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Guidance on Marine Baseline Ecological Assessments & Monitoring Activities

for Offshore Renewable Energy Projects

Part 1 April 2018

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1. Introduction: An overview

The Offshore Renewable Energy Plan (OREDP), its accompanying Strategic Environmental Assessment (SEA) and Appropriate Assessment (AA) have been prepared in response to the recognition that if Ireland is to develop our offshore renewable energy potential, we must improve our understanding of the impact such developments may have on our marine environment.

This non-statutory guidance document supports the *Guidance on EIS and NIS Preparation for Offshore Renewable Energy Projects*, DCCAE 2016 and is supported by *Data and Information Sources for Offshore Renewable Energy Developments*[1], DCCAE, 2016.

Offshore renewable energy projects envisaged to be delivered under the guise of the OREDP will be subject to national consenting regimes. This will include, where necessary, the requirement for a competent authority to undertake formal Environmental Impact Assessment and Appropriate Assessment prior to its decision in respect of an application for statutory consent of a project. The type(s) of consent and supporting environmental analysis required will vary by project type, scale and location. Depending on the size, location and type of a proposed project it may be that an Environmental Impact Assessment Report (EIAR and/or Natura Impact Statement (NIS) are required to accompany a consent application.

This document constitutes Part 1 of a 2 part series. It provides a non-technical summary of the baseline data requirements and monitoring that may be necessary to evaluate potential impacts of offshore renewable energy projects on the marine environment. It will be reviewed and updated as required. It is intended primarily for developers, but will also be of benefit to consenting authorities during the consenting processes. Part 2 provides greater technical detail and is primarily aimed at the experts designing and undertaking the required monitoring and assessments.

Guidelines on the Information to be Contained in Environmental Impact Statements, EPA, 2002 and *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements*, EPA, 2003 offer guidance on the undertaking of Environmental Impact Assessment (EIA) and on generating an Environmental Impact Assessment Report (EIAR).

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1 *Data and Information Sources for Offshore Renewable Energy Developments*. Available at: www.oceanenergyireland.com/Content/Documents/EnvData.xlsx

Similarly, *Appropriate Assessment of Projects and Plans in Ireland: Guidance for Planning Authorities*, DEHLG, 2009 offers guidance on the undertaking of Appropriate Assessment (AA) and preparing a Natura Impact Statement (NIS) where potential impact on a European site arises from a project. It is important to note, that assessment of terrestrial habitats with the potential to be impacted by offshore renewable energy developments should form part of the EIS or AA, and should not constitute a separate project of assessment.

Part 2 outlines methods for conducting baseline assessments of offshore renewable energy projects and identifies project lifecycle potential pressures, impacts, indicators and monitoring methods for receptors. It does not consider those elements of offshore renewable energy projects which are unlikely to be the subject of future monitoring.

2. Collecting baseline data

2.1 Why is data required?

Data and information collection is fundamental to the preparation of both EIS and NIS. For developments in, or likely to impact on, Natura Sites, the NPWS Website (http://www.npws.ie/protected-sites) contains a large amount of data and information for establishing baseline conditions. Good quality ecological data and information establishes the baseline of a proposed project site and identifies suitable indicators that underpin the analysis necessary to predict potential pressures and impacts. Indicators are required to facilitate assessment of impacts and these should relate to the pressures and subsequent potential changes in the environment resulting from the proposed development.

In most cases baseline data and information will already be available for a site. *Data and Information Sources for Offshore Renewable Energy Developments* provides a reference to available data sources. In cases where there is insufficient data, field based surveys should be conducted to gather information relevant to the receiving environment. It is the responsibility of the developer to collect and assess the data required to prepare an EIS and/or NIS, and conduct future monitoring. In such instances, site surveys and assessments should be undertaken by suitably qualified specialists.

2.2 What kind of data is required? (Scoping)

The type and range of data and information gathered will depend on:

- the complexity of, and anthropogenic pressure on, the receiving environment;
- the scale and type of proposed project; and
- whether an EIS or NIS (or both) is required to support a consent application.

This is known as the scoping stage of the project. Scoping should identify the issues that are likely to be significant during the preparation of the EIAR and/or NIS and acknowledge and eliminate those that are not. *Guidance on EIS and NIS Preparation for Offshore Renewable Energy Projects* [2] provide more detailed information on the scope and stages of the EIA and AA processes.

Early engagement and consultation with the competent authority and other relevant state agencies to whom aspects of the formal project proposal may be referred is advisable at the scoping stage. Statutory agencies that should be consulted can be viewed in Appendix IV of the *Guidance on EIS and NIS Preparation for Offshore Renewable Energy Projects.*

As this document focuses primarily on marine habitats and on topics that are likely to require monitoring in the future, data and information relevant to each of the topics listed in Table 1 should be gathered and/or collated and evaluated. In certain cases, not all of the listed items will be relevant to the proposed development and some may require limited consideration. However, each item should be considered during the scoping stage, and a clearly documented rationale provided if any are to be “scoped out” of the subsequent assessment procedure.

The **type** of data and information and the **scale and duration** of surveys required should be considered on a project and site-by-site basis. Type and level of detail required is dealt with in section 2.3.3. The methodology described in Chapter 5 provides guidance on pre-construction and post-construction survey methods which are further detailed in Part 2 of this guidance.

Table 1 describes the environmental topics that require consideration in the EIA process for offshore renewable energy projects and highlights those that generally require ongoing monitoring[3]. Not all of these topics are covered in this report, Table 1 clarifies the areas that this report focuses on.

[2] https://www.dccae.gov.ie/documents

[3] Adapted from SEA of the OREDP (SEAI, Aecom, Metoc, 2010)

Table 1: Environmental topics requiring consideration in the EIA process for offshore renewable projects and the topics that generally require ongoing monitoring and assessment.

EIA Topic	Marine EIA Topic	Monitoring requirements considered in this report
Biodiversity, Flora and Fauna	Protected sites and species	Yes
	Benthic ecology	Yes
	Fish and shellfish	Yes
	Marine mammals and reptiles	Yes
	Birds	Yes
	Energy (noise and EMF)	No
Soils and Geology	Coastal erosion	Yes
	Sedimentation processes	Yes
	Seabed geology and morphology	No
Water	Water quality	No
	Bathymetry and hydrology	No
	Sediments (Benthic macrofauna)	Yes
Seascapes and Landscapes	Seascapes	No
	Visual impacts	No
Climate	Climate factors	No
	Gas storage	No
	Renewable energy	No
Cultural/Archaeological Heritage	Marine and coastal archaeology	Yes
	Shipwrecks	Yes
Population and Human Health	Ports, shipping and navigation	No
	Aviation safety and military exercise	No
	Recreation and tourism	No
	Commercial fisheries and aquaculture	Yes
	Noise	No
Material Assets	Oil and gas infrastructure	No
	Cables and pipelines	No
	Aggregates, dredging, disposal areas	No
The inter-relationship between the Above Factors		

2.3 How is data collected? (Identifying the baseline)

Relevant baseline datasets are identified by considering the species, habitats and receiving environment that may be impacted by the proposed project. Any data and information on receptors that could be impacted which are available from previously published studies should be collated. When relevant data on the receiving environment is unavailable, the developer should commission surveys to be conducted by specialists (e.g. marine ecologists, ornithologists, archaeologists, etc.). This information will provide the basis for predicting and assessing impacts that may be attributable to the development.

