Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

Guidance on Survey and Monitoring in Relation to Marine Renewables Deployments in Scotland
Volume 1: Context and General Principals

This report was produced by **Royal Haskoning** on behalf of Scottish Natural Heritage (SNH) and Marine Scotland (MS) and provides context and guidance on the need for and conduct of site characterisation surveys and impact monitoring programmes for marine (wave and tidal) renewables developments in Scotland. Four accompanying volumes are also available, focusing on survey and monitoring techniques relating to:

- Vol 2. Cetaceans and Basking Sharks
- Vol 3. Seals
- Vol 4. Birds
- Vol 5. Benthic Habitats

At present, the contents of all five reports should be regarded as recommendations to SNH and MS but not as formal SNH or MS guidance. It is the intention of both organisations to prepare a separate, short overview of the documents offering additional guidance on SNH and Marine Scotland's preferred approach to key issues such as survey effort, site characterisation and links to Scottish Government's Survey, Deploy and Monitor policy.

To assist in the preparation of this guidance note, the views of developers, consultants and others involved in the marine renewables sector are sought on the content of this and the accompanying reports. Specifically we would welcome feedback on:

A. The format and structure of the current reports
B. Changes that should be considered
C. Key issues that you would wish to see incorporated within the guidance note.

Feedback should be provided by e-mail to SNH (marinerenewables@snh.gov.uk) by 31 October 2011, marked 'Marine Renewables Guidance Feedback'.

It is hoped that developers and their advisers will find these documents to be a useful resource for planning and delivery of site characterisation surveys and impact monitoring programmes. They may be cited, but any such reference must refer to the draft status of the report concerned and to its specific authors. For this report (Volume 1), the appropriate citation is: **Trendall, J.R., Fortune, F. and Bedford, G.S. (2011).** ***Guidance on survey and monitoring in relation to marine renewables deployments in Scotland. Volume 1. Context and General Principals*****. Unpublished draft report to Scottish Natural Heritage and Marine Scotland**.

Queries regarding this guidance should be addressed to:
marinerenewables@snh.gov.uk

CONSULTATION DRAFT

Guidance on survey and monitoring in relation to marine renewables deployments in Scotland.

Vol 1. Context and General Principals.

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Trendall, J.R., Fortune, F. and Bedford, G.S. (2011). *Guidance on survey and monitoring in relation to marine renewables deployments in Scotland. Volume 1. Context and General Principals*. Unpublished draft report to Scottish Natural Heritage and Marine Scotland.

COMMISSIONED REPORT

Summary

Guidance on survey and monitoring in relation to marine renewables deployments in Scotland

Commissioned Report No. [To be added on report publication]

Contractor: Royal Haskoning

Year of publication: 2011

Background

It has been estimated that Scotland possesses 25% of Europe's tidal power, and 10% of Europe's wave power resources. The Scottish Government has set a renewable energy target of 80% of Scottish electricity demand to be met by renewables by 2020 and it is estimated that one fifth of this supply could come from marine (wave and tidal stream) resources. In order to meet the ambitious target, rapid progress needs to be made in the understanding not only of the latest technologies but also of their likely impacts on the environment.

This guidance has been produced to aid and inform developers, their consultants, and regulators as to the planning and execution of survey and monitoring for key natural heritage receptors. The guidance for survey and monitoring of the following features is provided in this five volume document:

- Overview, approach and generic advice (Volume I);
- Cetaceans and basking sharks (Volume II);
- Seals (Volume III);
- Marine birds (Volume IV); and
- Benthic habitats and species (Volume V).

Main findings

For each interest feature, advice and discussion is provided on the following:

- Legislation and regulations driving the need for survey and monitoring;
- Sources of further information;
- Establishment of an appropriate pre-development baseline for the development area when considering the habitats and species present;
- The potential impacts of all stages of the development on the natural heritage interests (habitats and species) present;
- Collection of pre development survey and monitoring data sufficiently robust to support assessment of the proposed development. In some circumstances these data may also be used support post development impact monitoring.

Glossary of selected terms

Annex I habitats	Habitats under the 'Habitats Directive' which require assessment of the conservation status
Connectivity	1) The degree to which discrete populations of animals interact with each other; 2) The degree of movement between and utilisation of different areas or resources by a population; 3) A process or pathway by which a development or activity might affect a designated site or qualifying feature.
Establishment of monitoring baseline	The collection of data sufficient to support initial characterisation of a site, but also in some circumstances to form the baseline data for ongoing monitoring for change.
Floating attenuator	Wave energy device which moves in parallel to the wave direction
Horizontal axis turbine with exposed blades	Tidal device akin in shape to a horizontal axis wind turbine, with the axis of rotation horizontal and the blades of the turbine rotating around that axis
Monitoring	The ongoing and periodic collection of data with the purpose of answering one or more questions identified during the assessment (EIA, AA) process
Point absorber	Floating structure which absorbs energy from all directions through its movements at/near the water surface
Seabed mounted oscillating waver surge convertor	Wave device with pendulum mounted on a pivoted joint which oscillates with wave movements

Site characterisation	The establishment of an appropriate level of information regarding species and habitats and their distribution within a site to allow assessment of potential impacts due to the proposed development, to satisfy requirements of licensing.
Site integrity	The coherence of a site's ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified or designated. Particularly used in the UK in relation to Natura 2000 sites.

Selected acronyms

AA	Appropriate Assessment
BACI	Before After Control Impact
BAG	Before After Gradient
COWRIE	Collaborative Offshore Wind Research into The Environment
CPA	Coast Protection Act
EIA	Environmental Impact Assessment
EPS	European Protected Species
EU	European Union
FCS	Favourable Condition Status
FEPA	Food and Environment Protection Act
HRA	Habitats Regulations Appraisal
IROPI	Imperative Reason of Over-riding Public Interest
MSLOT	Marine Scotland Licensing Operations Team
RSPB	Royal Society for Protection of Birds
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SIC	Shetland Island Council
SNH	Scottish Natural Heritage
SPA	Special Protection Area
UKBAP	United Kingdom Biodiversity Action Plan

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1 INTRODUCTION

1.1 Context of Guidance

It has been estimated that Scotland possesses 25% of Europe's tidal power, and 10% of Europe's wave power resources. The Scottish Government has set a renewable energy target of 80% of Scottish electricity demand to be met by renewables by 2020 and it is estimated that one fifth of this supply could come from marine (wave and tidal stream) resources. In order to meet the ambitious target, rapid progress needs to be made in the understanding not only of the latest technologies but also of their likely impacts on the environment. Development of this understanding is strongly supported by Scottish Natural Heritage (SNH) and the Scottish Government.

Recent reports, such as Scotland's marine renewable energy Strategic Environmental Assessment (SEA) (Faber Maunsel and Metoc, 2008[1]) and the Strategic Research Assessment of wave and tidal devices (FRS, 2008) aim to meet statutory requirements and provide guidance in relation to stakeholders, including licensing authorities and developers. These reports highlight the lack of understanding in relation to impacts of wave and tidal devices on marine biodiversity including marine mammals, seabirds, migratory birds, fish and benthic ecology. Building upon these findings, SNH and Scottish Government identified a need to establish appropriate 'baseline' conditions for potential development sites if the following potential regulatory requirements were to be undertaken at an appropriate level:

Environmental Impact Assessment of the project;

Habitats Regulation Appraisal, including Appropriate Assessment (AA)

Post installation monitoring measurement of future environmental changes at the site.

In most locations, existing information on benthic habitats and marine wildlife is unlikely to be sufficiently detailed to inform such assessments and site (and project) specific field surveys will be required, to support applications for consent to develop.By their nature, wave and tidal power technologies are distinct from other forms of marine development, not least because they are designed to be deployed in, and generate power from, high energy environments. Although marine monitoring guidance already exists for various marine activities as well as natural heritage interests, for example guidance available from

[1] Scottish Marine Renewables Strategic Environmental Assessment Environmental Report. Available from: http://www.seaenergyscotland.net/SEA_Public_Environmental_Report.htm

COWRIE, the novel nature of wave and tidal devices means that their potential interactions with the marine environment may be very different from those associated with more established types of development. This report seeks to develop and draft survey and monitoring guidance sufficient to enable developers of wave and tidal turbines to establish the base line conditions of a site with respect to four key natural heritage interests (see Section 1.2), and support developers and regulators in ascertaining the nature and significance of potential impacts in a manner which is scientifically robust.

The designs and technologies currently under development and undertaking early deployment in Scottish waters span a wide spectrum of designs. For the purpose of this guidance, three generic device types are considered:

Wave devices:

1) A floating attenuator or point absorber
2) A seabed mounted oscillating waver surge convertor

Tidal device:

3) A horizontal axis turbine with exposed blades.

Details of these devices are provided in Table 1.1.

1.2 Aims of Guidance

Each potential wet renewables development site will have unique characteristics, while the devices deployed at those sites will have both generic and specific impacts associated with them. For this reason, this guidance cannot be prescriptive and expert input to site-specific survey and monitoring requirements and design will be essential if they are to be relevant to the location, scale of development and technologies being considered for any specific scheme.

The guidance for survey and monitoring of the following features is provided in this volume and a series of additional supporting volumes:

- Overview, approach and generic advice (Volume I) – this document;
- Cetaceans and basking sharks (Volume II);
- Seals (Volume III);
- Marine birds (Volume IV); and

- Benthic habitats and species (Volume V).

