marine mammals and fish at sufficient distances to disorientate them or discourage them from passing along the Irish Channel. However by staging developments is it likely these effects could be avoided or would be negligible.
	Displacement of shipping movements	There is potential that development in the REZ area off the North Wales coast/Liverpool Bay area combined with extensions of the Round 1 and 2 sites in this area and development off Kilkeel (Wind Resource Zone 2) could potentially displace vessels into the North Channel (Irish Channel) where there is a very high intensity of vessel movements. This could significantly affect navigational safety within the North Channel and lead to the re-routing of vessels increasing journey times and fuel consumption. However, the main Liverpool Bay Round 3 Offshore Wind Zone and possible extensions to Round 1 and 2 areas currently sit to the east of the main North Channel shipping route. There is potential, due to its location, that developments would displace vessels entering or leaving Ports around the North West coast of England and off the North Wales coast rather than vessel travelling north south along the north channel. Development off the Kilkeel Coast may affect vessels entering or leaving Belfast and Warrenpoint and travelling east across the channel to England/Wales or north south along the north channel. There is potential that the displacement of vessels travelling to and from English/Welsh and Northern Ireland Ports this could lead to increased vessel movements in the North Channel. These potential effects would need to be taken into account in the

Overview of main proposals within plan/strategy	Potential for significant cumulative effects in relation to the SAP	Comments
		siting of developments both Round 3 offshore wind developments and any offshore wind developments of the Kilkeel Coast. Further consultation with ports authorities, DRD and the Chamber of Shipping would be required.
Scottish Marine Renewable Energy Strategy (April 2007)		
Sets out proposals for developing wave and tidal energy to contribute towards the Scottish Governments' target of 50% energy from renewable sources by 2020. At present this strategy does not identify any areas for development close to Northern Ireland waters although there has been a recent announcement of proposals to construct a tidal stream array off the coast of Islay (West Coast Scotland).	**Barriers to movement (noise from piling and increased collision risk with tidal devices)**	Although there are no specific areas or zones identified for future development there are known areas of potential tidal resource around the Rhinns of Galloway and Kintyre and there has been a recent announcement of plans to develop a tidal array off the coast of Islay. There is therefore potential that in combination with tidal developments along the east coast of NI on the other side of the North Channel, the cumulative levels of noise from the piling of tidal devices and the increased risk of collision (marine mammals and fish) could lead to disorientation and discourage movement along the channel. This could affect movement between feeding areas and to known breeding grounds. Careful phasing and siting of developments on either side of the North Channel could help to reduce potential effects.
	Displacement of shipping movements	The distance between Northern Ireland and Scotland is very short (e.g. around 23 miles in parts). The North Channel which passes between Scotland and Northern Ireland is a recognised navigation route of international importance and experience very high levels of vessel movements. There is potentially a risk that the installation of tidal arrays on either side of the North Channel (NI and Scottish Waters could have significant adverse effects on shipping and navigation by restricting shipping movements in certain locations and potentially displacing some vessels into the higher intensity shipping routes. This could potentially have a significant adverse effect on navigational safety and increased collision risk. Where possible development in this location should be restricted to areas where vessel movements are known to be low to minimise the potential for the displacement of vessels into areas where shipping movements are of a much higher density and frequency.
TCE Licensing Round for Wave and Tidal Developments in the Pentland Firth		
Licensing round for the deployment of commercial wave and tidal arrays in the Pentland Firth	**No cumulative effects identified**	The area included in the current wave and tidal licensing round in the Pentland Firth extends from Cape Wrath to Duncansby Head. Given the distances between the Pentland Firth (off the North Coast of Scotland) and Northern Ireland it is unlikely that there will be any significant cumulative effects relating to this licensing round.

<table>
<tr><th>Overview of main proposals within plan/strategy</th><th>Potential for significant cumulative effects in relation to the SAP</th><th>Comments</th></tr>
<tr><td colspan="3">TCE Scottish Offshore Wind Development Round</td></tr>
<tr><td rowspan="3">On the 16th February 2009 The Crown Estate announced awards for offshore wind farms within Scottish Territorial Waters. In total 10 sites for development have been identified, five of which are located in off the west coast of Scotland. Included within the five sites are two sites in the Solway Firth, one site off the southern end of the Rhinns of Kintyre (north coast), one off the west of Islay and one off south west tip of Tiree.</td><td>Barriers to movement (noise from piling)</td><td>There is potential that noise from pile driving activities associated with offshore wind farm developments off the west coastal of Scotland, in particular off the Rhinns of Kintyre, Islay and Tiree could, in combination with pile driving activities associated with wind farms off the north coast of NI and the installation and operation of tidal developments along the east coast of NI, create could lead to disorientation and discourage the movement of mammals and fish along the channel (barrier effects). This could affect movement between feeding areas and to known breeding grounds. Careful phasing and siting of developments on either side of the North Channel could help to reduce potential effects.</td></tr>
<tr><td>Effects on Seascape</td><td>There is potential that, due to the relatively short distance between Northern Ireland and Scotland, in particular between the north east coast and the Rhinns of Kintyre, offshore wind farms in both of these locations could have significant cumulative effects on the seascape character. In particular, further more detailed assessment would be required to determine the potential significance of any cumulative effects on the Giant's Causeway WHS located on the North Coast of Northern Ireland. The potential for significant adverse cumulative effects on seascape will also have to be assessed in detail as part of the ongoing Scottish Offshore Wind SEA. There is potential that the significance of effects could be reduced through the careful siting of the wind farms and the configuration of the developments.</td></tr>
<tr><td>Displacement of shipping movements</td><td>The distance between Northern Ireland and Scotland is very short (e.g. around 23 miles in parts). The North Channel which passes between Scotland and Northern Ireland is a recognised navigation route of international importance and experience very high levels of vessel movements. There is potential that the installation of offshore wind farms in the locations that have been awarded in Scottish waters combined with tidal array and offshore wind farm developments in Northern Ireland waters on the other side of the North Channel could have significant adverse effects on shipping and navigation by restricting shipping movements in certain locations and potentially displacing some vessels into the higher intensity shipping routes. This could potentially have a significant adverse effect on navigational safety, increased collision risk and could lead to the re-routing of vessels on to longer, less fuel efficient routes. These developments may also restrict the movement of vessels between ports and harbours (both Scottish and Northern Ireland). Where possible developments should be restricted to areas where vessel movements are known to be low to minimise the potential for the displacement of vessels.</td></tr>
</table>

Overview of main proposals within plan/strategy	Potential for significant cumulative effects in relation to the SAP	Comments
Welsh Assembly Government (WAG) Ministerial Policy Statement on Marine Energy in Wales (July 2009)		
Sets out Welsh Assembly Government plans to for developing marine renewable energy. Does not identify specific development areas. These will be identified as part of the ongoing Marine Renewable Energy Strategy Framework (MRESF)	**Barriers to movement (noise from piling)**	As with the Round 3 offshore wind developments off the North Coast of Wales there is potential that cumulatively noise generated by piling activities associated with offshore wind farm developments in Welsh Waters and NI waters (Wind Resource Zone 2 off Kilkeel) could create barriers to movement between feeding and breeding ground and on migration routes by disorientating fish and marine mammals and discouraging them from moving into and through the Irish Channel. However by staging developments is it likely these effects could be avoided or would be negligible.
	Displacement of Shipping Movements	There is potential that offshore wind farm developments in Welsh waters combined with development off Kilkeel (Wind Resource Zone 2) could potentially displace vessels into the North Channel (Irish Channel) which has a high intensity of vessel movements. This could affect navigational safety within the North Channel. However, given the distance between these two areas it is likely that additional vessels could safely be accommodated on alternative routes.
Potential offshore renewable energy developments in Isle of Man waters		
At present there are no formal plans or strategies relating to the development of offshore renewable energy in Isle of Man waters.	**Potential effects on:** ▪ **Sediment Processes and geomorphology** ▪ **Collision risk (birds)** ▪ **Barriers to movement (noise and collision risk)** ▪ **Seascape effects** ▪ **Navigational safety** ▪ **Fishing displacement**	As there is no formal plan (either adopted or in preparation) no assessment of potential cumulative effects has been undertaken, although it is likely that renewable energy developments in Isle of Man waters could have significant adverse cumulative effects on the environment (as identified).

13.2.6 *Summary of Results from Assessment of Cumulative Effects*

Although there is potential that the implementation of other plans and programmes relating to offshore wind and marine renewable energy developments could, in-combination with the SAP have potential significant adverse effects on the environment, the likelihood of these adverse effects occurring is fairly low.

The plans and programmes with the greatest potential to give rise to significant adverse effects or negative effects are:

- The SEI Offshore Renewable Energy Development Plan (Draft 2009)
- Scottish Marine Renewable Energy Strategy (April 2007)
- The Crown Estate Offshore Wind Round 3
- The Crown Estate Offshore Wind Licensing Round in Scotland
- Potential offshore renewable energy developments in the Isle of Man territorial waters

13.2.6.1 Potential Significant Adverse Effects

The results presented in Table 13.1 indicate that there is potential for offshore wind (The Crown Estate Offshore Wind Licensing Round) and marine renewable energy developments off the southwest coast of Scotland, and within the Isle of Man Territorial Waters, to have a significant adverse effect on the displacement of shipping movements and navigational safety in the North Channel, although the likelihood of this occurring is fairly low.

Whilst developments may not be sited directly within the North Channel, there is potential that developments occurring in waters adjacent to the channel, on the Northern Ireland side and the Scottish and Isle of Man sides, could reduce the overall width of the navigational channel or displace vessels that use the less intensely used peripheral routes into busier channels. This would potentially have a significant adverse effect on navigational safety, both within the North Channel and the surrounding waters.

However, at present there are no firm plans for offshore renewable energy developments to be located in Isle of Man waters. In Scotland, the current focus for marine renewable energy (wave and tidal) is in the Pentland Firth, although development elsewhere in Scotland should not be discounted for example proposals have recently been announced for the development of the Sound of Islay Tidal Energy Project by ScottishPower. There are also five potential offshore wind sites located on the west coast of Scotland, three in close proximity to the North Channel. Although these developments could potentially have significant effects on shipping movements within the North Channel, these effects could be reduced or avoided by siting developments in areas where vessel movements are low therefore reducing the potential for the displacement of vessels.

There is also potential that, in combination the Scottish Offshore Wind Licensing Round and the SAP could have significant effects on seascape, in particular in relation to developments of the southern end of the Rhinns of Kintyre and Islay and off the North Coast of Northern Ireland. Although the potential for significant effects could be reduced through careful site selection and the layout and configuration of developments, it is likely that further assessment work would be required in to assess the effects in more detail, in particular in relation to the potential effects on the Giant’s Causeway World Heritage Site. This would be the project stage and may also need to be included in the current SEA of the Scottish Offshore Wind Round.