2.3.1 Receptors

Receptors are described as any species or habitat supporting that species, which could be adversely affected by a proposed development. In the case of offshore marine renewable energy projects, the receptors that usually require evaluation are contained within the topics described in Table 1. The receptors considered here are those that will most likely require future monitoring and that have the potential to be impacted by the development.

2.3.2 Impacts

The identification of potential environmental pressures and subsequent impacts on receptors is a critical first step in preparing an EIS or NIS. Such pressures and subsequent impacts should be evaluated at the scoping stage of the project. Article 5 of Directive 2014/52/EU states that “the developer shall ensure that the environmental impact assessment report is prepared by competent experts”. Experts should gather and collate the data and information required to characterise the existing environment and should evaluate its significance and sensitivity to the project. The methodology in Chapter 5 provides an indication of the likely pressures and impacts that the various development stages of a project in the marine area may have on the receiving environment.

Anticipated impacts must be defined: positive, negative, duration and significance. They must be considered in combination with other anticipated impacts.

Term	Definition	Example
Pressures	A pressure is a project stress factor causing either temporary or permanent disturbance or damage. Pressures can be physical (e.g. abrasion), chemical (e.g. introduction of synthetic components) or biological	Dredging causing smothering of benthic species.

	(e.g. introduction of microbial pathogens).	
Impacts	An impact is the change to the receptor caused by the pressure.	Loss of benthic species due to smothering pressure.
Indicators	A measurable variable pointer that can be used to reveal and monitor the conditions and trends for an environmental pressure or state. Indicators should relate to the pressures and subsequent potential changes in the environment resulting from the proposed development.	Loss of key species.

2.3.3 Type and level of detail required (Scale)

The type of data required and the scale of the surveys will depend on the complexity of the receiving environment, the scale and type of the development and the pressures emanating from the development and the presence of other developments that may have an in-combination effect with the potential impacts from the proposed development. For example, developments that are in close proximity to areas designated for a range of protected habitats[4] or protected species[5] are likely to require a higher level of survey effort. However, these areas are also more likely to have a higher level of previously published data which may be utilised.

Therefore, the type of data and scale of surveys required should be considered on a site-by site and project-by-project basis. It is important that the baseline data gathered and subsequent monitoring is capable of detecting any change that may be attributable to the development and can distinguish these for changes occurring irrespective of the development i.e. change due to other anthropogenic and/or natural impacts. The methodology described in Chapter 5 provides guidance on pre-construction and post-construction survey methods, and these are further detailed in Part 2 of this guidance.

[4] Annex I habitats designated under the EU Habitats Directive
[5] Annex II species designated under the EU Habitats Directive or Annex I of the EU Birds Directive

2.3.4 Practical considerations

Gathering data in marine environments can be challenging; this is particularly relevant to offshore renewable energy projects where the site may have been selected for its exposure to high wind, wave and/or tidal conditions.

While an ideal baseline survey or monitoring programme design may require collection of data at pre-set regular intervals, inclement weather conditions may prevent the collection of this data. For this reason, contingencies for data gaps should be built into the survey design to ensure that the required data can be gathered to enable a meaningful evaluation. This may necessitate longer survey periods and/or the use of modelling. The increase in use of digital aerial imagery which can be collected during a relatively short survey period, is likely to reduce the impact of weather on data collection.

Establishing a baseline

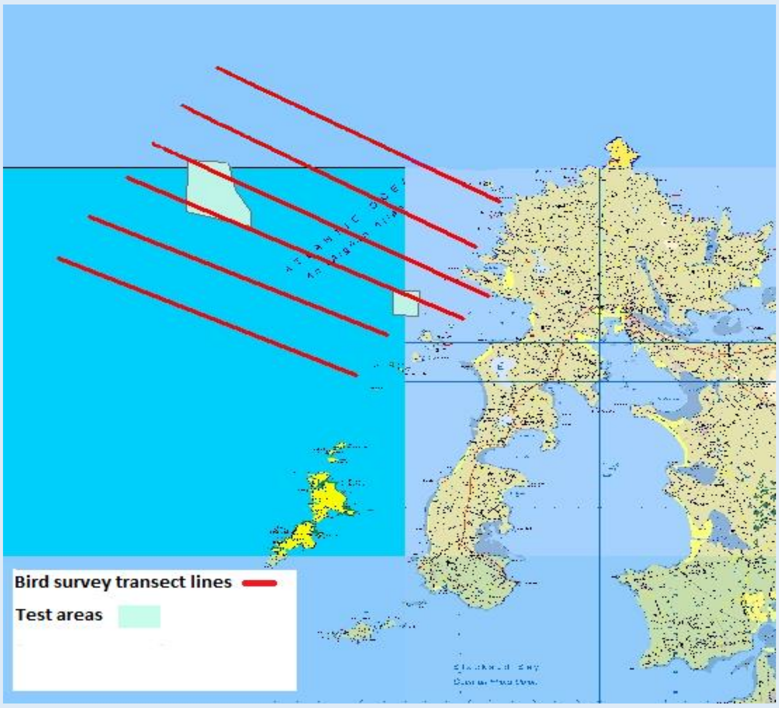
Case study: Atlantic Marine Energy Test Site (AMETS)

The AMETS test site covers an area of 8.4km^2 divided into two separate test areas; one at 100m Below Chart Datum (BCD) and one at 50m BCD.

An Environmental Baseline Study was commenced in 2009 and in the absence of specific guidance for conducting marine surveys at that time, a programme of surveys based on best practice was developed. The initial baseline survey was carried out in 2009, followed by 2 years of further surveys to establish an accurate baseline for the site against which potential impacts could be measured and evaluated, should the development of the site be consented.

With the exception of data for seals and cultural heritage sites, little data for the identified receptors was available for this site. Therefore site-based surveys of the following identified receptors were conducted:

- Benthos: Subtidal reef and subtidal sediments.
- Littoral habitats: intertidal reef and intertidal habitats.
- Birds: Sea birds at sea and breeding bird surveys.
- Marine Mammals: Cetaceans.
- Coastal process.
- Cultural heritage: Shipwrecks and Associated remains and Coastal Archaeology and Cultural heritage sites.



While the site is of a small scale, relative to a commercial offshore renewable energy site, surveys, where necessary, covered a much larger area than the actual site itself. This figure shows the area covered by the bird surveys, relative to the test areas.

2.3.5 Consultation

As noted in the scoping section 2.2- early consultation with relevant organisations and bodies is recommended.

The views of other organisations, including non-Governmental organisations who may have an interest in the site, may also be sought at an early stage. In addition to their input as stakeholders, such organisations may also hold data and information specific to the site which can assist in establishing the environmental baseline. Early consultation may also help to avoid unnecessary duplication of survey effort.

2.4. When is data gathered? (Survey frequency)

The frequency of surveys for both the gathering of baseline data and future monitoring will be dependent on the receptor and its natural background variability. For example, data on seabirds at sea is generally poor in Ireland and their natural variability is moderately high. In order to obtain a consistent data set representing all seasons, surveys may be required over a 2year period to allow a baseline to be established. On the other hand, there is little variability in the composition of the macro-faunal species that occupy sandy sediments in exposed sites. In this instance, species abundance and diversity is generally low and changes in the composition of macrofauna of these sediments is also low. Consequently, baseline survey of subtidal sediments in exposed offshore sites may be required only on one occasion.