The original scope for this study requested the development of advice for a notional demonstration array size of 10-20 devices, with further consideration to be given to the scaling up or down of the advice regarding methods for larger or smaller arrays. However during the development of the guidance, it has become apparent that the general principles applied to the survey and monitoring of the sites and the suite of methods available remain largely constant, with only limited changes in terms of a notional scale of the array in terms of number of devices.

For each interest feature, identification is made of the potential impacts anticipated during construction, operation and decommissioning of a wave or tidal energy array. Advice is provided on the following:

- Establishment of an appropriate pre-development baseline for the development area when considering the habitats and species present;
- The potential impacts of all stages of the development on the natural heritage interests (habitats and species) present;
- Collection of pre development survey and monitoring data sufficiently robust to support assessment of the proposed development. In some circumstances these data may also be used support post development impact monitoring.

For each interest feature, knowledge / data gaps and uncertainties are identified, as is the potential for developers to align surveys between interest features, and collaboration with other nearby developments.

This guidance considers device characteristics applicable to a range of device types, both near shore (shallow water approximately 10m depth) and offshore, to a maximum of 70m.

1.3 Restrictions to this guidance

This guidance does not consider:

- Survey and monitoring of fish species;
- Tidal barrages, tidal lagoons or offshore wind farms;
- Construction of onshore infrastructure relating to offshore wave and tidal devices (including associated survey and monitoring of birds)

- Impacts associated with cable routing, and
- The maritime access route for device installation, maintenance or decommissioning.

1.4 Introduction to wave and tidal devices and their environmental requirements

Table 1.1, below, identifies the physical aspects and environmental conditions required for each generic device type considered.

Table 1.1 Generic tidal and wave devices

Technology	Industry Examples	Physical Aspects of Device	Environmental conditions
Wave Devices			
Floating attenuator or point absorber	Pelamis (Pelamis Wave Power Ltd); Wave Swing (Archimedes) PowerBuoy (Ocean Power Technology);	Tethered to the seabed via anchors or pile mounted methods with flexible or rigid mooring	An attenuator is a floating device which works parallel to the wave direction. Movements along its length can be selectively constrained to produce energy2. A point absorber is a floating structure which absorbs energy in all directions through its movements at/near the water surface. Devices are deployed offshore (typically 1-10 km) in water depths generally ranging from 30-70m (device specific).
Seabed mounted oscillating wave surge converter	Oyster (Aquamarine Power Ltd)	Attached to the seabed via gravity base or piling.	Extracts the energy from wave surges and the movement of water particles within them. The arm oscillates as a pendulum mounted on a pivoted joint in response to the movement of water in the waves3 . Devices are situated in near shore environments, in depths of around 15m.
Tidal Devices			
	SeaGen (Marine Current Turbines	Attached to the seabed via	Extract energy from moving water

[2] Information available from http://www.emec.org.uk/wave_energy_devices.asp
[3] Information available from: http://www.emec.org.uk/tidal_devices.asp

Technology	Industry Examples	Physical Aspects of Device	Environmental conditions
Wave Devices			
Floating attenuator or point absorber	Pelamis (Pelamis Wave Power Ltd); Wave Swing (Archimedes) PowerBuoy (Ocean Power Technology);	Tethered to the seabed via anchors or pile mounted methods with flexible or rigid mooring	An attenuator is a floating device which works parallel to the wave direction. Movements along its length can be selectively constrained to produce energy2. A point absorber is a floating structure which absorbs energy in all directions through its movements at/near the water surface. Devices are deployed offshore (typically 1-10 km) in water depths generally ranging from 30-70m (device specific).
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Horizontal axis turbine with exposed blades	Ltd); HS 1000 (Hammerfest Strom UK Ltd) Deltastream (Tidal	gravity base or piling.	akin to onshore wind farms. They can be located near to shore or offshore, in depths of up to approximately 60m (device dependant). Require deployment in areas of tidal velocity, typically

Technology	Industry Examples	Physical Aspects of Device	Environmental conditions
Wave Devices			
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	Energy Ltd) AK-1000 (Atlantis Resources Corporation) TidEL Tidal		sounds, narrows, or headlands.

Technology	Industry Examples	Physical Aspects of Device	Environmental conditions
Wave Devices			
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	Turbines Deep-Gen (Tidal Generation Limited)		

2 LEGISLATION DRIVING THE NEED FOR MONITORING

Legislation affords protection to marine mammals, basking sharks and birds as well as benthic habitats and species.

Statutory drivers for undertaking monitoring include:

- National and international Environmental Impact Assessment (EIA) legislation;
- National and international conservation legislation and agreements; and
- Environmental liability legislation.

The statutory processes driving the requirement for collection of baseline and monitoring data are Environmental Impact Assessment (EIA) and Appropriate Assessment (AA), details of which are provided below.

An EIA will be required for all marine renewable energy developments >1MW in generating capacity; however an Appropriate Assessment will only be required where potential for "likely significant effect" on a qualifying interest of a Natura 2000 site is identified. It is important to note that an AA could be required even where no formal EIA is considered necessary, to inform provision of other consents required, such as a Marine Licence. Guidance on definitions of "likely significant effect" and its implications for consenting are provided in Section 3.1.

Key aspects of EIA and AA, and responsibilities associated with them are summarised in Table 2.1 below.

Table 2.1. Aspects of assessment under EIA and AA, for marine renewables developments, as well as responsibility

Aspect of assessment considered	Environmental Impact Assessment	Appropriate Assessment
Responsibility	Developer	Competent Authority (Marine Scotland).
Data for assessment	Existing data compiled and first party data collected to support EIA. Responsibility of developer.	Information (additional) to support AA normally provided as part of EIA process by developer, at request of competent authority.
Response to negative assessment	Conclusions are not binding on competent authority in reaching decisions on consenting.	Competent authority should not agree to the proposal unless specific exceptional circumstances are met.
Granting of consent	Regulator has ability to reach its own conclusions, although the advice gained from the EIA should be a major factor in determination of application.	A development should not be given consent unless it can be ascertained that it will not adversely affect the integrity of any Natura 2000 site.

2.1 Environmental Impact Assessment

Comprehensive guidance on the Environmental Impact Assessment (EIA) process, as it relates to marine renewables consenting in Scotland, is set out in Marine Scotland's *Marine*

Renewables Licensing Manual (Marine Scotland, 2011[4]), to which reference should be made. The main aspects of the process are as follows.

The key driver for undertaking assessment and monitoring works is the requirement for Environmental Impact Assessment (EIA) in support of licensing under Section 36 of the Electricity Act 1989, required for any proposed arrays with potential installed capacity of >1MW. An application for a Marine Licence under the Marine (Scotland) Act, 2010, will also be required after April 2011 for all installations, regardless of their proposed installed capacity.

The major stages of the EIA are identified in Table 2.2. The stages of direct relevance to environmental monitoring are highlighted in blue.

[4] Marine Renewables Licencing Manual: Available from http://www.scotland.gov.uk/Topics/marine/Licensing/marine/LicensingManual

Table 2.2 Stages of the Environmental Impact Assessment process.

Stage	Task	Aim/objective	Work/output (examples)	Public Participation and Consultation
	Scoping study	To identify the potentially significant direct and indirect impacts of the proposed development	Targets for specialist studies (e.g. hydrodynamic studies, sediment quality)	Public participation is an important part of the planning process, in particular at the EIA and pre-application stages. Preliminary consultation with key consultees is considered important for setting the framework for consent. Consultation with statutory and non-statutory organisations and individuals with an interest in the area and the proposed development throughout the EIA process is likely to be regulated by the new consenting regime.
	Secondary data collection	To characterise the existing environment	Background data including existing literature and specialist studies	
	Primary data collection - specialist studies	To further investigate those environmental parameters which may be subject to potentially significant effects	Specialist reports	
	Impact assessment	To evaluate the existing environment, in terms of sensitivity To evaluate and predict the magnitude of impact on the existing environment To assess the significance of the predicted impacts	Series of significant adverse and beneficial impacts	
	Mitigation measures	To identify appropriate and practicable mitigation measures and enhancement measures	The provision of solutions to minimise adverse impacts as far as possible. Feedback into the design process, as applicable	
	Environmental Statement	Production of the Environmental Statement in accordance with EIA guidance Including a Non Technical Summary (NTS).	Environmental Statement Four main volumes: • NTS • Written statement • Appendices • Figures	
	Pre-Application Consultation	Advertising of application for licensing must occur at least 12 weeks prior to submission of joint s36 Application	Joint s36 / Marine Licence Application (if applicable)	
	Post submission	Liaison and consultation to resolve matters or representations/objections	Addendum to ES	
Consenting / Licensing Decision				

The EIA process will provide an assessment of the following (SNH, 2009):

- Features at risk (including species and habitats);
- Processes of environmental change;
- Exposure to environmental change;
- Sensitivities of particular features to environmental change;
- Vulnerabilities of a feature to environmental change; and
- Significance of the impact.

Collection of appropriate data to allow characterisation of the site in terms of presence, nature and extent of potential receptors is a key part of the EIA process. The type of data for characterisation and the way in which they are collected will generally be determined during EIA scoping and associated consultation with the regulator and statutory advisors. Post EIA, a condition of granting consent may be the monitoring of features considered to be potentially at risk from the development and for this reason, a pragmatic decision may be required when collecting characterisation data to ensure that those data are also sufficient to potentially form a monitoring baseline.