In terms of the Northern Ireland SAP, as discussed in Chapter 12, the cumulative assessment has identified that tidal developments in Tidal Resource Zone 4 (the Copeland Islands) which is in closest proximity to, and therefore likely to have greatest effect on, the North Channel, are very limited. Similarly, while there are no plans in relation to the Isle of Man, it is likely initial developments would focus on sites that are not located within or adjacent to the North Channel.

The review of other plans and programmes has also identified that although The Crown Estate third offshore wind leasing round has identified an area off the north coast of Wales and to the west of Liverpool Bay, this area is a significant distance from the North Channel. Therefore whilst offshore wind developments in this area may affect navigation routes between Wales, England, Northern Ireland and the Republic of Ireland it is unlikely that they would affect vessel movements in the North Channel.

13.2.6.2 Potential Negative Effects

In addition to the potential significant adverse effects identified for shipping and navigation, the assessment of in-combination effects also identified a number of potential negative effects:

- Collision risk (seabirds)
- Barriers to movement
- Seascape
- Recreation and tourism
- Displacement from fishing grounds

The potential effects listed above are most likely to occur as a result of in-combination effects from developments implemented through the Republic of Ireland Offshore Renewable Energy Plan, in particular in locations where there is potential for developments to occur either side of the territorial boundaries.

Most of the potential negative effects identified relate to cumulative effects from offshore wind farm developments as there are limited areas of wave or tidal resource in transboundary locations. However, Wind Resource Zones 1 and 2 both extend towards Republic of Ireland waters where there could be potential for further offshore wind developments.

There is also a potential risk that developments off the south west coast of Scotland could have negative effects on marine mammals and fish due to noise from piling activities creating barriers to movement between Scotland and Northern Ireland. These potential effects are most likely to occur where pile driving activities are undertaken at the same time. However, it is likely that due to the distances between likely developments (Northern Ireland and Scotland) that these potential effects, at most would only be negative.

13.2.6.3 Suggested Mitigation

It is likely that the potential for any significant adverse and negative in-combination effects can be avoided or reduced through close consultation with relevant Government Departments in the UK and the Republic of Ireland to liaise closely on the development and implementation of relevant plans and programmes e.g. through the SEA process. Such co-operation is a requirement of the EIA and Habitats Directive and will also be required under MSFD and MSP.

13.3 Cumulative Effects Associated with Known Environmental Issues and Problems

This part of the assessment considers the potential effects of implementing the SAP in terms of existing environmental issues and problems. The assessment examines whether the SAP will contribute towards resolving or addressing the identified environmental issues and problems or whether it would exacerbate them. This provides a check on the overall robustness of the SAP proposals in terms of the wider marine environment of Northern Ireland and gives an indication of the overall sustainability of the proposals. It is not, however, the role of the SEA or SAP to specifically address existing environmental problems.

13.3.1 Environmental Issues and Problems

The environmental issues and problems listed below were identified from a review of existing, available desk-based information. For the purpose of this SEA, it is important to note that the main issues and problems are those that are identified as the main strategic issues. It is acknowledged that, in relation to the individual SEA topics, there are likely to be a number of specific problems and issues that are currently affecting the environment. Whist the SEA has tried to identify these issues, it is likely that some of the more localised issues/problems will only emerge from more detailed site specific studies or research undertaken by developers to inform project level Environmental Impact Assessments (EIAs) undertaken to meet specific licence/ consent applications.

13.3.2 Results of the Assessment of Environmental Issues and Problems

Table 13.2 provides a summary of the key findings of the assessment of the SAP proposals for the development of offshore wind and wave and tidal energy in terms of existing environmental issues and problems.

The assessment of the environmental problems is based on the following key:

Influence of the SAP	Key
Positive	✓
Negative	X
Not clear	?
No influence	~
Not applicable	N/A

Table 13.2: Assessment of SAP in Relation to Existing Environmental Issues or Problems

Environmental Problems				
SEA Topics /Receptor	**DETI SEA Topic**	**Issue or Problem**	**Influence of the SAP**	**Comments**
Water, Soil (Sediment)	Geology, geomorphological and sediment processes	Potential increased erosion rates due to increased intensity of storm events as a result of climate change.	✓	DETI, through its proposed target for 40% electricity to be generated from renewable energy sources by 2020 demonstrates its commitment to reducing carbon emissions from the generation of electricity from fossil fuels, one of the main causes of climate change. Given that one of the main aims of the SAP is to identify the extent to which offshore wind, wave and tidal energy can contribute towards achieving this 40% target, and therefore assist with tackling climate change, it will have positive influence on this environmental problem.
	Sediment contamination and water quality	Need to improve water quality to achieve MSFD targets for Good Environmental Status by 2020	✓	Under the MSFD there is a need to achieve good environmental status (GES) by 2020, of which water quality is a key component. The NIEA is currently responsible for managing estuarine and coastal waters under the WFD. The responsibilities for implementation of the MSFD are still to be fully defined, however all bodies with responsibilities in the marine environment will be required to comply with and further the aims of the Directive. The SAP includes actions to continue to work closely with DOE in relation to the implementation of the MSFD as DETI will need to comply with MSFD provisions as developed over the next few years.
Biodiversity, Flora and Fauna	Protected sites species and habitats (including benthic and intertidal ecology, seabirds, fish, marine mammals and marine reptiles)	Obligations to deliver a network of MPAs under European and International legislation.	~	The role of the SAP is to provide a framework for the development of offshore wind, wave and tidal energy within Northern Ireland waters. It is not the role of the SAP to identify sites, species or habitats of nature conservation importance for protection (this work is being delivered by DOE). However, the SAP does take into account the need to ensure that the deployment of offshore renewable energy developments does not have any significant adverse effects on existing **and future** sites, species or habitats of conservation importance.
		Need for increased protection of nationally important habitats and species not covered under European legislation	~	
		Obligation to protect sensitive species and habitats offshore (12-200nm) under European legislation.	~	The SAP focuses on the development of offshore renewable within the Northern Ireland territorial waters only (out to 12nm limit). It is also not the responsibility of the SAP to identify potential sites for protection. However as noted above, the SAP will need to ensure that that the deployment of offshore renewable energy developments does not have any significant adverse effects on existing **and future** sites, species or habitats of conservation importance. This includes mobile species that occur within both the 12nm limit and beyond (e.g. present between 0 and 200nm and beyond if necessary).

Environmental Problems

SEA Topics /Receptor	DETI SEA Topic	Issue or Problem	Influence of the SAP	Comments
Biodiversity, Flora and Fauna	Protected sites, species and habitats (including benthic and intertidal ecology, seabirds, fish, marine mammals and marine reptiles)	Data availability for designation of MPAs/MCZs	✓	Although it is not the roles of the SAP to identify and designate sites for protection, the SAP and this SEA has collated large amounts of baseline data on the Northern Ireland marine and coastal environment. There is an opportunity for this information to be used to help inform DOE where current data gaps existing and may also assist in the prioritisation or focusing of specific studies and surveys where additional data may help both the implementation of the SAP and the designation of MPAs/MCZs.
		Data availability relating to the distribution and abundance of habitats and species – need to expand scientific understanding of the sea.	✓	One of the key issues associated with the SEA of the SAP are data and knowledge gaps. These data and knowledge gaps relate to both the distribution and abundance of certain species and habitats within the study area (Northern Ireland waters) and the potential interactions between offshore renewable energy developments and certain species and habitats. These gaps are most notable in terms collision risk with tidal devices (for seabirds, marine mammals and fish) and noise from the operation of tidal and wave devices. As part of this SEA, possible solutions for filling data and knowledge gaps have been identified. These include a number of actions, some of which can be delivered through the SAP whereas others may have to be delivered as part of individual development applications or wider data sharing and joint working initiatives (e.g. with other UK countries). Further information on proposals to address data gaps is presented in Chapter 14.
		Data availability relating to the interactions and effects of offshore renewable energy developments on species and habitats.	✓	
		Unknown effects of climate change on species and habitat distribution and abundance	✓	There is evidence that decline in some seabird and fish populations could be linked to declines in sandeel populations which are thought to be due to change in plankton regime resulting from sea temperature rises. However it also is thought that commercial fishing activities may be a factor. Future potential impacts on species and habitats may relate to further changes in ocean chemistry, temperatures and currents. The SAP does not directly tackle the issue of protecting and conserving marine ecosystems and keystone species. However, it does have a positive influence on tackling climate change by promoting the development of offshore wind, wave and tidal and working towards achieving the Northern Ireland target of 40% renewable energy by 2020.
		Prey depletion	?	Although the SAP does not directly tackle the effect that prey depletion caused by overfishing and habitat destruction is having on marine mammals, seabirds and marine reptiles, it will aim to protect these species from other threats such as inappropriate offshore renewable energy developments.

Environmental Problems				
SEA Topics /Receptor	**DETI SEA Topic**	**Issue or Problem**	**Influence of the SAP**	**Comments**
Biodiversity, Flora and Fauna	Fish, shellfish and benthic habitats	Pressures on fish populations and benthic habitats from commercial fisheries.	✓	There is evidence that certain fishing methods e.g. dredging are having adverse effects on benthic habitats and species that these habitats support. There is also concern over the effects of fishing practices on fish populations (commercial and non commercial stocks) as a result of overfishing and high levels of by catch (discarded non commercial fish species that are caught accidentally). Whilst the SAP will not have any direct influence over fishing methods and practices there is potential that the deployment of offshore renewable energy developments could create exclusion zones within which fishing would not be permitted. These could have positive effects on both commercial fish stocks and non commercial fish populations whilst also increasing protection, and possible regeneration of, valuable benthic habitats.
Cultural Heritage including Archaeological Heritage	Marine and Coastal Archaeology and Wrecks	Unknown presence or distribution of marine archaeological features and sites.	~	It has been acknowledged in this SEA there are data gaps relating to the presence and distribution of marine (submerged) archaeological features and sites. There are a number of existing data bases which vary in accuracy, coverage and detail. There is also ongoing work to increase information along the North Coast as part of the Joint Irish Bathymetric Survey (JIBS) database. Although the SAP will not directly influence the availability of baseline relating to marine archaeology it there will be a requirement for the archaeological interest within development areas to be determined as part of the consenting of individual schemes. This may require additional survey work and data to be collected at that stage which will help contribute to increasing data and knowledge.
		No specific protection for marine assets such as submerged landscapes.	**N/A**	It is recognised that there is no specific protection for submerged landscapes. This will not be addressed by the SAP.
Population and Human Health	Commercial fisheries and aquaculture	Effect on commercial fishing on food webs (e.g. effect of depleted fish stocks on marine mammals and seabirds).	✓	As noted above there is concern over the effect of fishing practices on food webs (e.g. benthic habitats and species, seabirds, marine mammals and larger fish) as a result of reductions in populations of commercial and non commercial fish stocks due to overfishing and high levels of by-catch (discarded non commercial fish species that are caught accidentally). Whilst the SAP will not have any direct influence over fishing methods and practices there is potential that the deployment of offshore renewable energy developments could create exclusion zones within which fishing would not be permitted. These could have positive effects on both commercial fish stocks and non commercial fish populations whilst also increasing protection, and possible regeneration of, valuable benthic habitats.

