

**A review of the potential impacts of wave
and tidal energy development on
Scotland's marine environment**

**Appendix 3 – Addressing potential key
issues**

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In collaboration with:

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1 Introduction

The main objectives of this study were to identify the potential key issues associated with the development of marine energy and Scotland's marine ecological environment and to develop suitable strategies that can be used by developers, regulators and advisors to inform project specific EIA's, baseline survey and mitigation and monitoring plans on a project and site specific basis.

1.1 Appendix content

This appendix outlines suggested measures/activities for addressing each of the potential key issues identified through the assessment process on a project specific basis. These recommendations are based on the current status of the industry, best available knowledge regarding technology development pathways, regulatory concerns and the key environmental issues flagged up during the assessment process.

Commentary and recommendations regarding the following are provided for each key issue in relation to a single device deployment and a demonstration array:

- Desk based studies
- Baseline characterisation surveys
- Further desk based studies
- Monitoring during and post deployment
- Supplementary research opportunities

Objectives and recommendations are provided with regards to each suggested measure/activity.

The following information is also provided for each key issue:

- What are the relevant technologies and support structures?
- What species / groups may be vulnerable?
- How could the issue be addressed on a project and site specific basis?

This appendix is split into the following sections:

- marine mammals;
- basking shark;
- marine birds; and
- benthic species and habitats.

1.2 Using this information

This information should be used to facilitate early discussions between project developers and key stakeholders as part of each project specific Environmental Impact Assessment (EIA). The information contained in this appendix should be particularly useful for identifying and defining the following:

- The scope of the preliminary desk based studies required to inform a project specific environmental impact assessment (EIA) or environmental appraisal (EA)
- The baseline characterisation surveys that should be undertaken to undertake a project specific EIA/EA and under what circumstances these may be appropriate
- Any detailed desk studies/assessments that may be required following baseline characterisation surveys to inform a project specific EIA/EA and under what circumstances these may be appropriate
- Any mitigation and monitoring measures that should be implemented during installation and operation to mitigate and monitor potentially significant impacts and under what circumstances any measure(s) may be appropriate
- Any supplementary research that could be undertaken to inform future and larger scale project design, site selection and EIA/EA activities and reduce uncertainty around key issues

Please note that this information is not prescriptive and should be viewed as a starting point for discussion regarding any particular project or site. This information should be used to help inform and define the scope of any project specific environmental impact assessments and environmental mitigation and monitoring plans.

It is envisaged that this information will be particularly relevant during early discussions between developers, regulators and key stakeholders in preparation for, during and following the submission of project Scoping Reports and the drafting of Environmental Mitigation and Monitoring Plans.

The main aims of this Appendix are to:

1. Differentiate between studies and monitoring that **should** be undertaken around single device deployments and demonstration scale arrays to identify, assess and monitor any potentially significant project impacts and what further studies and research **could** be undertaken around single device deployments and demonstration scale arrays to help reduce uncertainty and better understand the potential impacts of larger scale arrays. This will help define what is required of developers at a project level and what opportunities exist for supplementary or strategic research.
2. Identify strategic research studies/initiatives that could be undertaken around single device deployments/demonstration scale arrays to help inform the design activities and consenting processes associated with future large scale arrays; particularly those that would help reduce uncertainty around potentially key issues.

Note: whilst it is important that developers are able to identify what assessments and monitoring studies should be undertaken to identify, assess and monitor any potentially significant impacts that may result from a proposed development, it is also critical that coordinated strategic research is undertaken around the first deployments and arrays in order to reduce uncertainty around potential key issues and ensure that the necessary data and information is available to inform the consenting of future larger scale arrays. This may include research around potential key issues not considered within this Appendix i.e. those that may only become relevant for larger/commercial scale arrays.

2 Marine Mammals

Key issue 1 - The potential effects on marine mammals from underwater noise generated by operational wave and tidal energy converters

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to underwater noise from operational devices that should be considered on a project specific basis: For definitions of the scoring criteria, refer to Section 0.