The key elements of legislation relating to the EIA and project consenting process, with potential, to influence survey and monitoring requirements for a project are summarised in Table 2.3, below

Note: This is not a comprehensive list of legislation that will apply to wave and tidal renewables developments in Scotland. Each project will require individual consideration and this list is provided as contextual framework for the monitoring discussed in Volumes II to V of this guidance.

A Scoping Study should identify data and monitoring requirements for the consenting process. However, if additional potentially significant effects are identified during the later EIA process, the design of the project and monitoring may need to be adjusted and relevant mitigation measures proposed.

EIA is the key mechanism to ensure that projects are developed only when environmental impacts have been removed or mitigated to acceptable levels. To assess impacts appropriately, data collection and modelling must be undertaken appropriately and the guidance presented here is designed to help satisfy these requirements.

Table 2.3 Key EIA and related legislation and its relevance to wave and tidal projects

Legislation	Regulator	Relevance to wave and tidal development.	Notes
Environmental Impact Assessment (EIA) Directive 1985 (European Union Council Directive 85/337/EEC, amended by Directive 97/11/EEC)	The competent authority in terms of the Directive is Marine Scotland.	Aim is to ensure that the authority giving the primary consent (the 'competent authority') for a particular project makes its decision in the knowledge of any likely significant effects on the environment. This legislation is a key driver for collection of survey and monitoring data. Applies to marine renewable developments exceeding 1MW in generating capacity. For smaller schemes formal EIA may not be required.	Requirements of the Directive are set out in the draft *Marine Renewables Licensing Manual*. A number of legislative instruments implement the requirements of the Directive.
The Marine Works (EIA) Regulations 2007	Marine Scotland	Regulations apply to works that require deposit of material in the sea. Such 'deposits' in the form of foundations or anchors are required by all device types considered.	One of the statutory instruments that implements requirements of the Environmental Impact Assessment (EIA) Directive 1985.

Legislation	Regulator	Relevance to wave and tidal development.	Notes
Electricity Act 1989[5],	Marine Scotland	Under Section 36 of the Electricity Act 1989 consent is required from Scottish Ministers for the construction, extension and operation of a wave or tidal power generating station with a capacity exceeding1 MW.	Ministers are prohibited from granting consent for an EIA development without taking into account an Environmental Statement, together with any associated environmental information.
Food & Environment Protection Act 1985 and Coastal Protection Act, 1949	Marine Scotland	Until April 2011 a licence under Section 5 of the Food & Environment Protection Act 1985 ("FEPA licence") for any deposits on the seabed and consent under Section 34 of the Coast Protection Act, 1949 ("CPA licence") for changes to navigation are required.	Consents under FEPA and CPA will be replaced by a unified Marine Licence under the Marine (Scotland) Act 2010 in April 2011.
Zetland County Council Act 1974	Shetland Islands Council	A Works Licence under the Act is required for all wave and tidal projects with works on	Under the Act Shetland Islands Council (SIC) has a duty to

[5] The electricity act http://www.opsi.gov.uk/ACTS/acts1989/ukpga_19890029_en_1

Legislation	Regulator	Relevance to wave and tidal development.	Notes
		the seabed or foreshore within 12 nautical miles of the coast of Shetland.	promote the conservancy and control of development.
Environmental Liability Directive The Directive is enacted in Scotland by the Environmental Liability (Scotland) Regulations 2009	Marine Scotland.	The operation of wave or tidal devices has potential to impact protected species. .	Regulation 4 (a) makes clear that the regulations apply to activities which damage protected species or habitats in terms of them achieving Favourable Condition Status (see Section 2.2), where that damage was caused by the fault or negligence of the operator while carrying out any activity.
Marine (Scotland) Act 2010	Marine Scotland	Under the Act a Marine Licence will be required for wave or tidal devices placed on the seabed or intertidal. The Act also introduces seal protection and licensing measures which could have potential implications for wave or tidal developments.	The Act introduced a framework for the sustainable management of the seas around Scotland, ensuring that the need to protect Scottish waters is integrated with economic growth of marine

Legislation	Regulator	Relevance to wave and tidal development.	Notes
		A Marine Licence will be required for developments placing materials on the seabed, and applies to all such wave and tidal developments, regardless of scale. Environmental Information is required to support any application and this may include EIA and associated data.	industries, including marine renewables.

2.2 Natura 2000, Habitats Regulations Appraisal and Appropriate Assessment

Comprehensive guidance on the Habitats Regulations Appraisal (HRA) and Appropriate Assessment (AA) processes, as they relate to marine renewable energy consenting in Scotland, is set out in Marine Scotland's draft *Marine Renewables Licensing Manual* (Marine Scotland 2011). The principal aspects of these are as follows.

2.2.1 Natura 2000

The Conservation (Natural Habitats, & c.) Regulations, 1994'[6] (Habitats Regulations) (including 2004 and 2007 amendments in Scotland) transpose the requirements of the Habitats Directive (Council Directive 92/43/EEC) and Birds Directive (Directive 79/409/EEC as amended) into national law and outline the designation and protection required for 'European sites' (namely Special Protection Areas SPAs and Special Areas of Conservation SACs, discussed below) and European protected species' (EPS), discussed in Section 2.3.

Special Protection Areas (SPAs)

SPAs are classified for rare and vulnerable birds (as listed on Annex I of the Birds Directive), and for regularly occurring migratory species. They can be designated for individual species (breeding or non-breeding populations) or bird assemblages. Key species considered potentially vulnerable to effects from wet renewable development are listed below and further discussed in Volume IV of this guidance.

Bird groups potentially vulnerable to wet renewable developments may include:

- *Shearwaters and petrels;*
- *Northern gannet;*
- *Cormorant and shag;*
- *Auks;*
- *Cliff-nesting raptors;*
- *Skuas and gulls;*
- *Terns;*
- *Seaducks, divers and grebes; and*

[6] The Conservation (Natural Habitats, &c.) Regulations 1994: Statutory Instrument 1994 No. 2716: Accessed at: http://www.opsi.gov.uk/si/si1994/Uksi_19942716_en_1.htm

- *Coastal waders.*

Special Areas of Conservation (SACs)

SAC qualifying features which may be affected by marine wet renewables development because of their spatial distribution or ecology are identified in Table 2.4, below. These features are also discussed in more detail in Volumes II, III (which deal with Annex II species) and V (which deals with Annex I Habitats) of this guidance.

Table 2.4 SAC qualifying features

Annex I Habitats	Annex II Species
Sandbanks which are slightly covered by sea water all the time; Reefs; and Large shallow inlets and bays.	Bottlenose dolphin *Tursiops truncatus*; Harbour porpoise Phocoena Phocoena; Grey seal Halichoerus grypus; and Harbour seal *Phoca vitulina*.

Amendments to Habitats Regulations

The Habitats Regulations have been amended several times in Scotland since their introduction, with key changes relevant to this guidance being:

- *Introduction of offences relating to intentional or reckless damage to habitats and intentional or reckless disturbance to species; and*
- *Statutory requirement to assess all plans and projects, developments plans (structure and local plans) with regard to Natura 2000 sites.*

Natura 2000 Management

There is a requirement to draw up conservation measures for all of the qualifying habitat types and species which are present within a Natura 2000 site (Anon, 2000) and these are tailored for each site. The maintenance or restoration of "favourable condition" is the overall objective of the conservation measures for all habitat types and species listed on Annexes II, IV and V to the Directive. Favourable condition is, in practice, very hard to assess, and will vary considerably depending on the site, according to the ecological requirements of the natural habitat types and species present (Anon, 2000).

Habitats Regulations Appraisal (HRA) and Appropriate Assessment (AA)

Care must be taken not to compromise the integrity of a Natura 2000 site, or its qualifying features and where a development, project or plan is proposed that might, potentially, affect such a site, a Habitats Regulations Appraisal (HRA) must be undertaken.

HRA is the tool through which the Competent Authority ascertains if a proposal is directly connected with or necessary for site management for nature conservation or, if not, whether the proposal is likely to have a "significant effect" upon the site or its qualifying features. This test removes from consideration schemes with no obvious connection to a site's qualifying interests and those for which it is obvious that there is no effect. During HRA, the definition of "significant" indicates simply a capacity for the scheme to affect the site's interests.

If a significant effect is considered likely then an "Appropriate Assessment" (AA) must be conducted of the proposed plan for its implications for the site, in view of the site's "conservation objectives." Responsibility for undertaking the AA lies with the 'Competent Authority' for the development or plan concerned and for marine electricity generation developments in Scotland, the Competent Authority is Marine Scotland.

An AA considers only the qualifying features of the Natura 2000 site and their conservation objectives. Information to help inform Appropriate Assessment is usually provided by the developer at the request of the competent authority and this may include supplementary studies over and above those required for the EIA. Marine Scotland will alert developers to the possible need for such information at the earliest opportunity within the consultation process.

AA can be broken into a scientific appraisal of the impact of the development on the qualifying features, coupled with a decision making process based on the appraisal. The AA must assess the implications for the site's conservation objectives to answer the following question:

- *Can it be ascertained that the proposal will <u>not</u> adversely affect the integrity of the site?*

The integrity of a site is "the coherence of its ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified" (revised Scottish Executive Circular 6/95) and only applies to the qualifying interest features for which the site is designated.

Table 2.5, below identifies the conservation objectives for Annex I Habitats, Annex II species and bird species against which to assess potential impacts on site integrity (Source SNH 2003).