Environmental Problems				
SEA Topics /Receptor	**DETI SEA Topic**	**Issue or Problem**	**Influence of the SAP**	**Comments**
Population and Human Health	Commercial fisheries and aquaculture	Increasing pressure on marine resources and space within inshore areas.	✓	A key issue in relation to offshore renewable energy is how it interacts with other marine sectors and activities, particularly in inshore waters. Taking this into account the SAP will provide a framework for enabling offshore renewable energy developments in a way that minimises effects/competition with other marine sectors and activities.
		Depleted fish stocks.	✓	One of the main threats to the commercial fishing industry is the depletion in commercial fish stocks due to overfishing. As identified above there is potential that the deployment of offshore renewable energy developments could create exclusion zones within which fishing would not be permitted. These could have positive effects on commercial fish stocks in providing protected areas for stocks to replenish.
		Modification of seabed from towing gear.	**N/A**	Although offshore wind, wave and tidal developments may lead to the creation of fisheries exclusion zones which could have a positive effect on fish stocks (commercial and non commercial), the SAP will not have any influence over the actual fishing methods that are used elsewhere in the study area (Northern Ireland waters).
		Pollution from aquaculture.	**N/A**	It is recognised that there are potential adverse environmental effects associated with aquaculture activities e.g. pollution from fish farms and risk of sea lice infections in wild fish species. However it is not the role of the SAP to implement controls over aquaculture activities.
		Effects of climate change on aquaculture due to increasing sea temperatures.	✓/?	Although the SAP does not have any direct controls/influence over aquaculture activities, by promoting the development of offshore renewable energy it is working towards tackling climate change and therefore would have a slight positive influence over reducing the effects on climate change on aquaculture.
	Shipping and navigation (including ports and harbours)	Opportunities for port and harbour expansions (e.g. Belfast Port) and associated infrastructure to support deployment of offshore renewable.	✓	The SAP identifies business and employment opportunities for Northern Ireland companies, including ports and harbours, in the development of offshore renewable.
		Increased requirement for dredging as part of day-to-day maintenance of ports and harbours and in association with future expansions required to offshore renewable energy developments.	✓/?	Where there are additional requirements for maintenance dredging, as part of any expansion of the ports, there may also be a need to identify additional harbour spoil disposal sites offshore. This would need to be looked at in more detail as part of future port and harbour expansion plans.

Environmental Problems				
SEA Topics /Receptor	**DETI SEA Topic**	**Issue or Problem**	**Influence of the SAP**	**Comments**
Material Assets	Cables and pipelines	Drive to increase telecommunications links between Europe and America could result in increased subsea cabling in Northern Ireland waters.	~	While the implementation of the SAP will have to take into account proposed future subsea cable routes to avoid potential sterilisation of important areas, it is not a direct role of the SAP to identify future subsea cable routes or actions associated with the identification of these routes.
	Mineral resource/ aggregate extraction	There is a need to take into account known areas of mineral resource (marine) potential future areas for aggregate extraction.	~	Although it is not a role of the SAP to identify areas of mineral resource and aggregate extraction, potential future sites do need to be taken into account in the identification of suitable areas for development to ensure that potential valuable areas of resource are considered in relation to future offshore renewable energy projects.
	Onshore grid and supporting infrastructure	Need to strengthen the NI grid capacity and associated onshore infrastructure to support development of offshore renewable energy.	✓	The SAP identifies the need to develop an appropriate programme of grid reinforcement works to increase the capacity of the grid network to handle additional electricity generated from offshore (and also other onshore) renewable energy projects. This programme of grid reinforcement works will be subject to a separate SEA.
	Renewable energy developments	Opportunity to streamline and improve system for licensing marine development.	✓	The SAP identifies the need to ensure that the licensing and consenting regime for offshore renewable energy projects is a clear and streamlined as possible for developers and stakeholders and identifies actions to be taken forward. The current licensing regime will be reviewed and simplified as part of the UK Marine and Coastal Access Act with possible further streamlining through the NI Marine Bill, although this is still under discussion.
Material Assets	Coastal infrastructure	Increased storm intensity and frequency as a result of climate change could potentially affect coastal infrastructure.	✓	The SEA does not directly influence the provision of coastal infrastructure in terms of coastal flood defences etc. By helping to tackle climate change through the development of offshore renewable energy the SAP will have a positive influence over the effects of climate change on coastal infrastructure. The actual siting of onshore/coastal infrastructure relating to offshore renewable will have to be agreed through close consultation with relevant land use planning authorities.
Landscape	Seascape	Need to protect important seascapes from development	✓	A strategic seascape assessment has been undertaken as part of the SEA of the SAP. The main focus for this assessment was to identify the most sensitive and important seascape areas around the Northern Ireland coast and assess the potential effects of offshore renewable energy developments (including cumulative effects) on those seascape areas. The outcomes from the seascape assessment (including cumulative assessment) will have a significant influence over the zones identified for future development as part of the SAP and any further assessments to be undertaken at the project level.

Environmental Problems				
SEA Topics /Receptor	**DETI SEA Topic**	**Issue or Problem**	**Influence of the SAP**	**Comments**
Climatic Factors	Carbon storage	Need to identify solutions for the storage of carbon	~	The SAP does not specifically focus on the identification of potential areas for the offshore storage of carbon. The site requirements for the storage of carbon are still being investigated and, at present, it appears that the most suitable sites are located in the 12nm to 200nm offshore areas rather than within specific territorial waters, although potential opportunities for gas storage in Lough Larne currently being investigated. Although no specific sites have been identified as part of this SEA, except Lough Larne which is outside the main SEA study area, there will be a need for any potential gas/carbon storage areas that are present in the resource zones to be taken into account in terms of any future offshore renewable energy projects to ensure these areas are safeguard for future development at gas or carbon storage area.

Section 4: Mitigation and Conclusions

14 Plan and Project Level Mitigation

14.1 Introduction

The results from the SEA indicate that there is potential for offshore wind and marine renewable energy developments (mainly tidal) to make a significant contribution towards achieving the proposed Northern Ireland target of providing 40% electricity from renewable energy sources by 2020 without having **significant adverse effects** on the environment. However, there are important qualifications to this general conclusion, primarily resulting from gaps in our knowledge of the marine environment and limited evidence on the effects of certain types of devices on the environment (e.g. collision risk) or differences of opinion on the acceptability of significance effects (e.g. seascape).

A fundamental element of the SEA process is mitigation and this chapter addresses the two forms of mitigation that have been identified in this SEA as being required to avoid or reduce adverse effects on the environment.

These are:

- **Plan level mitigation** –measures which have been identified through this SEA for reducing or avoiding adverse effects and which would be integrated directly into the plan - in this case the SAP – at a **strategic** level.

- **Project level mitigation** – mitigation measures which have been identified through this SEA which would be implemented through appropriate mechanisms at the specific **project** design and development stage (e.g. consenting requirements).

These two forms of mitigation and suggestions for mechanisms to aid their implementation are discussed below.

14.2 Plan Level Mitigation

In order to formulate plan level mitigation it is necessary to review the main aims and focus of the SAP and proposals for its delivery and to identify other key factors that influence could also influence the SAP from an environmental perspective.

14.2.1 Delivering the Strategic Action Plan (SAP)

The main focus of the SAP is to set out a strategic framework for optimising the development of offshore wind and marine renewable energy in Northern Ireland waters. In achieving this, the SAP sets out proposed targets for the future development of offshore wind and marine renewables and identifies a number of associated actions to be taken forward in order for those targets to be realised (Chapter 2.5 of the SAP). These include;

- <u>Regulatory and legislative work relating to the marine environment</u> through ongoing working with DOE on the policy and development within the marine environment e.g. the NI Marine Bill and the Marine Strategy Framework Directive (MSFD). Marine spatial planning is recognised as the mechanism for facilitating the sustainable management of marine activities and sectors, including offshore wind and marine renewable energy developments, and protection of the marine environment. It will therefore be necessary for DETI to continue to work closely with DOE and other members of the Marine Inter Departmental Group to ensure that the potential for offshore wind and marine renewable energy to contribute towards mitigating climate change and delivering sustainable development are fully recognised and acknowledged within the overall marine planning framework.

This will be particularly important at the current time, where in the absence of any formal Marine Bill in Northern Ireland, there is currently no statutory requirement to produce marine spatial plans within the 12 nautical mile limit. This could potentially cause uncertainty amongst stakeholders in terms of the implementation of the SAP in particular where decision makers are uncertain as to whether development should proceed in advance of, or following implementation of, a statutory MSP and it will be important to develop interim guidance and procedures to address this;

- Grid strengthening work; as part of the development of the grid proposals there may be an opportunity to examine options for coordinating onshore and offshore development activities required to support offshore wind, wave or tidal development that may occur in a similar location. This could have a number of benefits in terms of reducing the potential environmental effects associated with cabling by coordinating and focusing the provision of specific infrastructure requirements e.g. onshore connections and reducing costs and increasing confidence amongst developers; and

- The economic and business opportunities for local companies associated with the development of the offshore renewable energy sector. The growth of offshore renewables could lead to new infrastructure and supply chain opportunities not just for developments in Northern Ireland waters but for the wider national and international markets. For local manufacturing and service companies, ports and harbours, this represents a key economic development opportunity to benefit from a growing sector.

The SAP notes that post SEA, the next key stage in the development of this resource will be a competitive call from The Crown Estate for projects, scheduled for later in 2010-2011, and it is essential that the assessment, findings and potential renewable electricity targets identified in this SEA process are carried forward into this next stage to ensure the sustainable development of this resource and avoid any significant adverse impacts on the environment or other users.