Relevant technologies	Relevant species / groups	Summary of assessment results
<p>Tidal technologies Axial flow turbine Cross flow turbine Reciprocating hydrofoils Archimedes screw Tidal kite</p> <p>Wave technologies Oscillating wave surge converter Submerged pressure differential Oscillating water column (offshore) Overtopping device (offshore) Attenuator Rotating mass Point absorber</p>	<p>Seals Cetaceans Otters</p>	<p>Operational noise levels of devices are currently unknown however operational noise levels from existing measurements from wave and tidal devices suggest that noise is not likely to be at levels likely to cause injury or significant behavioural effects (Robinson & Lepper, 2013).</p> <p>Assessment score: 'unknown'</p>

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the effects of operational underwater noise on marine mammals.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies – underwater operational noise

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA.	No significant impacts are expected from the operation of a single machine unless noise levels are likely to be significantly different to those measured in previous studies.

Baseline characterisation surveys – underwater operational noise

Activity	Objective	Comment
None recommended	N/A	No significant impacts are expected from the operation of a single machine unless noise levels are likely to be significantly different to those measured in previous studies. Ambient noise measurements have already been undertaken at a number of wave and tidal energy sites. It is expected that these would be sufficient to inform assessments for most single devices.

Monitoring during and post installation – underwater operational noise

Activity	Objective	Comment
None recommended	N/A	No significant impacts are expected from the operation of a single machine unless noise levels are likely to be significantly different to those measured in previous studies; therefore, no acoustic monitoring should be required as part of any licence/consent. However, it should be noted that this issue could be informed by collection of operational noise data as outlined in the 'Strategic research opportunities and requirements' section (see below).

Strategic research opportunities and requirements – underwater operational noise

Activity	Objective	Comment
Monitor noise generated during device operation	To characterise the acoustic signature of a single operational device	<p>Any data that can be gathered regarding the acoustic characteristics of a single device will help to build an evidence base of operational noise levels of wave and tidal energy converters. This evidence base could be highly beneficial to inform future impact assessment work and help streamline future licence application processes.</p> <p>Noise measurements from single devices will also be extremely useful to inform EIA/HRA for larger scale arrays and can be used in noise propagation modelling (see below).</p> <p>It is therefore in any developer's best interest to gather as much information as possible from test deployments. This data should be gathered with a view as to how the data will be analysed and used to inform future developments, consenting activities and research.</p> <p>The usefulness of an acoustic evidence base will be dependent on the establishment of an agreed approach to measuring, analysing and reporting of operational device acoustic data e.g. Robinson <i>et al</i>, (2014) - NPL Good Practice Guide No. 133 Underwater Noise Measurement¹.</p>
Noise propagation modelling	To inform demonstration array site selection and consenting activities	<p>Acoustic signature data from single devices could be used to inform the development of noise propagation models for demonstration scale and commercial scale arrays. Noise propagation modelling can be used to increase understanding of array effects and to help predict the potential impacts of operational underwater noise on marine wildlife.</p> <p>Site specific baseline data may be required to inform noise propagation modelling. Measurement of ambient noise in high energy wave and tidal environments should be undertaken using best practice guidance e.g. Robinson <i>et al</i>, (2014) - NPL Good Practice Guide No. 133 Underwater</p>

¹ Good Practice Guide for Underwater Noise Measurement, National Measurement Office, Marine Scotland, The Crown Estate, Robinson, S.P., Lepper, P. A. and Hazelwood, R.A., NPL Good Practice Guide No. 133. 2014. Available at: <http://www.thecrownestate.co.uk/media/559036/ei-good-practice-guide-underwater-noise-measurement.pdf>

Activity	Objective	Comment
		Noise Measurement.