Table 2.5 Conservation Objectives for Annex 1 Habitats and Annex II Species

Annex 1 Habitats Conservation Objectives	To avoid deterioration of the qualifying habitat(s) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving FCS for each of the qualifying interests
	To ensure for the qualifying habitat(s) that the following are maintained in the long term:
	• Extent of the habitat on site
	• Distribution of the habitat within site
	• Structure and function of the habitat
	• Processes supporting the habitat
	• Distribution of typical species of the habitat
	• Viability of typical species as components of the habitat
	• No significant disturbance of typical species of the habitat
Annex II Species Conservation Objectives	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving FCS for each of the qualifying interests
	To ensure for the qualifying species that the following are maintained in the long term
	• Population of the species (including range of genetic types *where relevant*) as a viable component of the site
	• Distribution of the species within site
	• Distribution and extent of habitats supporting the species
	• Structure, function and supporting processes of habitats supporting the species
	• No significant disturbance of the species
	• Distribution and viability of the species' host species (*where relevant*)
	• Structure, function and supporting processes of habitats supporting the species' host species (*where relevant*)
Bird Species Conservation Objectives	To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained.
	To ensure for the qualifying species that the following are maintained in the long term
	• Population of the species as a viable component of the site
	• Distribution of the species within site
	• Distribution and extent of habitats supporting the species
	• Structure, function and supporting processes of habitats supporting the species
	• No significant disturbance of the species

The competent authority must also consider the following questions:

- *Are there alternative development options / solutions which could avoid or mitigate the potential significant effect identified?*
- *Is a qualifying SAC interest feature adversely affected?*

This includes consideration of other suitable and available sites, and other different but practical approaches which may have a lesser impact. It is important to note that a further AA may need to be undertaken should the proposed scheme change during consideration of other sites and approaches.

Consent should not be given unless it is ascertained that there will be **no** adverse effect on the integrity of the site or the features for which the site is designated. The licensing authorities should generally only consent a project after having ascertained "beyond reasonable scientific doubt" that a site will not be adversely affected by the installation of a device.

2.2.2 Imperative Reasons of Over-riding Public Interest (IROPI)

A scheme may be granted consent, despite a potential risk to, or impact upon a site or qualifying interests but only in specific circumstances, termed "Imperative Reasons of Over-riding Public Interest" (IROPI). Such reasons are defines as follows:

- *The need to address a serious risk to human health and public safety;*
- *The interests of national security and defence;*
- *The provision of a clear and demonstrable direct environmental benefit on a national or international scale;*
- *A vital contribution to strategic economic development or regeneration;*
- *Where failure to proceed would have unacceptable social and/or economic consequences.*

Where IROPI exists, it is also necessary to put in place compensatory measures to achieve a benefit at least equivalent to the loss or damage to the site's qualifying interest features. These measures should be in place before any damage occurs and would usually include:

- *Designation of an alternative site;*
- *Extension of the same or another site to include habitat equivalent to that lost or damaged;*
- *Restoration of non-qualifying habitat to qualifying standard on this or another site.*

The responsibility for compensation, including costs incurred, lies with the developer.

2.3 European Protected Species

European Protected Species (EPS) are species listed in Annex IV to the Habitats Directive as species of European Community interest and in need of strict protection. All cetaceans are EPS, however this legislation does not currently extend to pinnipeds, basking sharks, birds or benthic habitats or species.

For any EPS of wild animal, it is an offence to:

- Deliberately or recklessly capture, injure or kill such an animal (Regulation 39(1)(a))
- Deliberately or recklessly
  (i) Harass an animal or group of animals (Regulation 39(1)(b)(i));
  (ii) Disturb an animal while it is occupying a structure or place used for shelter or protection (Regulation 39(1)(b)(ii));
  (iii) Disturb an animal while it is rearing or otherwise caring for its young (Regulation 39(1)(b)(iii));
  (iv) Obstruct access to a breeding site or resting place, or otherwise deny the animal use of the breeding site or resting place (Regulation 39(1)(b)(iv));
  (v) Disturb an animal in a manner that is, or in circumstances which are, likely to significantly affect the local distribution or abundance of the species to which it belongs (Regulation 39(1)(b)(v));
  (vi) Disturb an animal in a manner that is, or in circumstances which are, likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young (Regulation 39(1)(b)(vi));
  (vii) Disturb an animal while it is migrating or hibernating (Regulation 39(1)(b)(vii);
- Deliberately or recklessly take or destroy its eggs (Regulation 39(1)(c));
- Damage or destroy a breeding site or resting place (Regulation 39(1)(d)); or
- Deliberately or recklessly disturb any dolphin, porpoise or whale (cetacean) (Regulation 39(2).

Some EPS are also listed on Annex II of the Habitats Directive and therefore they may also be a qualifying species for an SAC. In practice, the only species for which this is relevant in Scotland is the bottlenose dolphin.

2.3.1 Licensing

There is commonly potential for the activities involved in the construction and operation of a wave or tidal stream energy development to cause disturbance to an EPS, and therefore a licence may be required. Under Article 44 of the Habitats Regulations, and 49 of the Offshore Marine Regulations, licences may be issued under strict conditions. As of January 2011, Marine Scotland Licensing Operations Team (MSLOT) assumed responsibility for provision of licences for marine species.

A licence application submitted in relation to the Habitats Regulations can only be issued if it passes the following three tests:

(i) The licence application must demonstrably relate to one of the purposes specified in Regulation 44 (2); and
(ii) There must be **no satisfactory alternative** (i.e. to the granting of a licence); and
(iii) The action authorised must not be detrimental to the maintenance of the population of the EPS concerned at a *favourable conservation status* (FCS) in its natural range.

It is the responsibility of the relevant licensing authority (in most instances Marine Scotland) to address these tests.

Article 1(i) of the EC Habitats Directive provides a definition of FCS for species. This states that the conservation status will be taken as 'favourable' when:

- Population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- The natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- There is, and will probably continue to be, a sufficiently large habitat to maintain its population on a long term basis.

FCS applies at the level of the EU. However, effects on species at a local or national level contribute to this. In addressing the test for any piece of casework relating to FCS, MSLOT, the licensing authority, is required to look at how a specific proposal will affect an EPS in the specific locality and then decide whether this affects the FCS of the EPS overall. If it has no great impact at the local level, then it clearly cannot at the EU level. Where there is any concern that there could be a negative effect in a specific locality, then the local effect will

need to be considered in the wider context by the licensing authority before a final judgement on FCS is made

2.4 National Conservation Legislation

UK and Scottish legislation must be considered during the development of wave and tidal device arrays, and survey and monitoring must be robust enough to show the proposed developments comply. Table 2.6 summarises key UK and Scottish Legislation and details their relevance to wet renewable developments.

Table 2.6 National conservation legislation and its relevance to wave and tidal projects

Legislation	Regulator	Relevance to wave and tidal development.	Notes
Wildlife and Countryside Act 1981. The Act has had many amendments including: • Nature Conservation (Scotland) Act 2004 (in Scotland); • The Local Government Act 1985; • The Water Act 1989; and • The Environmental Protection Act 1990	Scottish Natural Heritage	The most direct implications of the Act for the offshore component of a development are that it makes it an offence to intentionally kill or injure any wild animal listed in Schedule 5 (including cetaceans and basking sharks), and prohibits interference with places used for shelter or protection, or intentionally disturbing animals occupying such places. Schedule 6 of the Nature Conservation (Scotland) Act 2004 further states that a person who, intentionally or recklessly, disturbs or harasses any wild animal included in Schedule 5 as a (a) Dolphin, whale or porpoise (cetacea); or (b) Basking shark (*Cetorhinus maximus*),	The Act also provides the following measures, potentially relevant to near shore devices and any cable / pipeline landfalls: • Protection for wild birds, nests in the terrestrial environment; • Establishment of Sites of Special Scientific Interest (SSSI) in the terrestrial and intertidal environments.

Legislation	Regulator	Relevance to wave and tidal development.	Notes
		shall be guilty of an offence.	
UK Biodiversity Action Plan	Scottish Government	The UK Biodiversity Action Plan identifies important habitats and species and identifies means for protecting and improving their biodiversity. The list of priority UK BAP habitats and species was reviewed and updated in 2007, and includes several bird and benthic species and benthic habitats, plus basking sharks and all cetaceans and seals species found within Scottish waters. Habitats and species relevant to wet renewable development are discussed in Volumes II, III and V of this guidance. Potential impacts upon these species and habitats will have to be considered during EIA and supported by appropriate data.	In Scotland, wave and tidal developments are likely to deployed in the following regions, which have a Local BAP (LBAP) specific to the habitats and species of the local area to stimulate action on national priorities and to focus the conservation work of local authorities: • Argyll and Bute, • Orkney, Shetland, • Highland, • Comhairle nan Eilean Siar (Western Isles), Ayrshire and Dumfries and

Legislation	Regulator	Relevance to wave and tidal development.	Notes
			Galloway.

3 GENERIC GUIDANCE INFORMATION

Wet renewables developments are expected to be far more prevalent in Scotland, and beyond, in the future, with sites potentially covering large areas of the marine environment. It is likely that there will be some overlap of locations that are attractive to these technologies with areas of high value to nature conservation (Faber Maunsel and Metoc, 2008). Potential conflict will need to be managed, potentially in the absence of operational experience with wet renewable technologies, or full understanding of how they will interact with potential species and habitat receptors.