14.2.2 *The Crown Estate Competitive Call*

The Crown Estate owns virtually the entire seabed out to the 12 nautical mile territorial limit and the rights to licence the generation of renewable energy on the continental shelf within the Renewable Energy Zone out to 200nm. Consequently any marine development that involves the installation of structures on the seabed, or attached to the seabed, requires a lease from The Crown Estate for the site/area where the development will be located. Therefore any developer wishing to install an offshore wind farm or tidal array within the Northern Ireland waters will firstly have to obtain a lease for their site of interest from The Crown Estate. All applications for the site leases are evaluated against predetermined criteria, relating principally to the economic business case for the use of the site/development and its clean up (decommissioning).

Therefore, in terms of taking forward the SAP, DETI is continuing to work closely with The Crown Estate to develop a ‘competitive call’ for offshore wind and marine renewable energy within Northern Ireland waters. As with Offshore Wind Rounds 1, 2 and 3, which cover all UK waters except Scotland and Northern Ireland territorial waters, individual project developers would be invited by The Crown Estate to tender for a lease for an area of the seabed within pre-defined zones of interest for offshore wind, wave and tidal development. In Northern Ireland, this is likely to reflect the resource zones identified in Chapters 8, 11 and 12 and shown in Figure 11.1, although these would have to be revised prior to a competitive call to reflect the findings from the assessment, in particular to recognise areas where there is considered to be limited or no potential for development e.g. Maiden Islands, Strangford Lough and Copeland Islands.

14.2.3 *Addressing Data Gaps and Uncertainties*

Competitive calls or leasing/licensing rounds are effective for identifying the main areas of interest for development and for stimulating interest and confidence amongst developers. They are also recognised as the main mechanism for delivering marine developments including offshore renewable energy projects. However, having a lease for a site does not guarantee that individual projects will be taken forward as developers are still required to obtain all the necessary development licences and consents for a specific project e.g.:

- Part 2 of Food and Environmental Protection Act 1985 (FEPA) Licence from the Northern Ireland Department of the Environment (DOE).
- Electricity (Northern Ireland) Order 1992 consent from DETI.

Both of the above would need to be accompanied by an EIA (Environmental Statement) and Appropriate Assessment.

As already noted within this assessment, there is still a relatively high level of uncertainty surrounding offshore renewable energy developments, in particular the potential effects that certain device types (mainly wave and tidal) have on the environment. This is mainly a result of a lack of data and knowledge on how marine renewable energy developments, in particular, interact with the environment.

In general the effects of offshore wind developments on the environment are better known and understood than wave or tidal developments. This reflects how the information, experience and knowledge gained from the onshore wind industry helped to inform and enable the deployment of a number of the initial offshore wind farms, which subsequently helped to inform further offshore wind developments and the successful growth and expansion of this industry.

In comparison, the wave and tidal industry is still at the testing and demonstration stage. As a consequence of this, and without any similar onshore or established industries from which experience and knowledge can be gained, there is still a relatively high level of uncertainty and lack of confidence with which potential effects can be identified. This has a knock on effect in terms of the consenting and licensing process as it is felt that, in a number of cases gaps in data and knowledge means that there is insufficient information and therefore evidence available for decision makers to determine whether a project would or would not have a significant adverse effect on the environment.

The consequence of this is that there is often a requirement for developers of individual projects to undertake significant amounts of survey work and monitoring to either inform consent or as a condition of consent. In an industry where financial margins are tight as scales of economies have not been reached/optimised, additional survey and monitoring work can place significant financial pressure on developers. These financial pressures can influence location decisions taken by developers, in particular areas which have been subject to additional monitoring or surveying as part of more strategic initiatives for promoting the development of offshore wind and marine renewable energy in certain locations e.g. Pentland Firth, could be considered more attractive to developers.

An objective of the SAP and the SEA is set out a strategic framework for offshore renewable energy and increase confidence amongst developers, decision makers and all stakeholders by identifying key environmental constraints or considerations that need to be taken into account in certain locations. The SEA also has an important role to play in identifying the data gaps and knowledge gaps that are likely to influence the level of potential constraint in certain locations and to identify opportunities for managing those data and knowledge gaps and associated uncertainties.

The main data and knowledge gaps that have been identified as part of this SEA, and related surveys, research or monitoring that may be required to fill those gaps are discussed in Table 14.1 below. The survey, research and monitoring requirements discussed in Table 14.1 relate to the specific data and knowledge gaps that have been identified in this SEA and which have influenced the levels of confidence of the assessment and the certainty with which significant adverse effects in certain locations have been identified. **However, it should be noted that there will still be a requirement for certain additional standard surveys and monitoring to**

be undertaken as part of specific project level mitigation. These are discussed in Section 14.4.

Table 14.1: Data and Knowledge Gaps and Proposed Survey/Research or Monitoring to Fill Gaps

SEA Topic	Data and Knowledge Gap	Possible Surveying/Research Solutions	Possible Monitoring Solutions
Water, Soil (Sediment)	Data and knowledge relating to the effect of offshore wind, wave and tidal developments on coastal processes and hydrodynamics. In particular the potential cumulative effects associated with multiple developments.	Hydrodynamic and coastal process modelling in known areas of interest e.g. resource zones and linked areas to establish current regimes.	Monitoring hydrodynamic and coastal processes to identify any changes that can be attributed to offshore renewable energy developments, in particular in areas of multiple developments.
Biodiversity, Flora and Fauna	Data relating to the distribution and abundance of seabirds, marine mammals, marine reptiles, bats and fish in Northern Ireland waters.	Surveys to confirm abundance and distribution of certain species that could be affected by offshore renewable energy developments including for example migratory and transit routes, foraging areas and loafing (seabird) areas.	
	Limited knowledge of the effects of noise and EMF from the installation and operation of devices/arrays on marine mammals, marine reptiles and fish including increased risk of barrier effects, habitat exclusion and species displacement.	Noise surveys to determine ambient noise levels in areas of interest for development e.g. resource zones. Surveys around current offshore wind farms during installation phase to establish: ▪ Noise levels generated during pile driving ▪ Effectiveness of mitigation measures to reduce noise levels ▪ Effect of noise from piling on sensitive receptors e.g. marine mammals and fish ▪ Whether noise from piling activities associated with large wind farms is creating barriers to movement of certain species (would need links to species abundance and distribution surveys) ▪ Surveys to determine effects of EMF on fish.	Monitoring to determine: ▪ Noise levels generated from operational wave and tidal devices. ▪ Effects of noise on sensitive receptors e.g. marine mammals and fish. ▪ Whether noise levels are causing barriers to movement for certain species e.g. along migratory routes and transit pathways. ▪ Whether noise from devices is leading to habitat exclusion or species displacement
	Limited knowledge on interactions between seabirds (diving), marine mammals and fish and devices e.g. tidal turbines (collision risk).	Surveys on species abundance and distribution. Surveys or research to understand the behaviour of diving seabirds e.g. dive depths, vertical diving or swimming underwater, distance from coast etc.	Monitoring seabird, marine mammal and fish responses to tidal and wave devices e.g. avoidance or collision. Monitor effectiveness of mitigation e.g. spacing of devices and visibility.
	Limited knowledge on the distribution of benthic habitats and species to determine effects of substratum loss and disturbance.	Surveys to identify presence of key benthic species and habitats in development areas (this is also usually carried out as part the design/consenting for specific projects although for smaller localised areas.	Monitoring response to certain benthic habitats and species to changes in wave or tidal regimes (to be linked to or informed by hydrodynamic studies).
	No knowledge on the presence of bats in offshore locations and the interaction with offshore wind turbine and associated effects.	See above for species abundance and distribution. Survey or obtain data collected elsewhere from current offshore wind farms to establish whether there is an interaction/effect on bats.	Monitoring effect of offshore wind farms on bats (this likely to be part of wider collaborative approach with England/Wales/Scotland to identify opportunities for sharing data and research.

SEA Topic	Data and Knowledge Gap	Possible Surveying/Research Solutions	Possible Monitoring Solutions
Cultural Heritage including Archaeological Heritage	Detailed data available off the north coast from the recent multibeam survey as part of the Joint Irish Bathymetric Survey (JIBS) database but this is still raw data and needs interpreting. Further data will be collected off the east coast over next few years and submerged landscapes are to be mapped over next 5 years.	No specific survey requirements identified as there are already ongoing studies being carried out as part of the development of the JIBS database. Possible need to examine availability of, or access to, JIBS data to developers.	No specific monitoring solutions identified at this stage.
Population and Human Health	Gaps in the location of specific fishing ground within Northern Ireland waters and type of grounds e.g. annual, seasonal, and spawning and nursery grounds.	Further consultation with fishermen will be required to identify more accurate locations of key fishing grounds and whether those grounds are used all year or are seasonal grounds. There will also be a need to identify location of spawning and nursery grounds.	Recommended ongoing consultation with fishermen to examine solutions for co-existence of commercial fishing activities and offshore renewable energy developments and/or criteria to assist with the management of offshore renewable energy developments in areas used for fishing.
	Limited knowledge on the movement (navigation routes) of vessels that are less than 15m in length.	Survey to identify the location and navigation routes used by vessels less than 15m length. Consultation will be required to identify what these surveys would involve/require.	No specific monitoring solutions identified at this stage.
	Further understanding is required in terms key navigation routes and clearance distances/depths for vessels and offshore renewable energy developments e.g. tidal.	Consultation with navigation authorities, MCA and ports and harbours to understand more accurate location of key navigation routes and examine options for how certain devices (e.g. submerged tidal devices) could co-exist e.g. establish optimal clearance depths.	Monitoring interactions between offshore renewable energy developments and navigation activities.
	No specific data gaps identified for military areas, disposal areas or radar interference.	Site specific surveys will be required at the project design/consent stage.	No specific monitoring solutions identified at this stage.
Material Assets	No specific data and knowledge gaps identified although there are likely to be specific surveys required at the project design/consent stage to confirm potential effects on cables and pipelines.	Site specific surveys will be required at the project design/consent stage.	No specific monitoring solutions identified at this stage.
Seascape	More detailed assessments will be required at the project design/consent stage to determine effects on seascape and visual amenity.	Site specific assessments will be required at the project design/consent stage.	Suggested monitoring of offshore renewable energy developments to confirm appropriateness of assessment criteria and mitigation e.g. spacing and configurations of farms/arrays in particular with regard to cumulative effects.
Climatic Factors	No specific data gap identified as part of the SEA.	No specific survey requirements	No specific monitoring solutions identified at this stage.

14.2.4 *Opportunities for Filling Data and Knowledge Gaps*

Most of these data and knowledge gaps listed above directly relate to subjects where potential significant adverse effects have been identified. It is therefore likely that additional survey work and monitoring will be required to help fill these data and knowledge gaps and provide greater resolution on the likely effect that would occur in a particular location.