Demonstration arrays (up to 10MW)

Preliminary desk based studies– underwater operational noise

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA.	Operational noise levels of devices are currently unknown however operational noise levels from existing measurements from wave and tidal devices suggest that noise is not likely to be at levels likely to cause injury or significant behavioural effects (Robinson & Lepper, 2013) ² . Therefore, no significant impacts are expected to arise from the operation of a 10MW array. A desk based study to inform EIA is recommended as a proportionate approach.

Baseline characterisation surveys – underwater operational noise

Activity	Objective	Comment
None recommended	N/A	Operational noise levels of devices are currently unknown however operational noise levels from existing measurements from wave and tidal devices suggest that noise is not likely to be at levels likely to cause injury or significant behavioural effects (Robinson & Lepper, 2013). Therefore, no significant impacts are expected to arise from the operation of a 10MW array. It is challenging to accurately characterise ambient acoustics in exposed offshore wave environments or in strong tidal conditions. This is a high cost activity which may need to be conducted over many months and should only be necessary in extreme circumstances i.e. where chronic noise is expected at levels which may cause injury to particularly sensitive species. This is not expected with regards to operational noise from a 10MW demonstration array.

² Robinson, S.P and Lepper, P.A. "Scoping study: Review of current knowledge of underwater noise emissions from wave and tidal stream energy devices". The Crown Estate, 2013.

Monitoring during and post installation– underwater operational noise

Activity	Objective	Comment
None recommended	N/A	<p>Operational noise levels of devices are currently unknown however operational noise levels from existing measurements from wave and tidal devices suggest that noise is not likely to be at levels likely to cause injury or significant behavioural effects (Robinson & Lepper, 2013). Therefore, no significant impacts are expected to arise from the operation of a 10MW array; therefore, no acoustic monitoring should be required as part of any licence/consent.</p> <p>However, it should be noted that this issue could be informed by collection of operational noise data as outlined in the 'Strategic research opportunities and requirements' section (see below).</p>

Strategic research opportunities and requirements– underwater operational noise

Activity	Objective	Comment
Monitor noise generated during device operation	To determine the character and extent of any noise generated by demonstration arrays	<p>In the absence of results from monitoring around single devices and demonstration arrays, it may become difficult to accurately assess the possible impacts associated with the operation of larger commercial scale arrays. This may affect the ability of the Regulators to determine consent applications.</p> <p>Therefore, any data that can be gathered regarding the acoustic characteristics of a demonstration array will help to build an evidence base of operational noise levels of wave and tidal energy converters. This evidence base could be highly beneficial to inform future impact assessment work and help streamline future licence application processes.</p> <p>Noise measurements from wave and tidal demonstration arrays will also be extremely useful to inform EIA/HRA for larger scale arrays and may be help to validate noise propagation modelling predictions (see below).</p> <p>It is therefore in any developer's best interest to gather as much information as possible from test deployments. This data should be gathered with a view as to how the data will be analysed and used to inform future developments, consenting</p>

Activity	Objective	Comment
		<p>activities and research.</p> <p>The usefulness of an acoustic evidence base will be dependent on the establishment of an agreed approach to measuring, analysing and reporting of operational device acoustic data e.g. Robinson <i>et al</i>, (2014) - NPL Good Practice Guide No. 133 Underwater Noise Measurement</p>
Noise propagation modelling	To inform commercial scale array site selection and consenting activities	<p>Acoustic signature data from demonstration arrays could be used to inform the development of noise propagation models for commercial scale arrays. Noise propagation modelling can be used to increase understanding of array effects and to help predict the potential impacts of operational underwater noise on marine wildlife.</p> <p>Site-specific baseline data may be required to inform noise propagation modelling. Measurement of ambient noise in high energy wave and tidal environments should be undertaken using best practice guidance e.g. Robinson <i>et al</i>, (2014) - NPL Good Practice Guide No. 133 Underwater Noise Measurement.</p>

Key issue 2 - The potential effects on marine mammals from underwater and above surface noise generated during piling and drilling activities