Due to the lack of data available for impacts of some offshore marine renewable energy devices, monitoring surveys following deployment may be more frequent than for some other types of development. As a result, the monitoring design should include an informed programme of monitoring at appropriate time intervals, depending on the site and initial evaluation of the receptors. Table 2 provides guidance on the frequency of surveys that may be required for offshore renewable energy project sites. However, this will vary depending on the size and scale of the site and development, and the sensitivity of the identified receptors to the pressures emanating from the development.

Table 2 Indicative timelines for surveys

Project timeline (years)			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	25	30	35
Project phase		**Survey frequency**	*Baseline*																		
						Construction/ deployment															
							Operation														
																				Decommissioning	
Receptors																					
Benthos	Subtidal reef	Between May & Sept.																		Note 1	
	Subtidal sediment	Between May & Sept.																		Note 1	
Littoral habitats	Intertidal reef	Between May & Sept.																		Note 1	
	Intertidal sediment	Between May & Sept.																		Note 1	
Birds	Offshore & nearshore	Monthly																		Note 2	
	Cable laying/land	Monthly																		Note 2	
Marine mammals	Cetaceans	Year round acoustic deployment. Quarterly sea surveys.																		Note 2	
	Seals	Year round																		Note 2	
Basking sharks		Between March and September																		Note 1	
Marine reptiles			Incidental as part of marine mammal surveys																		
Coastal processes	Coastal erosion sediment transport and deposition at project site and within zone of influence	Once during year of survey							Note 3											Note 1	
Cultural heritage	Shipwrecks & Associated remains	Once during year of survey							Note 3											Note 1	
	Coastal archaeology & cultural heritage sites	Once during year of survey							Note 3											Note 1	
Fisheries	Commercial fisheries	N/A	Note 4																	N/A	
	Shell fish fisheries	N/A	Note 4																	N/A	

Note 1: To be agreed at time of decommissioning but potentially 1 year following decommissioning.

Note 2: To be agreed at time of decommissioning but potentially 1-2 years following decommissioning.

Note 3: This will vary depending on the natural dynamics of the site and baseline information and should be evaluated on a case by case basis.

Note 4: Based on desk review data.

3. Using baseline data to inform EIS or NIS: Identifying impacts

Baseline data provides a description of the receiving environment against which change can be predicted and measured in the future. This may include change that is due to natural phenomena e.g. extreme weather events or unrelated human impacts, as well as the development itself.

The baseline survey dataset should be analysed to allow a set of suitable indicators to be identified. The methodology described in Section 5 provides guidance on the type of indicators suitable for detecting changes in receptors.

A thorough understanding of all stages of the construction, operation and maintenance of the development is required. Understanding its lifecycle from design to construction to operation and decommissioning is essential in order to identify key pressures and potential significant impacts, select appropriate indicators and establish necessary mitigation measures (which may include ongoing monitoring). An iterative approach to the design of the project, the monitoring programme and mitigation measures is necessary so as to integrate environmental considerations into all aspects of the project lifecycle.

In-combination effects

While a single development may not, in itself, cause a significant impact on the receiving environment, a combination of other activities within a localised area may. Therefore, when assessing the possible effects of the proposed development, the cumulative impacts of an offshore marine renewable energy development, in association with other human activities, projects and plans, must be taken into consideration.

Further details on assessing in-combination and cumulative effects of offshore marine renewable energy developments are provided in the guidance document: *Guidance on EIS and NIS Preparation for Offshore Renewable Energy Projects.*

Selecting Indicators
Case study: Ecological Assessment for the proposed Atlantic Marine Energy Test Site (AMETS). (Appendix 3)

A total of 38 species were recorded at the AMETS within the subtidal reef habitats of the site by drop down video imagery. Analysis of these data allowed the characterising biotopes (i.e. small areas with uniform biological conditions) of the area to be identified. It also allowed the main "indicator" species that characterised those biotopes to be identified.

Three biotopes, together with their characterising species were selected as indicators for the subtidal reef habitats. These biotopes and species provide an accurate baseline of the subtidal reef prior to development. The biotope *Laminaria hyperborea* and red seaweeds on exposed vertical rock was the most common biotope recorded within the site. It was therefore selected as an indicator for this habitat. Monitoring of this biotope, together with the other two recorded biotopes (which are indicators for deeper reef habitats) are to be conducted an annual basis for the first 2 years of the life of the development, and on a six yearly basis thereafter.

4. Monitoring

4.1 Why is monitoring required?

Monitoring provides the information necessary to evaluate the impacts on the receiving environment over the lifecycle of the project. As part of the EIS mitigation commitments, indicators and appropriate thresholds should be established for each project pressure that could lead to a significant and unacceptable impact on a receptor. Effective monitoring programmes require thresholds to be established for receptor indicators, which if exceeded, trigger an appropriate and clearly documented set of actions to be taken. Indicator assessment thresholds should be set as a deviation from a baseline value. It is important to determine a set of indicators that will allow such a change to be detected. Indicators and threshold values should be established once the baseline gathering stage of the project (pre-construction phase) has been completed, and they should be subsequently monitored. Surveillance indicators, that measures background changes not attributable to the project, can also be selected to enhance understanding of the environment and support interpretation of the monitoring results.

Monitoring and mitigation commitments set out in consent design documentation, and including an EIS or NIS, will be considered to form part of the project from a consent perspective. In addition, monitoring and mitigation may form explicit conditions on consent(s) for a project. Therefore, it is incumbent on the developer to ensure that these commitments are met to ensure compliance with the project consent(s) and to avoid enforcement action.

4.2 Design of a monitoring programme

Complexity of the receiving environment, evaluation of the baseline data and assessment of potential impacts of the particular project will influence the design of the monitoring programme. While generic indicators can be described for marine habitats and species, it is preferable to develop site specific indicators, following the completion of baseline surveys. Where these exist they should be linked to existing values agreed either nationally, at regional seas level (e.g. Celtic) or at EU level.

The design of the monitoring programme should demonstrate robust and practical indicators derived from the initial site surveys, and recognition of the practical challenges of monitoring in extreme marine environments. It should also consider issues such as natural variation which are inherent in any site. While specific thresholds cannot be specified in this document, it is important that where monitoring protocols are in place they relate to identified thresholds.

5. Survey and monitoring methodologies

Table 1 sets out the environmental topics that may arise in a generic offshore renewable energy project, and the topics that are most likely to require ongoing monitoring.

This section introduces the Baseline Survey Methodology and the Monitoring Methodology:

1. The **Baseline Survey Methodology** is intended to direct the extent and type of surveys undertaken to establish an environmental baseline for a receiving environment of a project.
2. The **Monitoring Methodology** acts as a guide for the identification of potential effects, impacts and indicators. Ongoing monitoring timings should also be considered as per proposed timelines in the table.

The information in these methodologies acts as a guide only and is not an exhaustive list. At the same time, surveys and monitoring conceived in these methodologies will not arise in every project. Baseline data identification and gathering as well as subsequent project design refinement, and testing against that baseline, will be project and location specific.