The type and level of surveying or monitoring required will be dependent on the nature of the data and knowledge gaps that have been identified. Taking this into account there are three possible options to be considered in terms of identifying the most effective and appropriate solution for filling these data and knowledge gaps. These options include:

- Filling certain data and knowledge gaps at a strategic level e.g. Northern Ireland Government Departments/ Agencies would identify options for carrying out certain surveys or monitoring or identifying options for data sharing and collaborative working with other UK and ROI Governments. These would be dependent on a number of factors including appropriate funding mechanisms and opportunities for collaborative working (See Action 2 below).
- Filling data and knowledge gaps at an individual project level e.g. to inform the project consenting and associated assessments e.g. EIAs. The nature and types of surveys and monitoring required would depend upon the potential site specific constraints identified through consultation and as part of EIA screening and scoping (See Section 14.4).
- Filling data gaps through the 'deploy and monitor' process. This approach may be required where knowledge gaps require the deployment of devices to enable their interaction and any associated effects on the marine environment and key receptors to be identified through monitoring. This approach may involve Government Departments, regulatory bodies, individual developers or combinations of these organisations and is discussed under Action 4 below.

The options for filling data and knowledge gaps listed above are considered in terms of both the plan level and project level mitigation measures discussed below. It is important to note that at this stage the focus is on identifying the data and knowledge gaps that exist and identifying solutions for filling those gaps. Further work will be required to determine what the priorities are for filling data and knowledge gaps, how they should/could be filled and who will be responsible for filling those gaps. This will be one of the potential and early roles of the proposed Offshore Renewable Energy Forum to be established as part of the plan level mitigation (Action 1 below).

14.3 Suggested Strategic Plan Level Mitigation Measures

It is suggested that the following measures or actions are integrated into the plan (SAP) to minimise or reduce the potential for significant adverse effects to occur from offshore wind and marine renewable energy developments in Northern Ireland waters. These measures/actions include:

- Establishment of an Offshore Renewable Energy Forum
- Addressing data and knowledge gaps at a strategic level
- Application of the 'deploy and monitor' approach to the management of development
- Preparation of locational guidance
- Development of a project level mitigation strategy

These actions are discussed in further detail below.

14.3.1 Action 1: Establishment of an Offshore Renewable Energy Forum

The DETI led Project Steering Group established to oversee the SEA work to date has operated well and enabled an important co-ordinated approach to the development of offshore renewable resources. There is considerable merit in retaining this Group and extending its membership to include key external stakeholders to ensure an extended bank of knowledge and expertise as the work develops. The establishment of such a Forum to advise DETI on the ongoing development and implementation of the SAP and the actions identified in the ER would raise the profile of the sector, increase confidence amongst stakeholders and potential developers and support the sustainable development of offshore renewable energy to optimise its economic, social and environmental benefits for Northern Ireland.

14.3.2 Action 2: Address Data and Knowledge Gaps at a Strategic Level

14.3.2.1 Aim

Examine options for developing a cross departmental approach to identifying and examining opportunities for filling strategic data and knowledge gaps and increasing the collation and availability/accessibility of current data sets/information e.g. COWRIE Work and current studies and surveys being carried out in Wales and Scotland.

14.3.2.2 Purpose

To help increase developer confidence and encourage investment in Northern Ireland waters by reducing the financial constraints placed on individual developers as a result of data collection, surveying and monitoring requirements and increasing overall knowledge to support the development of emerging marine environment policy and legislation.

14.3.2.3 Objectives

The main objectives for this work would be to:

- Ensure a collaborative approach to the identification and prioritisation of data and knowledge gaps that need to be filled to enable the industry to move forward and development to occur.
- Agree approaches and Terms of References for necessary surveys/research studies or monitoring programmes (strategic and project level).
- Establish a cross departmental approach to identifying revenues for providing financial support for undertaking specific strategic level studies that are identified by the Forum as being essential for moving the industry forward.
- Identify opportunities for undertaking studies/monitoring that would have cross departmental benefits e.g. marine mammal and seabird abundance and distribution studies.
- Develop and continue promoting partnerships with other marine fora (e.g. across the UK and ROI and elsewhere) to increase access to data and knowledge and ability to promote collaborative approach to data collection and sharing.

14.3.3 Action 3: Application of the Deploy and Monitor Approach to the Management of Development

14.3.3.1 Aim

Promote proposals for the deploy and monitoring approach to commercial scale developments to increase knowledge of possible impacts at project level and build on information from other developments such as those to be deployed in the Pentland Firth.

14.3.3.2 Purpose

To acquire necessary information on how marine renewable energy developments interact with the marine environment, in particular how interactions, and associated potential effects change as developments are scaled up from demonstration projects through to a full scale commercial developments. This information is essential for helping to increase confidence and certainty amongst regulatory authorities on the potential effects of commercial scale marine renewable energy developments and associated potential cumulative effects.

This approach would also help to reduce the potential barriers to development associated with knowledge and data gaps and the subsequent requirement to adopt a precautionary approach to development. It will also demonstrate support to the industry and encourage investment by enabling commercial tidal and wave energy developments to be deployed on a stage by stage basis within an agreed framework of monitoring and research.

14.3.3.3 Objectives

The main objectives of the deploy and monitor approach to development would be to:

- Adopt a stage by stage approach to the deployment of commercial scale developments by attaching conditions to site leases that specify that developments of a certain size or scale will only be permitted within the first few years of the lease award.
- Only permit consents for larger scale commercial developments where there is evidence (from surveying and monitoring) that the current development is not having an adverse effect on the environment and that there is sufficient evidence to support conclusions that a large scale development would also not have adverse effects on the environment. This may require the inclusion of more than one deploy and monitor stage within a lease agreement.

14.3.4 Action 4: Preparation of Locational Guidance

14.3.4.1 Aim

Examine opportunities for preparing locational guidance to assist developers, stakeholders and decision makers in the selection of specific sites for development.

14.3.4.2 Purpose

One of the main outputs from the SEA has been to identify the key environmental constraints and issues that would need to be considered or addressed as part of any future offshore wind or marine renewable energy developments within Northern Ireland waters. This information will be used by DETI and The Crown Estate to assist with preparation for a competitive call for offshore wind and marine renewable energy.

The competitive call will be for the lease of specific development sites within Northern Ireland waters. Given that the SEA is a strategic level study, covering all Northern Ireland waters, there may be a requirement for, and likely to be a number of potential benefits to, providing additional guidance and advice for specific areas or locations where future development is most likely to be focused (e.g. within the Resource Zones).

This guidance and advice could be presented in the form of Locational Guidance. This would be a non statutory document that would:

- Identify areas of opportunity for offshore wind, wave and tidal development within the identified Resource Zones.

- Identify competing interests (e.g. between developers and other marine sectors) that could affect development within certain locations and recommendations for resolving competing interests including requirements for additional studies and surveys etc.
- Identify ways of managing overlapping interests in a way that can be agreed by all stakeholders.
- Provide criteria that developers would need to meet in order to demonstrate the acceptability of their proposals.
- Provide locational guidance for multiple developments in certain locations.

14.3.4.3 Objectives

The main objectives for production of locational guidance would be to:

- Act as a bridging document or stepping stone between the SEA and the implementation of individual developments as part of The Crown Estate leasing round.
- Provide greater clarity and certainty on opportunities and requirements (including guidance and thresholds) for offshore renewable energy developments in certain locations.
- Increase confidence amongst developers and stakeholders.
- Encourage early stakeholder consultation in planning for offshore renewable energy developments.

14.3.5 Action 5: Development of a Project Level Mitigation Strategy

14.3.5.1 Aim

1. Develop a policy statement or series of policy statements for inclusion in the SAP that state the mechanisms by which project level mitigation measures will be adopted e.g. that certain surveys/monitoring etc would be a requirement of a development consent.
2. Prepare a mitigation framework document which supports the policy statements included in the SAP.

14.3.5.2 Purpose

Project specific mitigation measures have been identified throughout this SEA Environmental Report. As currently written, they represent the types of mitigation that could be implemented at the project level. However, unless there is a commitment made within the SAP to implement them, as appropriate, through the consents process, they do not satisfy the requirements of the SEA Regulations. Therefore there is a need to determine whether the project level measures identified in this report can actually be delivered and if so how their delivery would be best achieved.

In order for this to be addressed, it is suggested that the proposed Forum could review the project specific mitigation measures presented in this report and which are set out in further detail in Section 14.4 below and prepare a single framework document which clearly sets out:

- The recommended measures – these should be practical and suitable for adoption by developers.
- Whether they are legal requirements or standard ‘good practice’.
- Whether there are any specific guidelines available.
- When they would be required.
- Who would be required to implement them

14.3.5.3 Objectives

The main objective of including specific policies on the implementation of project level mitigation measures in the SAP and the development of a mitigation framework document would be to:

- Provide reliable assurance to regulatory authorities that the mitigation measures identified within this SEA will be capable of delivery and will be adopted by developers, where appropriate, to avoid and reduce potential adverse effects on the environment and other sea users.

14.4 Suggested Project Level Mitigation Measures

Project level mitigation measures are specific measures that would be implemented at the project design/development stage to reduce or avoid the risk of any significant adverse effects from occurring.

At this strategic level assessment, a number of project level mitigation measures have been integrated into both the resource zone assessment (Chapter 11) and the assessment of cumulative effects (Chapters 12 and 13) to enable residual effects to be identified i.e. effects that are likely to occur on the basis that mitigation measures are implemented appropriately. The mitigation measures included within Chapters 11, 12 and 13 reflect recognised good practice and standard requirements of the offshore renewable energy project consenting process.

Table 14.2 provides a summary of the key mitigation measures that may be appropriate for specific project developments and were considered as part of the assessment of potential effects in Chapters 11, 12 and 13. However, it should be noted that possible additional mitigation measures will also need to be assessed on a project specific basis, and developers will be obliged to apply specific mitigation as part of the individual project consenting process. Required mitigation will be set out in the conditions of the consent issued to the project developer.