The purpose of undertaking survey and monitoring studies of marine mammals, basking sharks, birds and benthos in relation to project consenting is twofold:

- Firstly, to provide information on the distribution and abundance of key species using the development area so as to inform site location and wider decision making throughout the consents processes; and
- Secondly, to provide a baseline against which to measure impacts, if any, on those species arising as a result of the development, through comparison of pre- and post-construction data.

The advice provided in Volumes II, III, IV and V of this guidance focuses on the nature of survey and monitoring information required, as well as its collection, in order to answer key questions applicable to any site under consideration. The status of existing knowledge, current best practice and scientific requirements for analysis are all considered. Our objective is to provide a framework for the collection of appropriate and robust information, which can serve the purposes of characterisation, monitoring and assessment.

3.1 Significance of Impact

3.1.1 Introduction

The significance of an impact can be interpreted in various ways, determined by the status of the species or habitat upon which an impact is measured, or the purpose for which changes to that status are measured. For example, there may be considerable differences between a species distribution or population that are considered statistically significant, or a change of no statistical significance which is considered significant in terms of the Habitats Directive. Significance may have different meanings in terms of statistical models, biology, individual

behaviour, population and legislation. For this guidance document the most relevant meanings of significance with bearing upon the development of site monitoring at all potential development locations are considered to be significance under the Habitats Directive and statistical significance, and these are discussed further below. Other meanings of significance may come into play in very specific circumstances at some locations, but are not thought to be of generic applicability.

3.1.2 Significance under the Habitats Directive

Under the Habitats Directive, it is necessary to consider any plan or project (not related directly to or necessary for the management of a European Site) in terms of its potential implications for the conservation objectives for the connected European sites. If potential effects cannot be excluded, based on objective information and an assessment of that risk made in the light, inter alia, of the characteristics and specific environmental conditions of the site concerned, then the plan is considered to have potential to have a significant effect and an Appropriate Assessment (see Section 2.2) must be undertaken,.

3.1.3 Statistical significance

It is possible for statistically significant changes to characteristics of habitats or species associated with a site (or sites) to be measured, without those changes being considered to pose a wider risk to the conservation objectives of the habitats or species concerned. For example, a small change in a migratory route through a site may be statistically significant, but may not pose a risk in terms of the biology of a population or its ability to exist within the limits of natural change. In such a case, an expert judgement, based on risk assessment, may need to be made by regulators with support from wider advisors if necessary.

If monitoring at a development site identifies statistically significant changes, attributing those changes to a particular activity or development may be difficult or not possible. Indeed, it may be that the changes measured are not directly related to development at all, but are part of a wider trend in the population. This uncertainty is more likely to be the case for mobile and wide ranging species, where the development site monitored is likely to form only a small part of the species' overall range. The availability of strategic level data covering wider areas and populations will be an important tool for regulators and their advisors when considering such changes. It is important to remember that the opposite argument may also be true and if a statistically significant change in a metric measured within a site is not reflected more generally in the population, then regulators and their advisors should consider whether the change may be the result of the development site.

3.2 Guiding principles for survey and monitoring

3.2.1 Introduction

The approach to data collection in support of an application for consent for a wet renewable project will depend upon the purpose for which those data are required. At their simplest, the likely purposes are:

Site characterisation – The establishment of an appropriate level of information regarding species and habitat and distribution within and around a site to allow assessment of potential impacts due to the proposed development; and

Establishment of Monitoring Baseline – The collection of data sufficient to both support initial characterisation of a site, but also to form the baseline and data for ongoing monitoring, should that be required.

Monitoring – The ongoing and periodic collection of data with the purpose of answering one or more questions raised but not answered during the assessment (EIA, AA) process.

3.2.2 Identification of key questions

The different stages of the consenting process pose different questions to the regulator in making a decision as to whether to grant consent. Identification of those questions is the essential first step in developing an EIA assessment. Collection of the information and data required to answer those questions then becomes a priority to support consenting.

Early questions in the process should include, but will not be limited to, the following:

- Do we have sufficient data for key receptors to allow us to characterise the site in terms of the species/habitats present, their distribution and, for species, what the site is used for?
- Are characterisation data to be collected sufficient to quantify impacts at all stages of the project for EIA and, if appropriate, HRA purposes?
- Based on current understanding and risk assessment, which key receptors may require ongoing monitoring over time and which receptors require a one- off description to allow assessment of potential impacts?
- What metrics are being measured for monitoring purposes and why were they chosen?

- Will data collected be sufficient to allow change to be measured over time?

Consideration of these initial questions will determine the nature of data collected to inform the EIA, potentially AA, and any ongoing monitoring programme. These questions should drive the assessment and monitoring program from survey design through data analysis to reporting.

The risk of not undertaking a question led study is wasted time and wider resources as data collected speculatively or without direction may not adequately inform an assessment or be appropriate for ongoing monitoring.

3.2.3 Sampling frequency

The sampling frequency required for an individual study will be dictated by the key questions being asked, the survey/ monitoring method used and site-specific factors (e.g. species present, type of site usage, seasonal variation, and natural variability in metric to be measured).

When characterising a site, the assessment of the presence and distribution of a receptor may require only one visit to characterise the site, or potentially a number of visits throughout the year if the seasonal distribution of that receptor is a necessary element of impact prediction.

When collecting monitoring data the frequency of data collection may also be influenced by the survey effort possible during each visit and the purpose of the data collection. For example, a single aerial survey of a grey seal pupping site may result in large amounts of data being captured in a single visit and which represents a large proportion of relevant data for a key stage in the seals' life-cycle. By comparison, aerial survey of birds at sea, while collecting large amounts of data of use for monitoring as well as assessment, will require a number of repeat surveys to capture the potentially changing use of the survey area by various species through the year.

Further consideration is given to these issues in each section on survey and monitoring protocols:

- Volume II (Cetaceans and basking sharks) Section 7;
- Volume III (Seals) Section 7;
- Volume III (Birds) Section 8; and

- Volume V (Benthic habitats and species) Sections 8 and 15

3.2.4 Survey and monitoring periods

As with survey and monitoring frequency the length of time that surveys and monitoring are undertaken is very much dependent upon the receptor being considered and the metric(s) being measured.

It is currently the view of SNH that baseline monitoring, to inform the consenting process for wave or tidal arrays, should be conducted for a minimum of two years for mobile species to provide an understanding of both seasonal and temporal inter-variations in populations and ecology. This is in line with COWRIE guidance (Maclean et al, 2009) for bird surveys required for offshore wind farms and recent advice from RSPB (Langston, 2010). Two years of baseline data for mobile species allows for greater understanding of annual variation of the populations likely to be present at the site in question and therefore provides a better baseline in terms of distribution/ abundance surveys to inform an EIA or AA.

In most cases, two years of data will not allow annual variation in abundance to be fully considered and a narrow estimate of abundance to be produced because of the naturally high variation in numbers of many marine species. However, significantly increasing the duration of the survey period may also still not provide the power to detect change that might be desired and could result in substantial resources and time being inefficiently deployed.

The issues identified above for collection of baseline data, in terms of change detection, will also apply to post installation data collection for impact monitoring. An acceptance of the limits on data collection and the ability to detect change may be required, with pragmatism and judgement on behalf of regulators focussing on the collection of sufficient data to inform the judgement of the regulator and their advisors on the basis of 'best available knowledge'.

Further consideration is given to these issues in each section on survey and monitoring protocols:

- Volume II (Cetaceans and basking sharks) Section 7;
- Volume III (Seals) Section 7;
- Volume III (Birds) Section 8; and
- Volume V (Benthic habitats and species) Sections 8 and 15.

3.2.5 Spatial consideration: development footprint

The scale and location of the development footprint will have significant bearing on the key questions to be addressed and the survey/ monitoring methods utilised. For example, a smaller footprint close to a suitable land-based vantage point may be appropriate for the collection of data on mobile species (birds and marine mammals) via vantage point observations, with a view of the entire footprint and data collected at an appropriate level for assessment of risk. However, the same vantage point may not be suitable for a large development in the same location, with parts of the footprint not adequately visible from land, or for footprints located offshore, where a large number of devices would not be visible.

In such circumstances it may be necessary to depend upon alternative survey methods including boat based surveys, or remote methods such as aerial survey and monitoring.

The size of a development site should not be assumed to preclude issues of large scale study areas and large distances when collecting data. The location of developments is largely subject to leasing rounds managed by the Crown Estate and as a result, developers are generally not able to choose the exact location or extent of sites within a wider leased area until after the award of lease. In reality, the collection of initial characterisation and baseline data across a wider lease area will often play a key role in the identification of the development site within the leased area. When this lack of choice is combined with limited data available for many areas for a number of receptors, it is apparent that data collection, even for smaller initial phases of development, may face challenges due to the spatial nature of the site and the need to identify the most appropriate areas within a site for development.

3.2.6 Spatial consideration: potential impact footprint

Whilst a development footprint may be relatively small and localised, a potential impact footprint may extend some considerable distance from the development, for example, through interactions with tidal or wave resources, influences on key receptors either through direct physical interaction or through other mechanisms such as noise, or the movement of vessels associated with the development. This has significant implications on survey design, scale and method as well as in properly assessing the potential impacts of the proposed development or activity. It may also be essential in properly assessing the cumulative impacts of the proposal in combination with other activities in the region.