5.1 Baseline survey methodology: Summary of pre-construction and post-construction survey methods

1. BENTHOS | 1.1 Subtidal reef
Pre-construction baseline survey methods
Survey method
Calculate the total habitat area and the approximate area of each biotope within the habitat. Surveys should be designed to record the characterising species and their abundance within each biotope so that change can be measured in the future. Survey methods should consider calculating the potential effects of sediment suspension during the construction phase of the project. Drop down video and Marine Nature Conservation Review (MNCR)Phase II surveys, conducted by divers, where possible, should be used to survey pre-selected sites within Natura 2000 sites where subtidal reef forms a "Feature of Interest" for the site. MNCR Phase 1 surveys should be used for all other subtidal reef.
Time/duration/extent
During the months of May to September. The scale and extent of the survey should reflect the extent of the habitat and complexity of biotopes and the proposed footprint of the project.
Data/statistical analysis.
Before, After, Control, Impact (BACI) design. Include adequate replication of sampling sites and surveys to provide a robust data set that will allow temporal and spatial variation, together with differences associated with various exposure regimes to be calculated. Adequate control sites should be included within this design. The use of community level analyses, incorporating the whole species community present is considered to provide a statistically robust measure of an ecosystem response to change and should therefore be utilised.
Practical considerations
Survey design should provide for contingencies to allow the baseline to be measured as planned so that data gaps are avoided. Survey sites should be selected to avoid bias, while at the same time providing for practical considerations. For example, problems associated with operating drop down video in exposed areas and conducting dive surveys when weather conditions are unsuitable. Monitoring effort should be proportional to risk, and a compromise between the quantity of resources required to detect change and the perceived consequence of that impact should be made.
Post-construction operation monitoring methods DECOMISSIONING APPLY TO ALL
The monitoring sites should be selected to represent the range of spatial variation of biotope complexes identified across the site and should include the continued monitoring of selected control sites. Monitoring surveys should include an assessment of sessile epifauna and flora on the devices and their associated infrastructure. Changes to flow regimes should be measured. Surveys should take place on an annual basis for the first 3 years of the life of the farm, and on a six yearly basis thereafter. Surveys should take place between the months of May and September.
1. BENTHOS | 1.2 Subtidal sediment
Preconstruction baseline survey methods
Survey Method
Calculate the total habitat area and the approximate area of each biotope within the habitat. Site characterisation by drop down video should be used in the first instance, followed by grab sampling surveys to assess the macrofaunal communities, sediment particle size and organic carbon content.
Time/Duration/Extent
During the months of May to September. The scale and extent of the survey should reflect the extent of the habitat and complexity of biotopes and the proposed footprint of the project.
Data/statistical analysis
Before, After, Control, Impact (BACI) design. Include adequate replication of sampling sites and surveys to provide a robust data set that will allow temporal and spatial variation, together with differences associated with various exposure regimes to be calculated. Adequate control sites should be included within this design. The use of community level analyses, incorporating the whole species community present is considered to provide a statistically robust measure of an ecosystem response to change and should therefore be utilised.
Practical considerations
Survey design should provide for contingencies to allow the baseline to be measured as planned so that data gaps are avoided. Survey sites should be selected to avoid bias, while at the same time providing for practical considerations. For example, problems associated with operating drop down video in exposed areas. Monitoring effort should be proportional to risk, and a compromise between the quantity of resources required to detect change and the perceived consequence of that impact should be made.
Post-construction monitoring methods
The monitoring sites should be selected to represent the range of spatial variation of biotope complexes identified across the site and should include the continued monitoring of selected control sites. Changes to flow regimes should be measured. Survey should take place on an annual base for the first 3 years of the life of the farm and on a six yearly basis thereafter. However, in exposed sites, monitoring on a 6 yearly cycle would be considered sufficient. Surveys should take place between the months of May and September.
2. LITTORAL HABITATS | 2.1 Intertidal reef
Pre-construction baseline survey methods
Survey method
Baseline surveys should calculate the total habitat area and the approximate area of each biotope within the habitat. They should be designed to record the characterising species and their abundance within each biotope so that change can be measured in the future. MNCR Phase II surveys, should be used to survey pre-selected sites within Natura 2000 sites where intertidal reef forms a 'Feature of Interest' for the site. MNCR Phase I surveys should be used for all other intertidal reef.
Time/Duration/Extent
During the months of May to September. All surveys should take place when the predicted tidal height is no greater than 0.6 meters. Intertidal reef surveys are generally quite localised focusing on the potential area of impact and a surrounding buffer zone.
Data/statistical analysis
Data analysis should include the use of appropriate techniques to allow the measurement of change to be calculated following a Before, After, Control, Impact (BACI) design. It should include adequate replication of sampling stations. Adequate control sites should be included within this design. The use of community level analyses, incorporating the whole species community present is considered to provide a statistically robust measure of an ecosystem response to change and should therefore be utilised.
Practical considerations
Survey design should provide for contingencies to allow the baseline to be measured as planned so that data gaps are avoided. Surveys should be planned to ensure the surveys take place when the predicted tidal height is no greater than 0.6 meters and account for poor weather conditions when wind and swell may prevent surveys being completed as planned.
Post-construction monitoring methods
Surveys should take place between the months of May and September. They should take place at a pre-determined subset of the baseline survey site/s. They should include the continued monitoring of selected control sites. Survey should take place on an annual base for the first 3 years of the life of the farm and on a six yearly basis thereafter.
2. LITTORAL HABITATS | 2.1 Intertidal sediment
Pre-construction Baseline survey methods
Survey Method
Baseline surveys should calculate the total habitat area and the approximate area of each biotope within the habitat. Intertidal cores to assess macrofaunal composition, sediment grain size and total organic carbon. Assessment of habitats designated for intertidal eel grass (*Zostera noltii*).

Time/Duration/Extent
During the months of May to September. The scale and extent of the survey should reflect the extent of the habitat and complexity of biotopes and the proposed footprint of the project.
Data/Statistical analysis
Before, After, Control, Impact (BACI) design. Include adequate replication of sampling sites and surveys to provide a robust data set that will allow temporal and spatial variation, together with differences associated with various exposure regimes to be calculated. Adequate control sites should be included within this design. The use of community level analyses, incorporating the whole species community present is considered to provide a statistically robust measure of an ecosystem response to change and should therefore be utilised.
Practical considerations
Survey design should provide for contingencies to allow the baseline to be measured as planned so that data gaps are avoided. Survey sites should be selected to avoid bias, while at the same time providing for practical considerations. Surveys should take place when the predicted tidal height is no greater than 0.6 meters. Monitoring effort should be proportional to risk.
Post-construction monitoring methods
Monitoring of intertidal sediment habitats should not be required unless cable inspection or maintenance works are likely to cause further disturbance to the habitat.
3. BIRDS | 3.1 Birds (Construction and operation)
Pre-construction baseline survey methods
Survey method
Offshore (>2 km from shore): Boat/aerial/High definition videography transect surveys (line/point/strip) following European Seabirds at Sea (ESAS) survey methodology and conventional distance sampling (CDS/MCDS) using recommended software (Distance, MRSea, GLM, design based methods) and recording additional data (e.g. behaviour, flight height) as appropriate. **Near shore** (<2km from shore): Vantage point watches with timed scans of defined count units (no standard methodology available) and recording additional data (e.g. behaviour, flight height, dive direction and location) as appropriate. Record radial distance and angle to observations (analysis with R package nupoint) where possible. **Breeding seabird surveys** (where realistic risk of impact to colony): whole colony or sample plot counts depending on the colony size and following standard breeding seabird survey methodology. **Remote Monitoring Techniques** (radar, thermal camera, night vision, telemetry, tagging) to study specific interactions (e.g. night time migration, SPA connectivity).
Time/Duration/Extent
Extent: Impact area and buffer zone around this area. If designed/quasi-designed BACI analysis, surveys should cover area of impact and appropriate control sites. **Duration:** If no previous data available for the area, a minimum of three years of baseline data should be collected; reduced survey years (2 years) depending on sensitivity of site and availability of existing data **Boat/aerial surveys**: Monthly as weather allows otherwise covering each "marine bird survey period" (see report). Disperse surveys throughout day and cover each tidal state at least once. **Vantage point surveys**: Monthly throughout year, covering all tidal states and times of day. **Additional surveys:** Depending on survey focus, but likely covering baseline survey period of three years if no previous site data is available. Where realistic impact, monitor seabird colonies within the impact area (including buffer zone).