Table 14.2: Suggested Project Level Mitigation Measures

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Geology, geomorphology and hydrography			
Increase in suspended sediment	CD CC	▪ Suspended sediment dispersion modelling at the project stage	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Change in seabed morphology	CD CC	▪ Avoidance of installation of devices / cables in coastal GCR and SSSI sites.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Change in sediment processes	OD	▪ Avoidance of placement of devices in areas where sediment transport pathways are modelled as highly sensitive to change.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Change in coastal processes	OD	▪ Modelling the effects on coastal processes should form part of pre-project activities to optimise location. ▪ Avoidance of placement of devices within zones where coastal processes are modelled as highly sensitive to change	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Seabed contamination and water quality			
Disturbance of natural sediments	CD CC	▪ Minimise dredging ▪ Use cable and device installation methods that minimise sediment re-suspension ▪ Carry out work in appropriate tidal conditions to minimise effect	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Release of additional sediment during construction	CD	▪ Use cable and device installation methods that minimise sediment re-suspension ▪ Release sediment in appropriate tidal conditions to minimise effect	▪ Project design stage ▪ EIA stage ▪ Project installation
Release of contaminants during construction	CD	▪ Use low toxicity materials ▪ Minimise contact of materials with water ▪ Minimise quantity of materials used	▪ Project design stage ▪ EIA stage
Disturbance of contaminated sediments	CD CC	▪ Avoid device/infrastructure placement within 500m of areas of known sediment contamination ▪ Carry out pre-installation bottom surveys ▪ Use installation methods that minimise disturbance of sediments ▪ Carry out work in appropriate tidal conditions to minimise effect ▪ Avoid sensitive time periods for local receptors ▪ Risk assessment and contingency planning ▪ If munitions are encountered Crown Estates 2006 (Dealing with munitions in marine aggregates) should be followed.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Accidental release of contaminants (hydraulic fluids / vessel fuel)	CD CC OD	▪ Carry out potentially hazardous operations under appropriate weather/tide conditions ▪ Use low toxicity and biodegradable materials ▪ Use minimum quantities ▪ Design for minimum maintenance ▪ Risk assessment and contingency planning ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Contamination – erosion of sacrificial anodes	OD	▪ Minimise use of sacrificial anodes	▪ Project design stage ▪ EIA stage ▪ Project operation
Contamination – anti-fouling compounds	OD	▪ Use non-biocidal antifoulants ▪ Minimise use of antifoulants	▪ Project design stage ▪ EIA stage ▪ Project operation
Protected sites and species			
Impacts on protected sites	CC CD	▪ Careful site selection avoiding sensitive sites for devices and export cables (i.e. existing and proposed protected sites). ▪ Possible mitigation measures relevant to the specific interest features of the sites and their seasonal and other sensitivities are described elsewhere in this table for the relevant topic areas.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Impacts on protected species	CC CD	▪ See sections below on benthic ecology, fish and shellfish, seabirds and marine mammals.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Benthic Ecology			
Smothering	CC CD	▪ Benthic survey to characterise seabed and identify sensitive sites and species. ▪ Avoid habitats/species sensitive to smothering ▪ Avoid installation during sensitive seasons	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Increase in suspended sediment and turbidity during construction	CC CD	▪ Use cable and device installation methods that minimise sediment re-suspension ▪ Carry out work in appropriate tidal conditions to minimise effect	▪ Project design stage ▪ EIA stage ▪ Project installation
Decrease in wave exposure Decrease in water flow	OD	▪ Careful site selection and assessment of effects	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Substratum loss	OD	▪ Avoid device placement in sensitive areas / features	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Disturbance of contaminated sediments	CC CD	▪ Avoid device placement in areas of known sediment contamination ▪ Use installation methods that minimise disturbance of sediments ▪ Carry out work in appropriate tidal conditions to minimise effect	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Contamination from anti-fouling paints and sacrificial anodes	OD	▪ Design devices to minimise leakage of pollutants ▪ Use of non toxic anti-foulants ▪ Minimise use of anti-foulants ▪ Minimise use of sacrificial anodes ▪ Use low toxicity grout ▪ Minimise contact of grout with water ▪ Minimise quantity of grout used	▪ Project design stage ▪ EIA stage ▪ Project operation
Accidental contamination (hydraulic fluids or vessel cargo/fuel)	OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan)	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Fish and Shellfish			
Disturbance	CC CD	▪ Avoid sensitive sites/species ▪ Avoid installation during sensitive seasons	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Smothering	CC CD	▪ Avoid sensitive sites/species/periods	▪ Project design stage ▪ EIA stage ▪ Project installation
Increased suspended sediment and turbidity	CC CD OD	▪ Use cable and device installation methods that minimise sediment re-suspension ▪ Release sediment in appropriate tidal conditions to minimise effect ▪ Carry out work in appropriate tidal conditions to minimise effect ▪ Avoid installation during sensitive seasons such as during key spawning seasons ▪	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Collision risk	OD	▪ Design device for minimal impact ▪ Do not site devices in particularly sensitive areas – e.g. migration routes, feeding, breeding areas ▪ Maximise device visibility ▪ Use of Acoustic Deterrent Devices (there is concern regarding the benefit of using these devices) ▪ Use of protective netting or grids	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project operation

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Substratum loss	CD CC OD	▪ Avoid sensitive sites/species	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Decrease in water flow	OD	▪ Avoid sensitive sites/species/periods	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Decrease in wave exposure	OD	▪ Avoid sensitive sites/species/periods	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Disturbance of contaminated sediments	CC CD OD	▪ Avoid device placement in areas of known sediment contamination ▪ Use installation methods that minimise disturbance of sediments ▪ Carry out work in appropriate tidal conditions to minimise effect	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Contamination from antifouling paints and sacrificial anodes and grout	OD	▪ Design devices to minimise leakage of pollutants ▪ Use of non toxic antifoulants ▪ Minimise use of antifoulants ▪ Minimise use of sacrificial anodes ▪ Use low toxicity grout ▪ Minimise contact of grout with water ▪ Minimise quantity of grout used	▪ Project design stage ▪ EIA stage
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Design to reduce risk ▪ Avoid shipping routes where collision risk is high	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
EMF	OC	▪ Cable export design to minimise EMF fields ▪ Cable burial to minimise the field strength at the seabed.	▪ Project design stage ▪ EIA stage
Marine Noise	OD CD CC	▪ Minimise use of high noise emission activities such as impact piling ▪ Avoid installation during sensitive periods ▪ Underwater noise during operation may be beneficial in alerting species to the presence of the device, reducing the risk of collisions. This requires further research.	▪ Project design stage ▪ EIA stage ▪ Project installation
Barrier to movement	OD	▪ Avoid constrained waterways ▪ Avoid sensitive areas	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Marine Birds			

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Physical disturbance	CC CD	▪ Avoid sensitive sites/species ▪ Avoid installation during sensitive seasons	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Increased turbidity (reduced visibility)	CC CD OD	▪ Use cable and device installation methods that minimise sediment re-suspension ▪ Release sediment in appropriate tidal conditions to minimise effect ▪ Carry out work in appropriate tidal conditions to minimise effect	▪ Project design stage ▪ EIA stage ▪ Project installation
Collision risk	CD OD	▪ Design device for minimal impact ▪ Avoid siting devices in particularly sensitive areas – e.g. migration routes, feeding, breeding areas ▪ Do not undertake installation activities at night when birds are more vulnerable to collisions. ▪ Increase device visibility, or use of acoustic warning devices. ▪ Tidal turbine blades should not be shiny, as diving birds may mistake them for fish. ▪ Use of protective netting or grids ▪ Consider siting wind turbines close together to minimise the area accommodated by a wind farm; grouping turbines to avoid alignment perpendicular to main flight paths; providing corridors (up to a few kilometres wide) between groups of turbines to allow passage by birds.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Disturbance of contaminated sediments	CC CD OD	▪ Avoid device placement in areas of known sediment contamination ▪ Use installation methods that minimise disturbance of sediments ▪ Carry out work in appropriate tidal conditions to minimise effect	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Contamination from anti-fouling paints, sacrificial anodes and grout	OD	▪ Design devices to minimise leakage of pollutants ▪ Use of non toxic anti-foulants ▪ Minimise use of anti-foulants ▪ Minimise use of sacrificial anodes ▪ Use low toxicity grout ▪ Minimise contact of grout with water ▪ Minimise quantity of grout used	▪ Project design stage ▪ EIA stage ▪ Project operation
Accidental contamination (hydraulic fluids or vessel fuel/cargo)	OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Design to reduce risk ▪ Avoid shipping routes and other areas of potential high collision risk	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Marine Noise	OD CD CC	▪ Minimise use of high noise emission activities such as impact piling ▪ Avoid installation during sensitive periods ▪ Use full sound insulation on plant equipment device design. ▪ Underwater noise during operation may be beneficial in alerting species to the presence of the device, reducing the risk of collisions. This requires further research.	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Marine Mammals and Reptiles and Bats			
Physical Disturbance	CC CD	▪ Detailed study would be required to examine marine mammal and reptile distribution around the coast in order to fully understand and mitigate for this risk. ▪ Avoid sensitive sites/species ▪ Avoid installation during sensitive seasons	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Increased Turbidity (reduced visibility)	CC CD OD	▪ ▪ Use cable and device installation methods that minimise sediment re-suspension ▪ Release sediment in appropriate tidal conditions to minimise effect ▪ Carry out work in appropriate tidal conditions to minimise effect	▪ Project design stage ▪ EIA stage ▪ Project installation
Collision risk	CD CC OD	▪ Design device for minimal impact ▪ Do not site devices in particularly sensitive areas – e.g. migration routes, feeding, breeding areas ▪ Increase device visibility, or use of acoustic deterrent devices ▪ Enforce speed limits for vessels used in construction and establish a code of conduct to avoid disturbance to marine mammals both during construction activities and in transit to the construction area if entering areas of high animal abundance. ▪ Use of protective netting or grids ▪ Seasonal restrictions could be placed on operation to avoid impacting on marine mammals at vulnerable times such as breeding season. ▪ The use of acoustic deterrents such as pingers or acoustic harassment devices. ▪ Soften collision by adding smooth edges or padding. ▪ Protect against entrapment by incorporating escape hatches into device design.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Barrier to movement	OD	▪ Avoid sensitive areas ▪ Avoid placement of devices within constrained areas where array could completely block or cause a significant perceptual barrier to marine mammals	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Habitat Exclusion	OD	▪ Avoid sensitive sites/species	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Disturbance of contaminated sediments	CC CD OD	▪ Avoid device placement in areas of known sediment contamination ▪ Use installation methods that minimise disturbance of sediments ▪ Carry out work in appropriate tidal conditions to minimise effect	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Contamination from anti-fouling paints and sacrificial anodes and grout	OD	▪ Design devices to minimise leakage of pollutants ▪ Use of non toxic anti-foulants ▪ Minimise use of anti-foulants ▪ Minimise use of sacrificial anodes ▪ Use low toxicity grout ▪ Minimise contact of grout with water ▪ Minimise quantity of grout used	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Accidental contamination (hydraulic fluids or vessel cargo/ fuel)	OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Design to reduce risk ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan)	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
EMF	OC	▪ Cable export design to minimise EMF fields	▪ Project design stage ▪ EIA stage
Marine Noise	OD CD CC	▪ Minimise use of high noise emission activities such as impact piling ▪ Avoid installation during sensitive periods ▪ "soft starting" piling activities / passive acoustic deterrents – gradually increasing noise produced to allow mammals to move away from activities ▪ Underwater noise during operation may be beneficial in alerting species to the presence of the device, reducing the risk of collisions. This requires further research. ▪ Noise from operating turbines can be reduced by using isolators. However this has not been tested over long term and to account for cumulative effects ▪ Use sound insulation on equipment. ▪ Use of bubble curtains (this is expensive and may only be effective in shallow water). ▪ Use acoustic deterrent or disturbance devices to scare sensitive species away ▪ Use of mammal observers and passive acoustic monitoring to facilitate implementation of exclusion zone during noisy activities (500 m zone is recommended by JNCC)	▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance
Hauling-out	OC	▪ Consideration should be given to whether any surface platforms have moving parts that could cause injury.	▪ Project design stage ▪ EIA stage
Effects of offshore wind turbines on bats (collision risk and barotraumas)	OD	▪ Surveys to determine presence of bats in offshore wind locations ▪ Monitoring to determine effects of offshore wind on bats	▪ Project design stage ▪ EIA stage ▪ Project operation