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to noise generated during piling and drilling activities that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant support structures	Relevant species / groups	Significance scoring
Underwater noise		
Driven/percussion piles	Cetaceans	<p>Increased/altered noise levels will occur temporarily during installation activities (pile – driving driven / percussion piles). There is the potential for noise levels to result in injury of an individual cetacean however there are mitigation measures that must be implemented to avoid any such impact.</p> <p>Disturbance is also a possibility (e.g. displacement / avoidance, reduction in foraging success, etc.) and the significance of any effects may be site specific.</p> <p>Assessment score: ‘1’ – potentially significant</p>
	Seals Otters	<p>Increased/altered noise levels will occur temporarily during installation activities (pile-driving driven / percussion piles). The effects of pile-driving noise on seals / otters are currently unknown however disturbance is possible (e.g. displacement / avoidance, reduction in foraging success, etc.). At 10MW scale of development it is unlikely that these impacts would affect a significant number of animals to the extent that would result in a change in the stability of the local / regional population.</p> <p>It should be noted that for certain populations, the loss of a single animal may be considered to be potentially significant.</p> <p>Assessment score: ‘unknown’</p>
Drilled / grouted	Cetaceans	Increased/altered noise levels will occur

Relevant support structures	Relevant species / groups	Significance scoring
piles Rock anchors	Seals Otters	<p>temporarily during installation activities (pile-drilling and drilling for rock anchors). The effects of drilling noise on cetaceans, seals and otters are currently unknown. Death / non-auditory / auditory tissue damage is considered unlikely however disturbance is possible (e.g. displacement / avoidance, reduction in foraging success) or there may be no effect. The significance of any effects may be site specific.</p> <p>Pile drilling is generally a much less noisy activity than percussion pile driving, and consists of a large, heavy drill bit rotating slowly on the seabed and grinding the rock. Though there are only a few datasets of noise measured during pile-drilling, the levels reported indicate that the radiated noise is similar to a vessel of modest size (Robinson & Lepper, 2013).</p> <p>Assessment score: 'unknown'</p>
Above surface noise		
Driven/percussion piles	Seals Otter	<p>Noise above surface would occur during installation of driven piles. It is unknown whether any noise generated during driven piling would be at a level sufficient to disturb seals or otters. Any disturbance would be temporary and may also be site specific.</p> <p>Assessment score: 'unknown'</p>

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the effects of noise generated from piling and drilling activities on marine mammals.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies – piling / drilling noise

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA.	<p>Piling / drilling noise should be considered during all project EIAs where this installation method is under consideration.</p> <p>It is recommended that a 'noise profile' for the project is produced to identify the components / activities associated with the proposed development which may generate potentially significant levels of noise; including piling/drilling activities.</p> <p>There is likely to be sufficient data available on noise levels from piling activities (particularly from the offshore wind industry) and drilling activities (projects such as MCT Strangford Lough, Voith Hydro and Bauer at EMEC) to inform EIA/HRA.</p>
Develop a project specific Environmental Mitigation and Monitoring Plan (EMMP)	To ensure that suitable mitigation, monitoring and management measures are agreed and implemented	<p>A project and site specific EMMP should be developed based on the appropriate JNCC Protocols³. This should be agreed with the Regulator prior to any construction work commencing.</p> <p>With the appropriate mitigation measures in place, no significant impacts are expected from the installation of a single piled/drilled support structure or one rock anchor mooring system.</p> <p>Where a development is planned near to shore in close proximity (e.g. <1km) to known seal haul outs, potential disturbance to seals from above surface noise should be given appropriate consideration within the EMMP.</p>

³ Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010)

Activity	Objective	Comment
		Where a development is planned near to shore in close proximity (e.g. <250m) ⁴ to areas that could hold breeding otters, potential disturbance to otters from above surface noise should be given appropriate consideration within the EMMP.

Baseline characterisation surveys – piling / drilling noise

Activity	Objective	Comment
None recommended	N/A	With the appropriate mitigation measures in place, no significant impacts are expected from the installation of a single piled/drilled support structure or one rock anchor mooring system.