The selection of control areas or gradient lengths for BACI and BAG respectively (Section 3.4) must be determined by the size and nature of the potential impact footprint. Failure to do so may result in data not allowing proper assessment of potential impacts to be considered or all data being collected from within the impact footprint, wasting resources that have been invested in surveying a questionable control area or gradient design.

Examples of how an area of impact may differ to the development footprint when surveying benthic ecology are presented below in Figures 3.1a to 3.1d showing potential survey and monitoring areas cross hatched, for two wave and two tidal device scenarios. These have been provided below to encourage consideration of relevant factors when designing a study area, and **must not** be used as a default. It is important to note factors requiring consideration for birds, marine mammals and basking sharks will be different, and further details are provided in Section 7 of Volumes II and III, and Section 8 of Volume IV. A key factor in the potential footprint of the site for monitoring impacts to benthic ecology is considered to be the resource being exploited for energy, the tidal stream or the main direction of wave energy. For most sites this 'direction of energy' will be approximately bi directional and as a consequence, consideration should be given to skewing the area of study and buffer areas in this direction. .

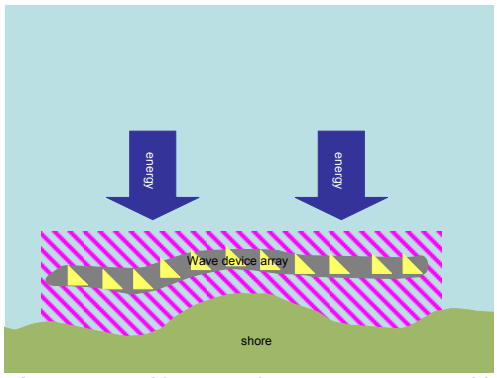

Figure 3.1a Near to shore wave array with study area focussed towards shore

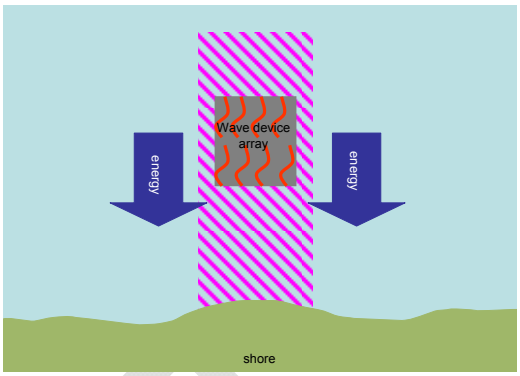

Figure 3.1b Offshore wave array with study area focussed in the direction of maximum wave energy

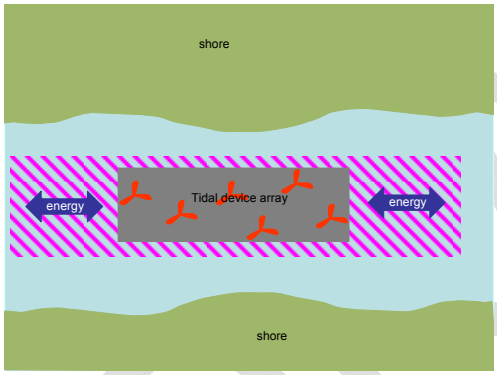

Figure 3.1c Tidal array in a narrows or strait with study area focussed in the direction of tidal stream

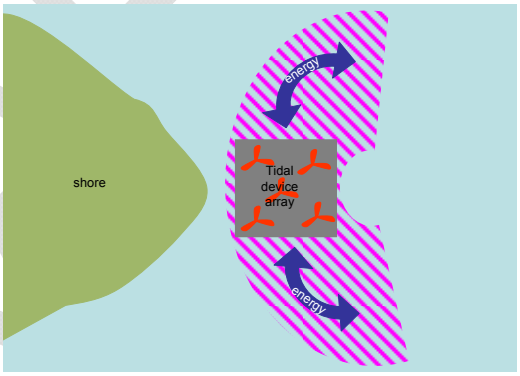

Figure 3.1d Tidal array close to headland with non linear resource and study area

Caveats:

*These examples relate specifically to consideration of the impact footprint upon benthic habitats to indicate how buffers may be site specific, and

* These examples are not applicable to determination of impact footprint for birds, mammals or basking sharks which will, in all likelihood, be very different.

The extent of the potential study area associated with a particular array of devices will be determined as a minimum by the nature of the development site (for example, proximity of

land), and the potential for a particular device type to extract energy and influence the environment both 'up and down stream / wave' of the array, as well as at the array location itself.

3.2.7 Distribution/ abundance data

In the past, a great deal of emphasis has been placed on obtaining distributional or abundance data for a development area. However, whilst this will provide an indication of the species that should be the focus of any assessment, it may provide poor information regarding the potential impact of the proposed development. There are a number of reasons for this. These types of data may not provide any indication of the importance of a site or area to a particular species or population. Nor do they provide information regarding, behaviour, activity patterns, area usage, or volume of movement of key species that may all be required to assess, for instance, collision risk. As a consequence distributional and abundance data alone may not necessarily provide sufficient information to allow full monitoring or assessment of all potential impacts to be undertaken. It may prove difficult to determine whether a change in abundance has occurred, or to attribute any change in abundance to a specific development rather than to larger scale drivers of change at a regional scale or beyond.

When faced with this challenge, consideration of the potential driver/s of any change in observed abundance during a particular development activity may be more important in assessing potential impact than any measure of change itself. Changes to behaviour (such as site use) and drivers for those changes will be of value to the regulator and their advisors, particularly when determining whether or not a site's conservation objectives will be maintained and implications for integrity. An environmental risk assessment approach based on best available data and understanding may be the most that is possible.

As discussed previously, it is essential than any study is question driven and metrics relevant to those questions collected[7]. Defaulting to data that has historically been collected may not provide the information required to adequately inform the EIA or AA. It may also be inappropriate for gaining additional understanding of the impacts (if any) of wet renewables development.

[7] Note: Details of appropriate questions for different receptor groups are provided in volumes II to V.

3.2.8 Behavioural data

Behavioural data may be an essential component of models used to estimate impact (e.g. dive patterns and area usage for collision risk to mammals or diving seabirds) and can provide information regarding the interactions between individual animals and devices or device arrays. The potential exists for behavioural data collected within study areas and more widely to provide evidence for the removal of a mechanism for interaction with wet renewable devices, particularly with regard to tidal devices and birds. There is potential for changes in the feeding ecology of potential receptor species in extreme tidal conditions, with species capable of diving to depths where they could potentially interact with a tidal array, choosing not to dive in those locations. Data collected in support of the EIA for the SeaGen tidal turbine in Strangford Lough (Royal Haskoning 2005) and subsequently as part of ongoing monitoring, found diving activity by birds within the study area largely limited to shallow plunge diving species with no potential for direct interaction with the turbine's rotors.

Behavioural data may allow the relative importance of a site or area for key receptors and the ecology of those receptors within that area to be determined. It may also provide important metrics for the assessment of potential and observed impacts, for example, time spent per dive as an indicator of depths potentially achieved.

Behavioural data, particularly in high energy marine areas is severely lacking at present and is essential in properly assessing potential impacts of developments. Such data have the potential to heavily influence the need for, and nature of, data collection at any site as well as being a key part of the initial baseline data collection and characterisation of a site. For example, the actual behaviour of potential bird receptors at a site (diving bird species) will determine whether there is an actual risk of interaction with tidal devices, rather than a theoretical risk based upon incomplete knowledge of the feeding ecology of the birds considered.

3.2.9 Predictive modelling

Predictive modelling techniques may be adapted to further understand the ecology or behaviour of a certain taxonomic group. In particular, modelling can be used to provide detail on the distribution or abundance of species, the potential for collision risk, or the connectivity of individuals with populations of conservation importance or nature designated sites.

It must be remembered that modelling exercises are *predictive* and therefore should only be used as one of several tools to further understand the interactions of these devices with species and habitats of concern.

3.2.10 Scaling up and scaling-down

The approaches summarised above may be adapted to fulfil the requirements of a range of development scales. The key consideration for scaling up or down will be simply the area of the development and its potential impact footprint which needs to be surveyed and the characteristics of the site. Where the area of study is driven purely by the area required to deploy a number of devices, the area of sea included in any study area will increase with the increasing numbers of devices, with the area required being dependent upon the nature of the devices used. Another key factor influencing the scale and shape of the study area (predominately for benthic ecology, but occasionally for birds too) will be the area of potential influence of the devices within the direction(s) of the energy source (wave or tide) being exploited, as summarised in Section 3.2.6, and of potential disturbance or impact from noise or other aspects of the development. Thus the potential impact footprint may not be limited to the immediate boundary of the devices, but could, potentially, extend a distance of several kilometres around it.

The expected / anticipated / predicted area of impact will define the boundary of the study area and the extent of data collection. In general, the larger the study area, the greater the resources required to conduct any survey. For example, the period of charter for boat or aerial surveys will be longer to ensure coverage of larger areas with consequences on the cost of the monitoring programme. Areas with multiple developments might be more efficiently surveyed collaboratively, requiring developers to work together on data collection and analysis. This approach may also help inform cumulative impact assessment and provide wider contextual data regarding use of the wider area around and in between the individual sites and their separate study areas.

It is important to remember that as sites get larger, because the survey effort (regardless of technique) is larger, the volumes of data collected will also increase. Acoustic and digital aerial survey data in particular can be acquired and accumulated rapidly. Sub sampling of data may be necessary and appropriate data management and storage systems will be needed.