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Marine and Coastal Historic Environment			
Effects on submarine historic environment	CC CD	▪ Follow NIEA and Crown Estates 2007 JNAPC code of conduct and guidance note for the offshore renewable energy sector. ▪ Carry out seabed investigations in preferred site locations prior to device installation. Avoid sites of interest and exclusion zones for protected sites.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Effects on coastal and terrestrial historic environment	CC CD	▪ Carry out desk based studies and field walkovers in preferred site locations to determine need for site investigations (geophysical surveys/trial trenching) in consultation with NIEA, Local Authorities and the Department of the Environment, Heritage and Local Government of the Republic of Ireland. ▪ With respect to cabling there is considerable opportunity to avoid effects through avoidance of protected archaeological sites.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Commercial Fisheries			
Direct disturbance of fishing grounds	CC CD	▪ Avoid device placement in sensitive areas ▪ Avoid key seasons such as the period of mussel seed settlement (Feb-Apr; Sept) and the main period of salmon migration (May-Jul). ▪ Clear area of debris post installation	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Temporary displacement from traditional fishing grounds	CC CD	▪ Avoid device placement in sensitive areas ▪ Avoid key fishing seasons ▪ Liaison with the fishing community to keep them informed of installation operations is also key to managing the level of this impact.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Long term displacement from traditional fishing grounds	OC OD	▪ Avoid device placement in sensitive areas ▪ Consider spacing of turbines at wide enough intervals to permit use of mobile fishing gear.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project operation and maintenance
Mariculture			
Smothering	CC CD	▪ Avoid sensitive sites/species/periods ▪ Consider cable installation methods that minimise suspended sediment (e.g. plough installation)	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Substratum loss	CC CD	▪ Avoid device placement in existing fish farms	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Marine noise (construction)	CC CD	▪ Minimise use of high noise emission activities such as impact piling ▪ Avoid installation during sensitive periods	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Marine noise (operation)	CC CD	▪ Device design. Underwater noise during operation may be useful in alerting species to the presence of the device, reducing the risk of collisions. This requires further research.	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project operation and maintenance
Increased suspended sediment and turbidity	CC CD OD	▪ ▪ Use cable and device installation methods that minimise sediment re-suspension ▪ Release sediments in appropriate tidal conditions to minimise effect	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Decrease in water flow	OD	▪ Avoid sensitive site/species/periods	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Decrease in wave exposure	OD	▪ Avoid sensitive site/species/periods	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage
Disturbance of contaminated sediments	CC CD OD	▪ Avoid placement in area of known sediment contamination ▪ Use installation methods that minimise the disturbance of sediments ▪ Carry out work in appropriate tidal conditions to minimise effect	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation
Contamination from anti-fouling paints, sacrificial anodes and grout	OD	▪ Design devices to minimise leakage of pollutants ▪ Use of non toxic anti-foulants ▪ Minimise use of anti-foulants ▪ Use low toxicity grout ▪ Minimise contact of grout with water ▪ Minimise quantity of grout used	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project operation and maintenance
Accidental contamination (hydraulic fluids or vessel fuel / cargo)	CC CD OD	▪ Design devices to minimise risk of leakage of pollutants ▪ Risk assessment and contingency planning ▪ Design to reduce risk ▪ Avoid shipping routes ▪ Implementation of SOPEP (Shipboard Oil Pollution Emergency Plan).	▪ Site / cable route selection stage ▪ Project design stage ▪ EIA stage ▪ Project installation ▪ Project operation and maintenance

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Shipping and Navigation (including ports and harbours)			
Displacement of shipping movement	CD CC OD	▪ Undertake a navigation risk assessment (NRA) which should include: ▪ A survey of vessels in the vicinity of the proposed development ▪ Full NRA of the likely impact of the development on navigation, taking into consideration MGN 371 (MCA 2008), MGN 372 (MCA 2008b) and the DTI Guidance Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (DTI 2005) ▪ Avoid busy shipping areas	▪ Site / cable route selection stage ▪ Project design stage ▪ Project installation stage ▪ Project operation and maintenance
Decreased trade / supply	CD CC OD	▪ Maintain good communications with the relevant ports ▪ Issue the appropriate notifications during installation and maintenance.	▪ Site / cable route selection stage ▪ Project design stage ▪ Project installation stage ▪ Project operation and maintenance
Reduced visibility	CD CC OD	▪ Avoid areas of high vessel densities and areas constrained by land e.g. adjacent to the mouth of Loughs. ▪ Minimise the period of installation, the number of vessels required and the area occupied during installation. ▪ Any vessels and devices should be lit and marked in accordance with regulations and MCA and Trinity House guidance	▪ Site / cable route selection stage ▪ Project design stage ▪ Project installation stage ▪ Project operation and maintenance
Collision risk	CD CC OD	▪ Avoid constrained areas or areas of high shipping densities and regularly used shipping routes. ▪ In busy shipping areas, potential effects may be reduced by minimising the period of installation, the number of vessels required and the area occupied during installation. ▪ Maintain good communications with the relevant ports, and issue the appropriate notifications during installation, maintenance, and decommissioning. ▪ The scale of potential effect on navigation should be assessed as part of the EIA and NRA as outlined above.	▪ Site / cable route selection stage ▪ Project design stage ▪ Project installation stage ▪ Project operation and maintenance
Recreation and Tourism			
Disturbance to Wildlife	CD OD	▪ Avoid areas that are popular with tourists and wildlife tour operators. ▪ Other mitigation measures aimed at reducing or avoiding disturbance to wildlife including sea mammals and birds is set out in the relevant parts of this table.	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Safety and Collision Risk	OD CD	▪ Avoid popular cruising routes, diving areas and key water sport locations ▪ Incorporate suitable safety features such as lighting, netting and buoys into the device design. Incorporate the RYA's recommendations within respect to safety as set out in the RYA's Position Statement on Offshore Energy Developments. ▪ Provide suitable information for the public regarding safety ▪ Restrict access to construction sites ▪ Observe good practice during construction, removal and maintenance	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage ▪ Project installation stage ▪ Project operation
Access Restrictions	OD CD	▪ Undertake construction, where possible, outside of peak tourist seasons (June to September) to minimise disruption to visitors and local people. ▪ Identify and avoid popular routes for sailing or other water sports such as kayaking. ▪ Where possible, facilitate safe access through arrays for sailing or other water sports.	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage
Transportation	OD CD	▪ Undertake a Transport Impact Assessment (TIA) at the project specific stage to minimise impacts of device transportation on local road networks ▪ Avoid popular cruising routes or areas used for water sports and diving ▪ Minimise congestion by transporting materials to and from deployment/landing sites during peak times for traffic to tourist areas e.g. Bank Holidays, Half-Term Holidays	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage
Aviation Radar			
Radar interference	OD	▪ Consultation with the CAA and NATS may be required to confirm whether wind turbines in the area will have a detrimental effect on radar.	▪ Site / cable route selection stage ▪ Project design stage ▪ Project EIA stage
Military Exercise Areas			
Disruption to activities during installation	CC CD	▪ Avoidance of byelawed and danger sites ▪ Carry out site selection studies in conjunction with liaison with MOD	▪ Site / cable route selection stage ▪ Project design stage ▪ Project installation
Disruption to activities during operation	OD	▪ Avoidance of byelawed and danger sites ▪ Carry out site selection studies in conjunction with liaison with MOD	▪ Site / cable route selection stage ▪ Project design stage ▪ Project operation and maintenance
Cables and Pipelines			
Direct damage	CC CD OC OD	▪ Use of recommended 500m avoidance zone ▪ Use of crossing agreements in accordance with ICPC guidelines	▪ Site / cable route selection stage ▪ Project design stage
Reduced access	CC CD OC OD	▪ Use of recommended 500m avoidance zone ▪ Use of crossing agreements in accordance with ICPC guidelines	▪ Site / cable route selection stage ▪ Project design stage

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

Potential Effect	Development Phase	Suggested Project Level Mitigation Measures	Timescale
Disposal Sites			
Disruption to access during installation	CC CD	▪ Avoid development within 500m of disposal sites ▪ Notification of port and harbour authorities of the proposed works	▪ Site / cable route selection stage ▪ Project design stage ▪ Project installation
Direct disturbance of contents of disposal sites	CC CD	▪ Avoid development within 500m of disposal sites	▪ Site / cable route selection stage ▪ Project design stage ▪ Project installation
Disruption to access during operation	OC OD	▪ Avoid development within 500m of disposal sites	▪ Site / cable route selection stage ▪ Project design stage ▪ Project operation and maintenance
Seascape			
Effects on seascape from offshore wind developments	CD OD	▪ Consideration should be given to locating devices at a maximum distance from the shore/coast (within technological constraints) ▪ Wind farms should not be sited where they appear to block or close the entrance to bays/ loughs/narrows/sounds or where they separate a bay from the open sea ▪ Wind farms should reflect the shape of the coastline and align with the dominant coastal edge ▪ Wind farms should not be sited where they have the potential to fill a bay. The open, expansive nature of the water surface area should be allowed to continue to dominate ▪ Wind farms should avoid locations near scattered settlements, as the scale of the array has the potential to dominate the fragmented pattern of the settlement ▪ Wind farms should be avoided where they conflict with the scale and subtleties of complex, indented coastal forms ▪ Consideration should be given to locating devices in already industrialised and developed seascapes	▪ Project design stage
Climate			
Potential sterilisation of future gas/carbon storage areas	OC OD	▪ Consultation to establish areas of search for possible future gas/carbon storage sites within Northern Ireland waters	▪ Site selection ▪ Project design

CC = Construction Cable CD = Construction Device
OC = Operation Cable OD = Operation Device

15 Monitoring Framework

15.1 Introduction

It is a requirement of the SEA Directive and The Environmental Assessment of Plans and Programmes (Northern Ireland) Regulations 2004 that the responsible authority (in this case DETI) monitors the significant effects of the implementation of the plan or programme for which it has carried out the assessment. Part IV (16) of the Regulations states that the responsible authority '*shall monitor the significant environmental effects of the implementation of each plan or programme with the purpose of identifying unforeseen adverse effects at an early stage and undertaking appropriate remedial action'*. This chapter of the SEA sets out the proposed monitoring framework required as part of the overall SEA. Following consultation the monitoring framework will be reviewed and finalised in the post-adoption SEA Statement.