Monitoring during and post installation – piling / drilling noise

Activity	Objective	Comment
Follow the project specific EMMP during construction	To avoid any possible significant impacts on sensitive species.	<p>A project and site specific EMMP should be developed based on the appropriate JNCC Protocols⁵. This should be agreed with the Regulator prior to any construction work commencing.</p> <p>Where percussion piling activities are to be undertaken for developments near to shore within close proximity (e.g. <1km) to known seal haul outs, measures to monitor potential disturbance to seals may be included in the EMMP if works are scheduled during sensitive periods and may be required outside of sensitive periods depending on the importance of the haul out site and the status of the population..</p> <p>Where percussion piling activities are to be undertaken for developments near to shore within close proximity (e.g. <250m) to areas that could hold breeding otters, measures to avoid potential disturbance to breeding otters may be included in the EMMP.</p> <p>It should be noted that this issue may be further informed by collection of acoustic data during</p>

⁴ <http://www.snh.gov.uk/about-scotlands-nature/wildlife-and-you/otters/assessing/>

⁵ Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise:

http://jncc.defra.gov.uk/pdf/JNCC_Guidelines_Piling%20protocol_August%202010.pdf

Activity	Objective	Comment
		<p>piling / drilling activities as outlined in the 'Strategic research opportunities and requirements' section (see below).</p> <p>No specific monitoring measures are recommended following construction.</p>

Strategic research opportunities and requirements – piling / drilling noise

Activity	Objective	Comment
Acoustic monitoring during construction	To inform future and larger scale project design and consenting activities (including EMMPs) and to validate noise propagation models	<p>Any data that can be gathered regarding noise levels of piling / drilling activities in wave / tidal high energy environments will help to build an evidence base. This evidence base could be highly beneficial to inform future impact assessment work and help streamline future licence application processes.</p> <p>Noise measurements of piling / drilling activities in high energy wave and tidal environments will also be extremely useful to inform EIA/HRA for larger scale arrays and may be useful to validate noise propagation modelling predictions.</p> <p>It is therefore in any developer's best interest to gather as much information as possible from test deployments. This data should be gathered with a view as to how the data will be analysed and used to inform future developments, consenting activities and research.</p>

Demonstration arrays (up to 10MW)

Preliminary desk based studies – piling / drilling noise

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA.	<p>Piling / drilling noise should be included in all project EIAs where this installation method is under consideration.</p> <p>It is recommended that a 'noise profile' for the project is produced to identify the components / activities associated with the proposed development which may generate potentially significant levels of noise.</p> <p>There is likely to be sufficient data available on noise levels from piling activities (particularly from the offshore wind industry) and drilling activities (projects such as MCT Strangford Lough, Voith Hydro and Bauer at EMEC) to inform EIA/HRA.</p> <p>Noise propagation modelling may be used to define the potential zone of ecological effect and establish appropriate mitigation and observation zones for the project EMMP.</p>
Develop a project specific Environmental Mitigation and Monitoring Plan (EMMP)	To ensure that suitable mitigation, monitoring and management measures are agreed and implemented	<p>A project and site specific EMMP should be developed based on the appropriate JNCC Protocols⁶. This should be agreed with the Regulator prior to any construction work.</p> <p>With the appropriate mitigation measures in place, no significant impacts are expected from the installation of piled / drilled support structures for a 10MW demonstration array.</p> <p>Where a development is planned near to shore in close proximity (e.g. <1km) to known seal haul outs, potential disturbance to seals from above surface noise should be given appropriate consideration within the EMMP.</p> <p>Where a development is planned near to shore in close proximity (e.g. <250m) to areas that could hold breeding otters, potential disturbance to otters from above surface noise should be given appropriate consideration within the EMMP.</p>

⁶ Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010)