Survey Methodology: Summary of pre-construction and post-construction survey methods (continued)

Data/statistical analysis DEFINE SPELL OUT HIGHLIGHTED
Pre-construction. Offshore: Line or strip transect data. Line transect data correction with CDS/MCDS (Software: DISTANCE, MRSea). Use species specific estimates/correction factors from other studies only if insufficient data for CDS. Develop pre-disturbance density surface models (CReSS/SALSA, GAM with GEE for spatial autocorrelation as needed) using CDS/MCDS corrected data and appropriate covariates (e.g. bathymetry, lat/long). Recommended software: R packages mgcv, lmne, geepack). Alternative: design or quasi-design (e.g. BACI/BAG; GLM/GAM or ANOVA analysis depending on design complexity) if conditions suitable (larger project area, randomisation possible, true control sites available, interested in large, short term changes). Power analysis for design-based approaches. Vantage point: Declining detection with distance confounds with animal distributions. Document angle and radial distance to observation, use R package nupoint to account for declining detection with distance. **Post-construction.** Offshore: Comparison of pre-and post-impact estimates of abundance and distribution. Use CReSS/SALSA or GAM derived density surface models with 'development' term. GAMs may require GEEs to estimate variances and derive confidence intervals. Result gives areas that are observed to be statistically higher/lower than baseline conditions. Due to natural variation, changes in dependant variables (e.g. abundance) may not be detected unless they are considerable. For BACI/BAG analysis - GAM/GAMM to account for repeated measures/spatial autocorrelation or multi-factor ANOVA if very simple design without repeated measures. **Vantage Point:** nupoint/MRSea programs to develop spatial models of 'point' count data. **Pre and post construction analysis**: Use of BAND Model (2012) for collision risk assessment, entrapment risk can also be assessed using modelling. Use of Population Viability Analysis as appropriate (e.g. SPA connectivity).
Practical considerations
Substantial natural variability in seabird distribution/abundance/productivity: long term data with robust sample size required to detect impacts. Small scale changes may not be detectable due to sample size (and substantial cost) that would be required. Weather will affect survey coverage throughout the year and detection during surveys. Detection will deteriorate with distance and local site conditions. Analysis will be limited by gaps in survey coverage and quality of data (as affected by detection). Difficulty obtaining data on avoidance, collision and entrapment, to inform analysis. Other considerations are: Site access (consistency pre-development and post-development) observer variability, accuracy in recording data (e.g. flight height), cost (with implications for survey effort, use of remote monitoring technologies, aerial and high definition imagery surveys) and health and safety. Offshore and nearshore surveys should not be undertaken in sea states greater than 4. License required from NPWS for use of telemetry devices.
Post-construction monitoring methods
Post-construction: survey over years 1, 2 and 3, 5, 10 and 15. Additional survey requirements for monitoring will be determined by the results of the baseline and ongoing surveys (site specific). Continue surveys for at 2-3 years post construction depending on availability of existing data and sensitivity for the site.
3. BIRDS | 3.2 Birds (Cable laying)
Pre-construction baseline survey methods
Survey Method
Wintering birds: Point counts of shore following standard I-WeBs methodology but including all tidal states. **Breeding bird surveys:** if shore nesting species within impact area.
Time/Duration/Extent
Wintering birds: monthly counts between Sept and March, covering impact area and buffer zone. **Breeding waders**: early and late season visits for (April to June). **Breeding seabirds:** timing of surveys varies with species, consult relevant guidance. Survey period will depend on level of existing data and sensitivity of the site.
Data/Statistical analysis
Wintering birds: monthly counts between Sept and March, covering impact area and buffer zone. **Breeding waders:** early and late season visits for (April to June). **Breeding seabirds**: timing of surveys varies with species, consult relevant guidance. Survey period will depend on level of existing data and sensitivity of the site.
Practical considerations
License required from NPWS for breeding seabird surveys.
Post-construction monitoring methods
As for pre-construction. Continue surveys for at 2-3 years post construction depending on availability of existing data and sensitivity for the site.
4. MARINE MAMMALS AND BASKING SHARKS | 4.1 Cetaceans
Pre-construction baseline survey methods
Survey method

Vantage point watches: For smaller local deployments, watches from vantage points if close enough to shore and acoustic monitoring is required. The use of passive acoustic and/or echolocation loggers have proved useful to gain a better understanding of how small cetaceans use the site but are still in developmental phase. **Inshore surveys:** Line transect with distance sampling, Passive and static acoustic monitoring (especially for odontocetes). **Offshore surveys**: Line transect with distance sampling, from vessels or from the air, passive acoustic monitoring (especially for odontocetes). Static acoustic monitoring can be carried out but require more specialised equipment. BACI or BAG designs are most suitable. Visual surveys will provide distribution and relative abundance data but less likely to produce robust density and absolute abundance estimates. Static Acoustic Monitoring (SAM) can provide robust datasets for monitoring odontocete species (Harbour porpoise, dolphins) but to a lesser extent baleen whales. All SAM equipment should be calibrated to account for different sensitivities and performance of individual units. When acquiring SAM data, the size of the total area to be monitored should be calculated and stratified into defined geographical grids (grids depending on the target species), to allow for a restricted stratified random sampling design and can be altered according to the number units available to a study. The number of units deployed should ensure statistically robust data are collected. **Mortality and injuries** can be monitored at coastal sites through stranding schemes.

Time/duration/extent

Given the lack of local scale baseline data for most onshore and offshore sites around Ireland and the variability of the marine environment, three years of pre-construction data is recommended to account for strong inter-annual variability, with two years considered an absolute minimum where data is lacking. Surveys are required to cover each season and ideally monthly where possible (often constrained by unfavourable weather). Surveys should cover the impact area and a buffer zone around this area (minimum of 10 km is recommended depending on size of site).

Data/statistical analysis

Displacement and attraction can be measured using BAG or BACI analysis. Collision and entanglement cannot be measured pre-construction, however the likelihood/risk of these impacts arising can be assessed pre-construction. This assessment must take account of the behaviour of the species present in the area (informed by survey data and existing data) and the type of device being installed. SAM data should be presented % DPMs (Detection Positive Minutes) as a monitoring index over various temporal scales, taking into account total deployment time. This index can therefore be used to compare data between sites even when the number of samples (hours monitored) from different areas are unbalanced. Fine scale assessment of distribution and relative abundance using a grid over the site including a suitable buffer zone (5-10 km depending on site). Depending on the size of the farm, a 1km grid resolution is the minimum required but can be greater at larger sites. Shape files with physical (depth, slope, seabed) and oceanographic (temperature, salinity, productivity, hydrography) layers.