15.2 Focus of the Monitoring Framework

The main focus of a monitoring framework is to set out measures that could be used by DETI to monitor the implementation of the SAP and the effects that it has on the environment.

The SAP provides a framework for a competitive call, to be undertaken by The Crown Estate (TCE) for commercial projects. It also sets out aims and objectives for the development of offshore renewable energy in Northern Ireland and establishes parameters and targets for that development. It also include a range of short, medium and longer term actions that will need to be delivered to support and to facilitate the development of offshore wind and marine renewable energy in Northern Ireland.

However, it will not involve the physical deployment of individual offshore renewable energy projects as this will be the responsibility of individual developers. Nor will it be responsible for the consenting and licensing of individual offshore renewable energy projects, although conformance with the SAP will be a material consideration in the determination of consent /licence applications.

The monitoring framework therefore needs to focus on monitoring the effectiveness of the SAP in promoting offshore renewable energy development in a way that minimises adverse effects on the environment and other marine users, rather than monitoring individual projects.

15.3 Approach to Monitoring Framework

By providing a framework for taking forward offshore renewable energy developments, the SAP could potentially have adverse effects on the Northern Ireland marine and coastal environment. These potential adverse effects have been assessed as part of this SEA.

The results from the SEA (presented in Chapters 11, 12 and 13) identified that offshore renewable energy developments (mainly offshore wind and tidal) could make a significant contribution towards achieving the proposed target that 40% of Northern Ireland electricity is to be provided from renewable sources by 2020. However, it also identifies that, due to data and knowledge gaps, there is still some uncertainty over the exact levels of development that could be delivered in Northern Ireland without having significant adverse effects on the environment.

This uncertainty needs to be taken into account in terms of the development of this monitoring strategy.

A number of plan level mitigation measures (presented in Chapter 14) have therefore been developed which focus on reducing the potential for individual projects, taken forward under the framework created by the SAP, to have significant adverse effects on the environment. This will be achieved by increasing the certainty with which potential significant adverse effects of individual projects can be identified and avoided/reduced by examining options for reducing data and knowledge gaps, either at the strategic or project level; providing guidance to assist in the selection of sites and consent applications; and establishing a strategy for managing the implementation of appropriate and practical project level mitigation.

15.4 Monitoring Plan Level Mitigation Measures

There are two ways in which the effectiveness with which SAP delivers the plan level mitigation can be monitored:

- Direct monitoring of the individual actions that comprise the plan level mitigation measures and
- Monitoring the delivery of individual projects where unforeseen significant adverse effects are identified as part of the project consent/licence application process

15.4.1 Direct Monitoring of Plan Level Mitigation Measures (Actions)

Each of the actions developed as part of the plan level mitigation (Chapter 14) have specific deliverables which will need to be achieved in order the mitigation measures to be effective. The suggested approach to the monitoring of the plan level mitigation measures is therefore based on carrying out periodic reviews against the timescales for the delivery of the individual actions. Where actions have not been delivered, further reviews will be required to identify reasons they have not been delivered and the implications that this has on the delivery of individual projects.

The draft SAP already proposes a formal review in 2013-2014 to take account of progress/ developments by that stage. It also proposes an annual report against planned actions and any revised plans for the incoming year. This report would be considered by the Sustainable Energy Inter Departmental Working Group, chaired by the DETI Minister, the new Offshore Renewable Energy Forum. It would also be forwarded to the Enterprise, Trade and Investment Assembly Committee and placed on the DETI website.

It is suggested that the establishment of the Offshore Renewable Energy Forum would be an early action and for it then to consider and advise DETI on the prioritisation of the other actions listed below (Actions 2 to 5). Following implementation of the SAP (2009 to 2010) it is likely to take a few years before significant progress is made on the deployment of commercial projects. This reflects the likely timescales involved in the current testing of individual devices and small scale projects (e.g. 10 to 20 MW developments) and the anticipated timescales involved in The Crown Estate Competitive Call. However, it is likely that developers during this time will be keen to make progress with acquiring necessary technical and environmental data in their main areas of interest to support both their lease applications and future consent applications.

Following implementation of Action 1 to initiate the establishment of the Offshore Renewable Energy Forum it would be appropriate for work to commence on the delivery of Actions 2, 4 and 5 within the first couple of years of the implementation of the SAP, for full delivery of these actions within a 5 year timescale. To reflect the nature and requirements of Action 3 to promote and support the deploy and monitor approach to development it is likely to be a few years (e.g. 2 to 3 years before significant progress can start to made on delivering this Action.

Suggested deliverables to be monitored for each of the actions and related timescales for their delivery are presented in Table 15.1 below.

Table 15.1: Monitoring Framework – Plan Level Mitigation Measures

Action	Deliverables to Monitor	Timescales	Achieved
Action 1: Establishment of an Offshore Renewable Energy Forum	▪ Agree Terms of Reference (TOR) for forum members ▪ Development of aims and objectives for the forum ▪ Develop of schedule of meetings	12 months	Yes or No Dates achieved/ delivered
	▪ Produce a programme of works ▪ Implement programme of works	18 months to 3 years	Yes or No Dates achieved/ delivered
Action 2: Address Strategic Data and Knowledge Gaps	▪ Identify priorities for filling data/knowledge gaps ▪ Agree level (e.g. strategic or project) that data/knowledge to be collected ▪ Identify opportunities for collaborative working (national and international) ▪ Develop programme or work/action plan for filling strategic level data and knowledge gaps	18 months to 2 years	Yes or No Dates achieved/ delivered
	▪ Develop TORs and specifications for surveys (strategic level) ▪ Examine options for integrating specific survey/data collection requirements into project level mitigation strategy	2 to 5 years	Yes or No Dates achieved/ delivered
	▪ Procure data collection/survey/ research projects/programmes ▪ Review findings from data collection/survey/research projects		
Action 3: Application of the Deploy and Monitor Approach to the Management of Development	▪ Consult regulatory authorities and The Crown Estate (TCE) ▪ Agree approach to the application of deploy and monitor of individual projects awarded under TCE leasing round ▪ Agree evidence required and criteria that would have be met as part of consenting of larger scale projects ▪ Implement deploy and monitor ▪ Provide feedback on findings from deploy and monitor	2 years onwards	Yes or No Dates achieved/ delivered
Action 4: Preparation of Locational Guidance	▪ Develop TOR for locational guidance ▪ Prepare programme for developing locational guidance ▪ Agree approach to consultation ▪ Procure preparation of locational guidance	0 to 2 years	Yes or No Dates achieved/ delivered
			Yes or No Dates achieved/ delivered
	▪ Provide feedback to preparation of statutory MSPs and TCE leasing round	2 years onwards	Yes or No Dates achieved/ delivered

Action	Deliverables to Monitor	Timescales	Achieved
Action 5: Development of a Project Level Mitigation Strategy	▪ Review mitigation measures identified as part of the SEA ▪ Review of best practice and lessons learned from other offshore renewable energy developments in terms of effectiveness and practicalities of certain mitigation measures ▪ Agree package of mitigation measures to be applied to individual projects ▪ Identify mechanisms for integrating mitigation measures into individual projects ▪ Produce project level mitigation strategy	0 to 3 years	Yes or No Dates achieved/ delivered
	▪ Implement project level mitigation strategy	3 years onwards	Yes or No Dates achieved/ delivered

15.4.2 *Monitoring Individual Projects to Identify Unforeseen Effects*

In addition to monitoring the plan level mitigation measures, it is also recommended that individual offshore renewable energy projects are subject to periodic strategic level reviews. Although the SAP is not directly responsible for the consenting or physical deployment of individual projects, it is responsible for providing a framework within which individual projects can be taken forward. It will be necessary to carry out a review of individual projects to identify whether any unforeseen significant adverse effects have been identified during the consenting process or during the installation or operation of projects as this will provide a measure as to the overall effectiveness of the plan level mitigation measures.

In carrying out periodic reviews of individual projects it will be necessary to consider:

- Whether the adverse effects identified during the SEA have occurred in respect to individual projects,
- The reasons why some of the effects of individual projects are less or more significant than those identified during the SEA ,
- Why potential cumulative effects of multiple developments in certain areas have been identified as potentially having more or less significant adverse effects than identified in the SEA and
- Possible actions to address any unforeseen significant adverse effects that may have been identified for individual or multiple projects

Given that the plan level mitigation measure have been developed specifically to help reduce the risk of significant adverse effects occurring at the project level, where unforeseen adverse effects do occur it will be necessary to review the progress that has been made against the plan level mitigation measures. This will help to identify whether the plan level mitigation measures are being delivered effectively through the implementation of the SAP.

However, given the strategic nature of the plan level mitigation measures, it may not always be possible to determine whether the unforeseen effects identified at the project level are directly attributable the implementation of the SAP.

The marine environment by its very nature will experience changes that are unrelated to the deployment of offshore renewable energy projects. These changes may be either natural or induced by other external factors e.g. other marine sectors. A full analysis of the likely cause and effect in the baseline environment identified either as part of the monitoring proposals developed through the plan level mitigation actions or from monitoring carried out as part of a condition of a development consent, would have to be analysed closely to confirm if this is a result of an offshore marine renewable energy project or other causes.

It should also be noted that, in some cases, unforeseen adverse effects will only be identified through project specific monitoring that is required as part of a condition on a specific consent. It is important that the monitoring framework developed as part of this SEA reflects the strategic nature of the plan (in this case the SAP). It would not be appropriate or practical to develop a monitoring strategy for this SAP that involves the collection of monitoring data on all potential receptors associated with each of the SEA topics due to the scale and level of investment that this would require. However, requirements for more detailed surveying and monitoring to assist in the development of offshore renewable energy projects are addressed as part of the plan level mitigation.

The relationship between the monitoring of the plan level mitigation measures and the periodic reviews of individual projects is illustrated in Diagram 15.1 below.

Diagram 15.1: Relationship between Monitoring of Plan Level Mitigation Measures and Monitoring of Individual Projects.