Baseline characterisation surveys – piling / drilling noise

Activity	Objective	Comment
Conduct baseline acoustic survey	To inform the development of a robust site specific Environmental Mitigation and Monitoring Plan.	<p>Baseline acoustic surveys may be needed where a development involving percussion piling is proposed in close proximity to a sensitive site during sensitive periods (e.g. within 1km of a known seal haul out during breeding / moulting season or within <250m of an otter breeding area) and in the absence of accurate and appropriate site specific baseline acoustic data.</p> <p>It may be necessary to undertake a baseline acoustic survey to gather data to inform noise propagation modelling to help to define the possible zone of ecological effect and establish appropriate mitigation and observation zones for the project EMMP.</p> <p>Where a proposed development site is distant to any particularly sensitive sites, baseline acoustic surveys are unlikely to be necessary as existing data and protocols can be used to develop a robust EMMP to ensure protection of marine mammals during construction.</p> <p>Drilling activities are not expected to have the same level of potential impact to marine mammals compared to percussion piling activities. For drilling activities, no baseline acoustic surveys are likely to be required as existing data and protocols can be used to develop a robust EMMP to ensure protection of marine mammals during construction.</p>

Further desk based studies – piling / drilling noise

Activity	Objective	Comment
Noise propagation modelling	To determine the possible extent of any effect and to inform the development of a robust site specific Environmental Mitigation and Monitoring Plan.	<p>Where a development involving percussion piling is proposed near to shore in close proximity to a sensitive site during sensitive periods (e.g. within 1km of a known seal haul out during breeding /moulting season or within <250m of an otter breeding area) noise propagation modelling could be used to define the possible zone of ecological effect of impacts from above surface noise and to establish appropriate mitigation and observation zones for the project EMMP.</p> <p>Should percussion piling be required over an extended time during sensitive periods in close</p>

Activity	Objective	Comment
		proximity to seal haul outs, it may be necessary to undertake noise propagation modelling using site specific baseline acoustic data (see above) to determine the zone of potential effect and inform the development of a site specific Marine Mammal Protection Plan.

Monitoring during and post installation – piling / drilling noise

Activity	Objective	Comment
Follow the project specific EMMP during construction	To avoid any possible significant impacts on sensitive species.	<p>A project and site specific EMMP should be developed based on the appropriate JNCC Protocols⁷. This should be agreed with the Regulator prior to any construction work.</p> <p>Where percussion piling activities are to be undertaken for developments near to shore within close proximity (e.g. <1km) to known seal haul outs, measures to monitor potential disturbance to seals may be included in the EMMP if works are scheduled during sensitive periods and may be required outside of sensitive periods depending on the importance of the haul out site and the status of the population...</p> <p>Where percussion piling activities are to be undertaken for developments near to shore within close proximity (e.g. <250m) to areas that could hold breeding otters, measures to avoid potential disturbance to breeding otters may be included in the EMMP.</p> <p>It should be noted that this issue may be further informed by collection of acoustic data during piling / drilling activities as outlined in the 'Strategic research opportunities and requirements' section (see below).</p> <p>No specific monitoring measures are recommended following construction.</p>

7 Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise. Available at: http://jncc.defra.gov.uk/pdf/JNCC_Guidelines_Piling%20protocol_August%202010.pdf

Strategic research opportunities and requirements– piling / drilling noise

Activity	Objective	Comment
Acoustic monitoring during construction	To inform future project design and consenting activities and to validate noise propagation models.	<p>Any data that can be gathered regarding noise levels of piling / drilling activities in wave / tidal high energy environments will help to build an evidence base. This evidence base could be highly beneficial to inform future impact assessment work and help streamline future licence application processes.</p> <p>Noise measurements of piling / drilling activities in high energy wave and tidal environments will also be extremely useful to inform EIA/HRA for larger scale arrays and may be useful to validate noise propagation modelling predictions.</p> <p>It is therefore in any developer's best interest to gather as much information as possible from test deployments. This data should be gathered with a view as to how the data will be analysed and used to inform future developments, consenting activities and research.</p>

Key issue 3 - Potential for collision between marine mammals and tidal energy converters and associated moorings / support structures