Practical considerations

Weather is a key factor in the success of a survey programme. For extreme sites (west coast of Ireland) it is important to factor into survey design likely data gaps (or poorer quality, e.g. lower detection with poor visibility or swell height) owing to unfavourable weather for visual surveys. Surveys covering the Autumn and Winter seasons may not be possible, or limited. Aerial surveys may be practicable for taking advantage of weather windows but are not ideal for small sites. Acoustic survey techniques are much less weather dependent especially static acoustics though the area monitored acoustically can be limited depending on detection distance for specific groups. High velocity sites add additional constraints, reducing the efficiency of visual techniques. Static acoustic monitoring methods, though spatially constrained, may be more suitable.

Post-construction monitoring methods

Post-construction monitoring should continue at a lower level (temporally and spatially) during the life of the site, to account for uncertainties in assessing impacts in this emergent field. Methods such as vantage point surveys (if site is close to land) where timed watches (at least 100 minutes) in favourable sea conditions (≤ sea state 2), is cost effective. Static acoustic monitoring (especially for odontocetes) using CPODS or underwater recording devices, which create large datasets with high resolution, is the most cost effective way of monitoring key species over long time periods. Reports of incidences (entanglements, collisions) should be ongoing for life of site. Monitoring of the use of the site by odontocetes could be achieved through Static Acoustic Monitoring (e.g. CPODS can be recovered, downloaded and re-batteried every four months). Standardised reporting procedure (compliant with statutory obligation to report to competent authority) for interactions (entanglement/collisions) to include nature of interaction to enable an investigation as to how it occurred. Incidents of entanglement of derelict fishing gear should also be included in reporting. Static acoustic monitoring data can be used to detect changes over different temporal scales and at a range of resolutions (e.g. 30% change in use of site over 5 year period). Standard GAMs and GAMMs are sufficient but Complex Region Spatial Smoother models currently considered more favourable when using surface densities to identify post-impact changes. A power analysis should be carried out using pre-construction monitoring data to identify the resolution at which change could be determined.

4. MARINE MAMMALS AND BASKING SHARKS | 4.2 Seals

Pre-construction baseline survey methods

Survey method

Vantage point surveys are useful for small, coastal sites. Surveys should be carried out in favourable sea conditions (sea state ≤3) and the duration of watch quantified as well an estimate of the distance to a sighting. Distribution and relative abundance in **inshore and offshore waters** can be recorded during line transect (both from the air and by boat) with distance sampling. **Haul out counts** during breeding and moulting seasons at or adjacent to the site (as seals can forage a long way from their haul out sites) are good indicators of local population and the likelihood of interactions. A system to report **entanglement or collision** incidences during life of farm is necessary.

Time/duration/extent

Given the lack of local scale baseline data on habitat use by seals for most onshore and offshore sites around Ireland and the variability of the marine environment, three years of pre-construction data is the recommended required to allow meaningful post construction monitoring, with two years considered an absolute minimum where data is lacking. Visual surveys are required to cover each season and can be carried out coincident with cetacean surveys. Telemetry studies indicating site use are ideal but expensive and not always practicable. Surveys should cover the impact area and a buffer zone around this area (a minimum of 10 km is recommended depending on site). Haul out site surveys should be at least monthly throughout the year and weekly if practicable, during pupping and moulting seasons if they occur.

Data/statistical analysis

Displacement and attraction can be measured using BAG or BACI analysis. Collision, entanglement and entrapment cannot be measured pre-construction. The likelihood of these impacts arising can be assessed pre-construction. This assessment must take account of the behaviour of the species present in the area (informed by survey data and existing data) and the type of device being installed

Practical considerations

Weather is a key factor in the success of a survey programme. For extreme sites (west coast of Ireland) it is important to factor into survey design likely data gaps (or poorer quality e.g. lower detection rate with poor visibility or swell height) owing to unfavourable weather. Aerial surveys may be practicable but are not ideal for small sites but useful during pupping seasons with infrared. Surveys covering the autumn and winter season may not be possible, or coverage may be limited. Haul out behaviour can also be influenced by environmental factors.

Post-construction monitoring methods

Post-construction monitoring should continue at a lower level (temporally and spatially) during the life of the site, to account for uncertainties in assessing impacts in this emergent field. Vantage point surveys (if site is close to land) and monitoring of local haul out sites are most cost effective methods. Reporting procedure (compliant with statutory obligation to report to competent authority) to include nature of interaction (entanglement/collision) to enable an investigation as to how it occurred. Incidents of entanglement of derelict fishing gear should also be included in reporting. Standard GAMs and GAMMs can be sufficient but Complex Region Spatial Smoother models currently considered more favorable to identify post-impact changes using surface densities. Power analysis approach should be used to quantify the probability that a genuine impact effect can be detected.

Survey Methodology: Summary of pre-construction and post-construction survey methods (continued)

4. MARINE MAMMALS AND BASKING SHARKS | 4.3 Basking sharks
Pre - construction baseline survey methods
Survey method **Vantage point surveys** are useful for small, coastal sites. Surveys should be carried out in favourable sea conditions (sea state ≤1) and the duration of watch quantified. **At sea surveys** along line transects coincident with marine mammal surveys with distance sampling. A system to **report interactions** (entanglement/collision) during life of farm.
Time/duration/extent Given the lack of local scale baseline data for basking sharks around Ireland and the variability of the marine environment, three years of pre-construction data is the recommended required to allow meaningful post construction monitoring, with two years considered an absolute minimum where data is lacking. Surveys are required to cover spring and early summer which is the peak time for surfacing basking sharks. Realistically, surveys for basking sharks will be incidental and concurrent with those for marine mammals.
Data/Statistical analysis Displacement and attraction can be measured using BAG or BACI analysis. Collision, entanglement and entrapment cannot be measured pre-construction. The likelihood of these impacts arising can be assessed pre-construction. This assessment must take account of their behaviour in the area (informed by survey data and existing data) and the type of device being installed. The large variability and uncertainty of shark abundance at the surface constrains the ability to detect significant changes using visual data. Telemetry data may provide a more robust dataset to assess the use of an area by basking sharks.
Practical considerations Weather is a key factor in the success of a survey programme. For extreme sites (west coast of Ireland) it is important to factor into survey design likely data gaps owing to unfavourable weather. Surveys covering the autumn and winter season may not be possible, or coverage may be limited.
Post-construction monitoring methods
Vantage point surveys (if site is close to land), and at sea surveys pre-determined transects using distance sampling if being carried out for marine mammals. Reporting procedure (compliant with statutory obligation to report to competent authority) to include nature of interaction (entanglement/collision) to enable an investigation as to how it occurred. Incidents of entanglement of derelict fishing gear should also be included in reporting. Ongoing for life of farm.