3.2.11 Consideration of scale

Wet renewable developments will vary in their scale, from single devices to large arrays. There is potential for smaller arrays and even single devices to require relatively large study areas covering a number of square kilometres, with the size of study areas increasing with larger arrays and increasing potential to influence the environment. In this context it is important to note that the seabed leasing process managed by the Crown Estate in UK waters may grant leases for wet renewable development much larger than the arrays which will eventually occupy those areas. For many lease areas data are limited and although some limited refinement and selection of the development site within the lease area is possible, the area potentially developed may be much larger than that which will actually be developed. Many leases will also be developed in a phased manner, with a number of smaller deployments of 10s of megawatts initially, gradually scaling up. In this context, while this guidance is focussed primarily upon arrays of 50 MW or less, it also acknowledged that we must consider survey over larger areas than the arrays, and that study areas and data collected may not vary in scale in a way which is proportionate to the proposed generation capacity of any individual array.

The actual scale of a development, as opposed to lease area, will influence its potential effects on ecology, with larger developments generally having greater potential for significant effects, even in areas which are not especially sensitive, although it should be acknowledged that certain devices may have greater potential for impact than others. All developments will have more potential to cause significant adverse effects if located within or close to sensitive areas and larger scale projects may also have increased potential to cause barrier effects or displace mobile species from a significant proportion of habitat.

The scale of a development and the, often, wider potential area within which it may be sited needs to be explicitly considered both in scoping and survey design and in the assessment of effects.

3.2.12 Retaining flexibility

In many cases, the programme of work to inform assessments will be spread over several years and during this time new relevant information is likely to be forthcoming, while the circumstances affecting development of the site may also change. This may be as a result of survey / monitoring work on that site or elsewhere, advances in understanding of species ecology, or changes in species conservation status, government policy and legislation. Such new information or understanding may identify issues that were previously unforeseen and

necessitate additional work, however, it may also allow some requirements for monitoring at a site to be reduced or even dismissed altogether. Any programme of survey and monitoring work for a development should have sufficient flexibility to allow its adaptation in response to new information and changing circumstances.

3.2.13 Encouraging standardisation and data compatibility

A key element of undertaking assessments is the placing of survey data into a wider context so that the true importance of a site for a key issue can be determined. This requires that data are comparable with those for other sites and more widely. To promote comparability, data should be collected using standardised methods, summarised in consistent ways and reported in common units. The use of a metadata file, with standardised column titles and opportunity to identify any potential weakness or issues relating to the data would be desirable. This will apply particularly to the generic surveys of distribution and abundance.

3.2.14 Encouraging data sharing collaboration and connectivity

It is in the interests of the renewable energy industry as a whole that no development adversely affects marine mammal, basking shark and bird populations, or their habitats. The wide ranging behaviour of marine species means that there is potential for considerable overlap in use by multiple development sites and study areas by single or multiple populations associated with one or multiple conservation sites. This highlights a potential need to establish which populations of animals are using which areas, at which times, and to ascertain if there is connectivity between development site study areas and particular conservation sites. This is especially important if generating information to inform an AA, so as to enable potential impacts on specific designated sites to be assessed. Connectivity is discussed further in Section 3.3.1.

3.2.15 Dealing with uncertainty

The wide ranging behaviour of marine species, their naturally high temporal and spatial variation in habitat use and the difficulties in studying them, all lead to inherent difficulties in obtaining sufficient good quality data to make robust predictions. Put simply, even with relatively good survey data it is likely that, for some species at least, there will remain a

certain amount of uncertainty. Key questions likely to be affected by uncertainty are the extent of connectivity between mobile species using a development site and designated sites (as discussed in Section 3.2.14, above), the extent of turnover of individuals using a site, and the actual encounter and collision risks posed to diving birds or pelagic species by marine turbines, and to a much lesser extent by wave energy devices.

Uncertainty should be explicitly recognised at all stages and reduced as far as is necessary to enable monitoring. In most cases, uncertainty can be reduced by careful study design. It may also be reduced by undertaking species-specific studies, for example, the use of GSM or similar electronic tags, to investigate the detailed behaviour of a sample of mobile individuals such as seals, in terms of movement over time, diving depths and times etc.

Uncertainty must also be considered as part of any assessments undertaken and one way of addressing this may be through the presentation of a range of scenarios. If uncertainty is thought to be high and potential for adverse impacts is significant, then a precautionary approach may be appropriate.

3.3 Species and habitats

Assessment and monitoring of developments should focus on the key receptor species and habitats for which the following apply:

- Potential for key receptors to be adversely affected.

And at least one of the following (in order of importance):

1. Subject to international protection legislation, (including individuals that are part of SPA or SAC populations);
2. Subject to national protection legislation (including SSSI, UKBAP or as listed in Wildlife and Countryside Act 1981);
3. Considered a Priority Marine Feature[8] in Scottish waters; or
4. Present at internationally or globally important numbers.

Although for a particular development almost any species could be of relevance, species that occur irregularly or rarely or that are not plausibly adversely affected will not be key species. The species that are most likely to be key species to wet renewables are

[8] http://www.snh.gov.uk/protecting-scotlands-nature/safeguarding-biodiversity/priority-marine-features/

summarised within Volumes II to V. However, Marine Scotland as the Regulator will direct developers as to species and habitats to consider during assessment.

3.3.1 Connectivity

Within the context of this guidance, connectivity relates to marine mammals and birds. The subject of connectivity is complex, difficult to study and for many species, poorly understood. Assessing connectivity at a strategic level would enable a greater breadth of understanding of the movement of species between sites. Developers and Government working together should be encouraged to undertake elements of work, including telemetry, genetic studies or models (if feasible) that could then be applied to a wide area.

Connectivity can be:

1) The degree to which discrete populations of animals interact with each other;
2) The degree of movement between and utilisation of different areas or resources by a population; or
3) A process or pathway by which a development or activity might affect a designated site or qualifying feature.

The degree of connectivity may have significant implications for the assessment of potential impacts as a result of proposed developments. For example, connectivity between a development site located outwith a Natura 2000 site and a SAC or SPA population may result in an Appropriate Assessment being required. Appropriate Assessment was discussed previously in Section 2.2.2.

The following text provides an example as to how connectivity may be considered when surveying for birds. **This example must not be considered as a default**, but aims to promote thought process for appropriate methodology, as other variables, including device type, depth, distance to shore, tidal flows will all need to be factored in when planning a survey. Connectivity with regards to marine mammals is discussed in Section 7 (Study Design) of Volumes II and III of this guidance. An understanding of the degree of connectivity between populations and sites allows any impact assessment to be placed into the correct local and regional context and may also be a fundamental component of assessments of potential cumulative and in combination impacts of the proposed development in the region.

When undertaking surveys it may be necessary to develop methods to collect data regarding potential connectivity with one or more SPA population. One approach that has been used successfully for birds at wet renewable sites (client in confidence), is the establishment of survey corridors in addition to the 'general' study area for a development site. Building upon a 'general' study area as outlined earlier in Section 3.2.6 additional sampling is directed towards discrete corridors in the direction of the nearest relevant conservation sites. The rationale is that it should be possible to demonstrate indicative connectivity between populations of key receptors using the 'general' study area and those in the conservation sites by surveying the corridors between them. Where connectivity exists one would expect to see increased sightings towards the designated site, with behaviour supporting movement between the site and the main study area. Such connectivity thus indicates a possible pathway for developments to have an effect on the bird populations for which the SPA has been designated.

Figures 3.2a and 3.2b, below, illustrate the general principal behind such a survey corridor approach for bird connectivity, with study area and study corridor cross hatched.

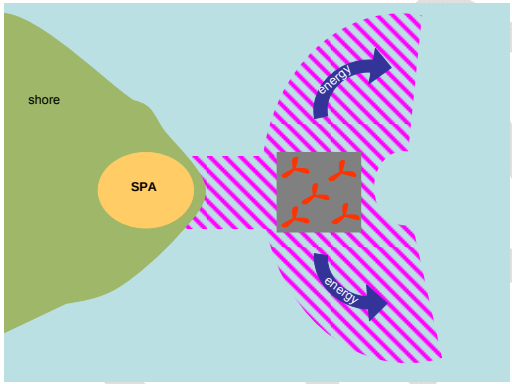

Figure 3.2a Study area biased to energy flow and study corridor to nearby SPA

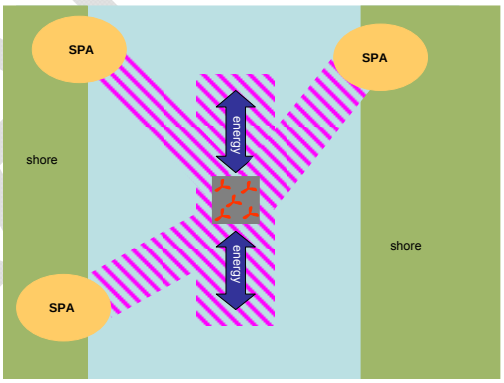

Figure 3.2b Study area biased to main energy flow and corridors towards multiple SPAs

Caveats:

*These figures relate specifically to consideration of the potential connectivity with SPAs, to indicate how survey buffers will be site specific, and

*The figures are not applicable to determination of impact footprint for benthic ecology or marine mammals which will, in all likelihood, be very different.