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to collision risk that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
<p>Tidal technologies Axial flow turbine Cross flow turbine Reciprocating hydrofoils Archimedes screw Tidal kite</p>	<p>Cetaceans</p>	<p>It is unknown whether an interaction between cetaceans and tidal devices is possible / likely to occur however death / severe injury of a single cetacean is considered potentially significant. It is possible that any collision event with a tidal turbine may potentially result in death / severe injury of a cetacean. The likelihood and physical consequences of such an event are unknown. Collisions with stationary structures e.g. mooring lines / support structures are less likely to cause death but injuries may result.</p> <p>Assessment score: '1' (potentially significant)</p>
<p>Moorings / support structures Driven/percussion piles Drilled / grouted piles Rock anchors / pinned gravity bases Rock anchors and mooring lines Rock anchors and taut mooring lines Gravity base structure Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines</p>	<p>Seals</p>	<p>It is unknown whether an interaction between seals and tidal turbines is possible / likely to occur. There is potential for collision with moving structures e.g. turbine blades. Collisions with stationary structures e.g. mooring lines / support structures are less likely to cause death but injuries may result. The significance of the impact on seal populations is unknown and will be site-specific. It is unknown whether collision could lead to death / injury of a significant number of seals to the extent that would result in a change in the stability of the local / regional population.</p> <p>It should be noted that for certain populations, the loss of a single animal may be considered to be potentially significant.</p>

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
		Assessment score: 'unknown'

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential collision risk for marine mammals.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies – collision risk - tidal

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA.	Collision risk should be considered in all tidal project EIAs.
Develop a project specific EMMP and Adaptive Management Strategy	To ensure that suitable mitigation, monitoring and management measures are agreed and implemented.	A project EMMP should be developed based on the best available information. This should include consideration of the species that will potentially be present across the proposed development area and their particular sensitivities. Any EMMP should be fully informed by the best available knowledge regarding other similar projects and monitoring as well as the most up to date information available regarding collision risk from tidal turbines.

Baseline characterisation surveys – collision risk - tidal

Activity	Objective	Comment
None recommended	N/A	All single device projects require a project specific EMMP and Adaptive Management Strategy. In some instances to date, these have been informed by collision risk modelling studies that have required site specific baseline survey data. Given the types of mitigation and monitoring measures available at this time, and the lack of understanding regarding avoidance and evasion behaviour, it is unlikely that the results from collision risk modelling studies will be a defining factor in the development of any EMMP and

Activity	Objective	Comment
		<p>Adaptive Management Strategy.</p> <p>However, it may be advantageous for developers to undertake collision risk modelling to inform the development of a site specific EMMP and Adaptive Management Strategy. Any benefits of such an approach should be discussed with the Regulator on a case by case basis. Any collision risk modelling requires an estimate of marine mammal density/passage rates for the development area. Site specific baseline characterisation studies may be required to provide additional data for use in collision risk modelling or to provide data where none exists.</p>

Monitoring during and post installation – collision risk - tidal

Activity	Objective	Comment
Implement project specific EMMP	To attempt to detect any possible collision events	<p>Uncertainty with regards to the possibility, likelihood and consequence of a collision event occurring between a marine mammal and a tidal turbine is one of the industry's key issues. It is essential that this issue is addressed appropriately at the earliest possible time in such a way that informs future site selection, project design and consenting activities.</p> <p>Therefore, it is essential that all single device deployments develop and a robust EMMP which contains an Adaptive Management Strategy. This should include measures to attempt to detect any collision events with the device. It is also important that results are regularly shared so as to quickly understand the possible risk of such an event occurring.</p> <p>It will also be highly advantageous for developers and researchers to undertake monitoring around single devices to better understand avoidance and evasion behaviour. It is recommended that such measures are incorporated into any single device deployment EMMP. Information gathered around single devices could inform larger scale project EIAs, EMMPs and Adaptive Management Strategies.</p> <p>It should be noted that greater understanding of collision risk may be gained by undertaking additional monitoring studies as outlined in the</p>

Activity	Objective	Comment
		'Strategic research opportunities and requirements' section (see below).