5. COASTAL PROCESSES | 5.1 Coastal erosion
Pre - construction baseline survey methods
Survey Method Baseline surveys should determine the physical characteristics of the site through bathymetric survey, wave height data collection/analysis, tidal current data collection/analysis and sediment processes. Mathematical modelling used to predict changes to wave climate and sedimentation processes. Repeat dGPS surveying and terrestrial LiDAR surveys for accurate coastal profile. Generation of 3D computer models of the coastline and volumetric change calculation over time. Determination of current erosion rate through comparison of vegetation line change over time on satellite/aerial imagery if LiDAR unavailable.
Time/duration/extent Pre- construction baseline survey for coastal processes should use available historic data and determine where new data should be acquired. Generally any new data collection should be acquired over a 12 month period prior to construction.
Data/statistical analysis Standard modelling approaches.
Practical considerations Data gaps are normally considerable for coastal process related to specific areas.
Post-construction monitoring methods
The provision of dedicated surveys will be dependent on the nature of the site and should be developed on a case by case basis.

6. CULTURAL HERITAGE | 6.1 Shipwrecks and associated remains
Pre - construction baseline survey methods
Survey method Prior to field based survey a desk based study should be undertaken to identify potential archaeological sites and known sites within the project area and characterise the general historic environment of the area. Baseline surveys should identify all known and potential shipwrecks and associated artefacts in the area. Bathymetric sides can sonar to identify potential shipwrecks/artefacts with ground truthing by diver or ROV. Mapping of potential sub surface wrecks/artefacts from geophysical survey. Sonar survey should be conducted to resolve all objects that have relief of more than 0.5m above the sea bed in the survey area. Magnetometer survey should be capable of resolving anomalies 5 Nano Teslas and above.
Time/duration/extent As informed by desk study.
Data/statistical analysis N/A
Practical considerations Exposed offshore sites will require planning. For example, problems associated with operating towed magnetometer in exposed areas during periods of heavy swell and high winds and conducting dive surveys when weather conditions are unsuitable.
Post-construction monitoring methods
The provision of dedicated surveys will be dependent on the nature of the site and should be developed on a case by case basis.

6. CULTURAL HERITAGE | 6.2 Coastal Archaeology and Cultural Heritage
Pre-construction baseline survey methods
Survey method Prior to field based survey a desk based study should be undertaken to identify potential archaeological and cultural sites and known sites within the project area and characterise the general historic environment of the area. Field surveys should verify desk studies and further assess the environment for the presence of significant heritage sites. Geophysical/geotechnical survey to identify potential areas of interest may be required. Boreholes/vibrocores of sediment horizons identified to be of archaeological interest may potentially be required.
Time/duration/extent As informed by desk study.
Data/statistical analysis: N/A
Practical considerations Littoral/coastal based survey should be possible at any time of the year.
Post-construction monitoring methods

The provision of dedicated surveys will be dependent on the nature of the site and should be developed on a case by case basis.
7. FISHERIES | 7.1 Commercial fisheries NON COMMERCIAL FISHERIES
Pre-construction baseline survey methods
Survey method Define fisheries within area through liaison with local fishery officers and Bord Iascaigh Mhara. Examine available stock/cpue data or conduct trawl/acoustic surveys to identify species present at the site if data is not available from other sources. It is recommended that the advice of the Marine Institute Fisheries Ecosystems Advisory Services (FEAS) is sought on suitable survey methods for the assessment of potential stock in the vicinity of localised renewable energy developments as it is unlikely that stand alone surveys will be capable of gathering sufficient data to measure change.
Time/duration/extent There is likely to be large temporal variation in fish species present and this must be accounted for.
Data/statistical analysis A wide variety of recognised models and statistical methods to assess fish stocks are available. These are generally based on either simple holistic methods or more complex statistical methods. It is recommended that, for localised developments, such as offshore renewable energy developments, the advice of the Marine Institute Fisheries Ecosystems Advisory Services (FEAS) is sought on a project by project basis.
Practical considerations The ephemeral nature of commercial fish species makes accurate survey predictions extremely difficult. Changes to the stock levels are likely to be related to a range external factors and these will be difficult to predict.
Post-construction monitoring methods
Use of ROV/diver survey for fish aggregation around surface/subsea structures.

Survey Methodology: Summary of pre-construction and post-construction survey methods (continued)

7. FISHERIES | 7.2 Shell-fish fisheries
Pre-construction baseline survey methods
Survey method Define shell-fish fisheries within the area. Examine available stock/cpue data
Time/duration/extent There may be temporal variance in species present. For examples some species such as brown crab, (*Cancer pagurus*) and shrimp (*Paelemon serratus*) among others, undergo migration.
Data/statistical analysis Species abundance assessments.
Practical considerations Surveys should take place to account for season migration of shellfish species. Monitoring of privately owned aquaculture installations will not be possible. Owners monitor their stock on a regular basis.
Post-construction monitoring methods
Use of ROV/diver survey for increased shellfish numbers around subsea structures.

5.2 Monitoring methodology: Summary of potential pressures, impacts and indicators

	POTENTIAL PRESSURES	LIKELY NEGATIVE IMPACTS	INDICATORS FOR IDENTIFIED IMPACT
1. BENTHOS | **1.1 Subtidal reef**	Installation of certain types of WECS with the potential for shading reef habitat. Drilling of rock habitats for device installation of anchor points. The placement of rock armour and mattressing over existing reef (e.g. cobble reef). Spillage/leaking of oil or fuel from construction vessels and devices. Scouring due to the placement of subsea structures.	Damage or mortality to species. Direct habitat loss, habitat fragmentation, changes to community structure and function, occurrence and/or increase in Invasive alien species, creation of artificial reef effect. Smothering of habitats and species as a result of sediment mobilisation and scouring both during construction and operation. Abrasion/mortality to sensitive species.	Reduction in habitat area. Reduction of key characterising species. Change to species composition. Occurrence and/or increase in Invasive Alien Species.
1. BENTHOS | **1.2 Subtidal sediments**	Installation of anchors on sensitive subtidal sediments (e.g. maërl and eelgrass). The placement of rock armour and/or mattressing over sediment habitats. Trenching and ploughing for the installation of cables. Scouring due to the placement of subsea structures.	Direct habitat and species loss, habitat fragmentation, changes to community structure and function, occurrence and/or increase in invasive alien species. Smothering of habitats and species as a result of sediment mobilisation both during construction and operation. Abrasion/mortality to sensitive species.	Reduction in habitat area. Reduction of key characterising species. Change to species composition. Occurrence and/or increase in Invasive Alien Species.
2. LITTORAL HABITATS | **2.1 Intertidal reef**	Directional drilling and/or the burial of cables and pipes with boulder material (rock armour) over existing hard substrates. The use of bentonite in the drilling fluid. The placement of wind turbines and their associated infrastructure on areas of intertidal reef. Construction traffic on intertidal reef areas. Spillage of oil or fuel from construction vehicles.	Direct habitat and species loss, habitat fragmentation, changes to community structure and function, occurrence and/or increase in invasive alien species.	Reduction in habitat area. Reduction of key characterising species. Change to species composition. Occurrence and/or increase in Invasive Alien Species.
2. LITTORAL HABITATS | **2.2 Intertidal sediment**	The placement of rock armour and/or mattressing over sensitive intertidal sediment habitats. Trenching and ploughing for the installation of cables. Spillage of oil or fuel from construction vehicles. Movement of construction traffic over intertidal sediments.	Direct habitat and species loss, habitat fragmentation, changes to community structure and function, occurrence and/or increase in invasive alien species. Compaction of sediment leading to habitat damage and species loss.	Reduction in habitat area. Reduction of key characterising species. Change to species composition. Occurrence and/or increase in Invasive Alien Species.
3. BIRDS | **3.1 Birds (Construction and operation)**	The construction and operation of MREI's. The presence, movement and activity of construction vessels.	Direct impacts are: Disturbance, displacement, attraction, collision (above and below water), entrapment and barrier effects. Indirect impacts are changes in sedimentary process, pollution, predation (use of devices as land bridges by predators) and displaced fishing effort with implications for foraging resources (positive and negative).	Regional effects may be determined by changes in the: composition of species present, their abundance, density and spatial distribution and by changes in patterns of temporal abundance (season, tide, time of day), habitat use (surface, mid water, seabed, air space) and changes in use of particular habitat features (e.g. shallows, tidal race). Local effects include be micro avoidance, injury or mortality. Where disturbance to breeding sites occurs, productivity may be affected.
3. BIRDS | **3.2 Birds (Cable laying)**	The presence, movement and activity of construction vessels.	Temporary disturbance	Displacement
4. MARINE MAMMALS AND BASKING SHARKS | **4.1 Cetaceans**	The construction and operation of MREI's. The presence, movement and activity of construction vessels.	**Direct impacts:** disturbance (noise, physical structure), collision, entanglement, displacement (physical obtrusion, acoustic stressor). Collision risk is considered highest for tidal devices. **Indirect impacts:** changes in food resources due to sedimentary and oceanographic processes or displaced fishing effort or through acting as a "fish aggregating device" with implications for foraging. Marine pollution events.	Changes in the abundance and distribution of individuals (and to a lesser extent their behaviour within and adjacent to the site) and can be considered in terms of attraction and displacement. Changes which are greater than "normal (baseline)" diel, tidal or daily changes are useful indicators. Local effects include collision and/or entanglement (which may cause mortality or injury) and