The approach outlined above may lend itself most appropriately to boat based and aerial survey methods and, in regions where multiple deployments are occurring, a collaborative approach between neighbouring developers may in many cases be the most appropriate way of achieving this. Data from a number of adjacent sites could potentially fulfil at least in part the role of survey corridors between conservation sites and study areas. In addition, larger scale regional surveys may also act as a tool for demonstrating potential connectivity, enabling developers to review in detail data collected across wide areas.

3.4 BACI vs BAG monitoring designs

In order to robustly establish and measure the magnitude of any effects of a development on birds some form of comparative data are required for areas away from the development site. The need for comparative information needs to be considered from the earliest stage as it fundamentally affects survey design. In particular, careful consideration should be given to whether a Before-After-Control-Impact (BACI) or a Before-After-Gradient (BAG) study design is most appropriate with regards to marine mammal or bird survey and monitoring. In particular, the use of classical BACI control areas for wide ranging species may be potentially problematic due to the size of potential impact areas, and the difficulty in identifying comparable areas that may act as controls may preclude large areas of resources. Where impact zones overlap between two or more adjacent developments, significant cooperation between developers will be required to enable successful employment of either BAG or BACI designs.

The use of BACI type study design is well established in biological impact assessment studies, but has limitations. It is advocated in the COWRIE guidance for offshore wind farm bird surveys (Camphuysen *et al.*, 2004) but the applicability to situations involving far-ranging seabird species has been questioned (Harding *et al.* 2010). Under the most basic BACI design (Green 1979), a sample is taken *before* and another sample taken *after* a possible impact, in the Impact (i.e. putatively disturbed) and an undisturbed "Control" location. However, the lack of both temporal and spatial replication in this most basic design means that no reliable conclusions can be reached with respect to potential impacts. For such conclusions to be possible, samples must be taken at repeated points in time before and after the development (providing temporal replication, Stewart-Oaten *et al.* 1986, Underwood 1991) and for multiple controls, randomly chosen from comparable locations (providing spatial replication, Underwood 1991, 1994). Collecting data at multiple points in time before and after installation of turbines is standard practice in the monitoring of wind

farm impacts, but many previous studies have only used a single control site, which severely limits their usefulness.

To allow the magnitude of an impact to be accurately assessed, the multiple control sites must be randomly chosen from within the set of comparable sites and this is often difficult to achieve. Control areas should have similar baseline conditions to, but be independent from,, the impact development site, both in terms of environmental conditions and biology, including the individuals that use them. However, the wide-ranging behaviour of seabirds and marine mammals in combination with the fact that birds and seals often concentrate into a relatively small number of large breeding colonies means that finding multiple control sites which are both comparable to and independent from the development site is likely to be extremely challenging if not practically impossible. Thus, if both the development site and control sites fall within the foraging range of animals from a single colony, then, although they may be comparable to one another they will not be independent because individuals feeding on the development site can potentially move to the control site, and vice versa. In addition, any impact on demographic parameters would potentially affect animals using both control and impact sites. Moreover, if development and control sites can be used which are sufficiently distant from one another that animals using them originate from different colonies, then they are unlikely to be comparable. Development and control sites must be comparable for any meaningful conclusions to be reached, and so analyses must be able to take into account that control and impact areas are not independent of one another. This is likely to be difficult to achieve within a BACI framework. There will also be serious constraints on finding suitable relatively distant control sites that are not potentially affected by other renewable energy developments.

Although the exact numbers of control areas required for the BACI design to be potentially effective at detecting impact will depend upon the sensitivity required, the minimum number is likely to be in the order of 5-6. Without a large number of controls, accurately assessing the magnitude and spatial extent of impacts is likely to be problematic. The large number of controls required to obtain meaningful results, in combination with the difficulties outlined above with respect to the lack of independence for comparable control sites suggest that the BACI design may be of limited value for monitoring the impacts of wet renewable developments on mobile species such as mammals and birds..

The use of a BACI design for monitoring the effect of wet renewable developments is only recommended provided that, for the key species of interest, it can be shown that the condition for control sites to be comparable and independent are likely to be broadly met.

An alternative to a BACI design is a Before-After-Gradient (BAG) study design (Ellis and Schneider 1997, Morrison *et al.* 2008, Manly 2009, Smith 2002, Harding 2010). In many cases, this may be a more appropriate approach to monitoring the effects of wet renewable developments upon mobile species. Under such a design all areas, within a given radius of the development (or sample areas radiating from the impact site, for example noise may be best monitored 50+ km from the impact site), are monitored before, during and after installation. Analyses of such data should be able to evaluate the magnitude and extent of potential impacts under the alternative scenarios that either changes in impacted and un-impacted areas are independent of one another (e.g. as a result of the additional mortality of birds using the development area compared to the un-impacted areas; or alternatively that the opposite applies and the changes are dependent upon one another (e.g. as a result of birds redistributing from more impacted areas to less impacted areas, or vice versa).

A BAG design assumes that impacts decline with increasing distance from the source of the impact (the development), a condition which wet renewable developments are likely to meet. Using appropriate statistical analytical methods, a BAG design is a scientifically powerful method for establishing the magnitude and spatial extent of displacement and habitat loss effects along a distance gradient provided data are collected along a long enough gradient. It is recommended that professional statistical advice is sought on the details of a BAG design, in particular regarding the length of gradient (distance from development) that should be surveyed in order to attain sufficient power to detect changes. An offshore windfarm site in Scotland that is using a BAG design is sampling out to 8 km in all directions (client in confidence).

Comment [G1]: Text commends use of reference areas contradicting advice earlier that reference areas will be difficult to identify and secure.

For wave and tidal energy developments, the gradients of potential displacement and habitat change effects are likely to be directional to some extent, i.e. they are likely to be greatest along the direction of the predominant tide current or swell or towards 'home' or breeding areas they are regularly travelling to. It may be appropriate to take this into account in the study design, for example collecting survey information suitable for BAG but limiting this to a selection of carefully chosen directions (survey corridors).

The Before-After-Gradient study design and subsequent data analysis provides a formal statistical basis for detecting and characterising the impacts of renewable energy developments through examining the changes in the distribution and abundance of birds with respect to distance from the development. A BAG study design has several advantages over BACI for examining the effects on mobile species distributions in the marine environment, not the least it overcomes the intractable problems associated with finding suitable independent control sites. In particular, within the study area, both the magnitude

and spatial extent of impacts can potentially be assessed. Furthermore, the spatial scale of impacts which can potentially be detected is transparent; if the study area extends 8 km from the development, for example, then this is the spatial scale at which impacts due to habitat loss and displacement can potentially be detected. .A statistically significant trend in seabird numbers with distance from the development site appearing after a development is built will provide stronger evidence that the development is responsible than a simple comparison of "impacted" and "non-impacted" areas, thereby reducing the chances of mistaking other effects as an impact of the development (Manly 2009). A further merit of a BAG design is that the results of gradient models are easy to interpret and present to regulatory authorities and other stakeholders (Ellis and Schneider 1997). The BAG approach has been used for offshore windfarm monitoring and is advocated by Fox *et al.* (2006) and has been used for the Horns Rev, Nysted and Arklow Bank offshore wind farms (Peterssen *et al*. (2006), Barton *et al.* (2008).

In contrast to its value for monitoring of mobile species, it is important to note that as there is rarely a guarantee of seabed heterogeneity, a BAG approach is not considered suitable for benthic surveying. This is discussed further in Volume V.

3.5 Adaptive approaches for site management

Adaptive management is a review and reassessment approach to management of, in this case, renewable devices, where there is uncertainty about potential impacts of device operation on key receptors and a need on the part of developers and regulators to proactively enable development, while safeguarding those key receptors. A major factor in this approach is the absence of direct data about the actual effects of the device on the key receptors and the need and desire on behalf of regulators and developers to collect real data in a careful and controlled manner. A tiered approach is taken to mitigation of potential impacts from the device, which is linked closely to active management of the device and a programme of monitoring of key receptors and device.

This approach allows management of the device to be changed in light of monitoring results, with operation parameters, and mitigation measures modified as required. The aim is the gradual removal of mitigation and development of appropriate operation of the device, in light of data collected. It may also be appropriate for licensing conditions and monitoring measures to be adapted in response to the results of on going monitoring.

Provision must be made to ensure that any adaptations required to management measures, mitigation and monitoring can be implemented effectively as required, and monitoring should be reinforced with effective review and remedial action mechanisms. These may include reassessment of the development in light of actual effects that occur, or may include observation and reporting on the nature and scale of effects and comparison with those predicted in the Environmental Statement.

3.6 Introduction to proceeding volumes

The proceeding volumes discuss each receptor group in turn, and discuss the following:

- Descriptions of relevant species or habitats in Scottish waters, including those which are at risk of interaction with wet renewable devices, protected by legislation, or highlighted for their rarity or importance;
- Identification of relevant legislation and licences which survey and monitoring would be required to satisfy;
- Discussion of potential impacts which may occur during construction, operation or decommissioning of the wave or tidal developments;
- Discussion of the key questions which would require answering by survey and monitoring;
- A summary of key information sources and data sources;
- Discussion of survey design;
- Discussion of survey methodology required for site characterisation and establishment of baseline conditions;
- Discussion of the monitoring methods required to establish the impacts of construction and operation of deployed devices;
- Identification of important data gaps and major mitigation measures for consideration;
- Discussion on the interaction of techniques and results across taxa groups; and
- Specification of protocols for survey and monitoring techniques.

Each volume contains a bespoke glossary of relevant terms, acronym list and reference list.

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