			displacement events. All records of interactions are indicators.
4. MARINE MAMMALS AND BASKING SHARKS | **4.2. Seals**	The construction and operation of MREI's. The presence, movement and activity of construction vessels.	**Direct impacts**: Disturbance (noise, physical structure), collision, entanglement, displacement. Indirect impacts are changes in in food resources due to sedimentary and oceanographic processes, and displaced fishing effort or through acting as a 'fish aggregating device' with implications for foraging. Where devices result in impacts, this may cause displacement or attraction of seals to a site, mortality or injury or changes in foraging resources with implications for breeding success. Risk of entanglement is considered very low and not significant but is considered to increase if derelict fishing gear is entangled. Collision risk is considered highest for tidal devices.	Regional effects: Changes in the abundance and distribution of individuals (including local haul out sites) considered in terms of attraction and displacement. Local effects: collision, entanglement and entrapment.
4. MARINE MAMMALS AND BASKING SHARKS | **4.3. Basking sharks**	The construction and operation of MREI's. The presence, movement and activity of construction vessels.	**Direct impacts**: Disturbance, collision, entanglement, displacement. There is currently no existing data on whether elasmobranchs could be affected by sound exposure however barotrauma as a result of the impulsive energy, is a possibility. **Indirect impacts**: Changes in sedimentary and oceanographic processes, resulting in changes in food resources with implications for foraging. The impact of any increase in suspended sediment on zooplankton at the development site be modelled and the potential impact re-assessed in light of such outputs. Where devices result in impacts, this may cause displacement of sharks to a site, mortality or injury or changes in foraging with implications for breeding success. Risk of entanglement is considered very low and not significant. It is suggested basking sharks use electroreception to find food patches.	Regionals effects: Changes in the abundance and distribution of individuals and can be considered in terms of displacement. Local effects could be collisions, entanglement and entrapment.
5. COASTAL PROCESSES | **5.1 Coastal erosion**	The construction and presence of MREI's.	**Wave Energy Devices,** depending on the scale of arrays, have the potential to alter tidal streams, currents, wave heights, sedimentation processes, and lead to coastal accretion and erosion. **Tidal devices** have the potential to reduce tidal current speeds locally and alter sedimentation processes both near and far field, and lead to coastal accretion and erosion. **Offshore wind turbines** are considered to have negligible impact on coastal processes due to the small effect the foundations have on tidal currents and sedimentation processes.	Change to erosion/accretion rates and topography of shore and/or seabed. Loss of/or change to landforms. Disturbance to or loss of habitats, species and landforms.
6. CULTURAL HERITAGE | **6.1 Shipwrecks and associated remains**	The construction and presence of MREI's.	The placement of renewable energy devices on, or in close proximity to, shipwrecks and their associated remains. Trenching and ploughing of the seabed. Positioning of anchors. Rock armouring and matressing. Tidal devices have the potential to alter tidal low and sediment deposition creating the potential for unearthing and damaging both recorded/unrecorded shipwrecks and their context.	Direct damage/destruction, exposure of known/unknown historical artefacts due to alteration of tides, currents, and sedimentation regimes and a combination of these effects leading to alteration of context of shipwrecks and associated artefacts.
6. CULTURAL HERITAGE | **6.2 Coastal archaeology and cultural heritage**	The construction and presence of MREI's.	The placement of renewable energy devices on, or in close proximity, to sites of archaeological or cultural importance. Trenching and ploughing of coastal environments. Rock armouring and matressing. **Tidal devices** have the potential to alter coastal processes and create the potential to damage both recorded/unrecorded coastal archaeological and cultural sites and their context.	Direct damage/destruction. Exposure of known/ unknown historical artefacts due to alteration of tides, currents, and sediment regimes and a combination of these effects. Impact may be considered positive.
7. FISHERIES | **7.1 Commercial Fisheries**	Presence and operation of MREI's. Spillage of oil or fuel from construction vessels.	**Direct impacts**: Alteration of species present due to habitat loss or change associated with offshore energy development and their infrastructure. Potential for creating fish Aggregation Devices (FAD's). Collision causing mortality (tidal stream devices). Creation of "exclusion zones" with the potential for reducing access to traditional fishing grounds. Mortality of commercially important fish larvae due to pollution. **Indirect impacts**: Reduced trawling effort in area potentially benefiting other fisheries. Negative impact to juvenile/larval stages of fish species. Salmonids and eels may have sensitivity to EMF with potential to increase mortality of migrating juveniles.	Increase/decrease catch per unit effort or stock of target fish species. Increase in fish species number within area of artificial reef created by development. Potential increase in biomass of certain target species. Certain species may be attracted to surface devices and subsurface infrastructure causing aggregation. Fish kills (associated with tidal stream devices).

7. FISHERIES | **7.2 Shell-fish fisheries**	Presence and operation of MREI's. Spillage of oil or fuel from construction vessels.	**Direct impacts:** Habitat loss and fragmentation. Creation of artificial reef effects. Pollution. Increase in sedimentation associated with construction. Creation of "exclusion zones". Indirect impacts: Potential to alter species present due to changes to coastal processes, tidal streams/currents and sedimentation rates.	Increase/decrease catch per unit effort or stock of target shell-fish species. Variation of mooring and armouring design can enhance target species numbers. Potential to alter species present due to habitat loss or change associated with offshore energy development and their infrastructure. Mortality and community change.