Strategic research opportunities and requirements - collision risk -tidal

Activity	Objective	Comment
Monitoring behaviour of marine mammals around tidal turbines, moorings and support structures.	To better understand the behaviour of marine mammals around tidal turbines; particularly with regards to detection and avoidance.	<p>Any additional monitoring that can be undertaken to better understand the behaviour of marine mammals in tidal streams and around operating tidal turbines e.g. passage rates, avoidance and evasion behaviour, etc., may provide essential information for future impact assessment work and licence applications.</p> <p>Such information could also be used to inform, improve and refine collision risk modelling.</p> <p>It is in the developer's, researchers and the industry's best interests to gather as much relevant data and information as possible around single devices to inform future project design and consenting activities.</p>
Further development of collision risk modelling approaches	To improve the ability of collision risk modelling to predict collision risk estimates	Data gathered during monitoring studies around single devices may help improve collision risk model input parameters and therefore improve confidence in collision risk estimates.

Demonstration arrays (up to 10MW)

Preliminary desk based studies – collision risk - tidal

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA.	Collision risk should be considered in all tidal project EIAs.
Develop a project EMMP and Adaptive Management Strategy	To ensure that suitable mitigation, monitoring and management measures are agreed and implemented.	<p>A project EMMP should be developed based on the best available information. This should include consideration of the species that will potentially be present across the proposed development area and their particular sensitivities.</p> <p>Any EMMP should be fully informed by the best available knowledge regarding other similar projects and monitoring as well as the most up to date information available regarding collision risk from tidal turbines.</p>

Baseline characterisation surveys – collision risk - tidal

Activity	Objective	Comment
None recommended	N/A	<p>All demonstration array projects require a project specific EMMP and Adaptive Management Strategy. In some instances to date, these have been informed by collision risk modelling studies that have required site specific baseline survey data.</p> <p>Given the types of mitigation and monitoring measures available at this time, and the lack of understanding regarding avoidance and evasion behaviour, it is unlikely that the results from collision risk modelling studies will be a defining factor in the development of any EMMP and Adaptive Management Strategy.</p> <p>However, it may be advantageous for developers to undertake collision risk modelling to inform the development of a site specific EMMP and Adaptive Management Strategy. Any benefits of such an approach should be discussed with the Regulator on a case by case basis. Any collision risk modelling requires an estimate of marine mammal density/passage rates for the development area. Site specific baseline characterisation studies may be required to provide additional data for use in collision risk modelling or to provide data where none exists.</p>

Monitoring during and post installation – collision risk - tidal

Activity	Objective	Comment
Implement project specific EMMP	To attempt to detect any possible collision events	<p>Uncertainty with regards to the possibility, likelihood and consequence of a collision event occurring between a marine mammal and a tidal turbine is one of the industry's key issues. It is essential that this issue is addressed appropriately at the earliest possible time in such a way that informs future site selection, project design and consenting activities.</p> <p>Therefore, it is essential that all projects develop a robust EMMP which contains an Adaptive Management Strategy. This should include measures to attempt to detect any collision events with a device. It is important that any results are regularly shared so as to quickly understand the possible risk of such an event occurring.</p>

Activity	Objective	Comment
		<p>It will also be highly advantageous for developers and researchers to undertake monitoring around single devices and demonstration arrays to better understand avoidance and evasion behaviour. It is recommended that such measures are incorporated into any demonstration array EMMP. Information gathered around demonstration arrays could inform other and larger scale project EIAs, EMMPs and Adaptive Management Strategies.</p> <p>It should be noted that greater understanding of collision risk may be gained by undertaking additional monitoring studies as outlined in the 'Strategic research opportunities and requirements' section (see below).</p>

Strategic research opportunities and requirements – collision risk - tidal

Activity	Objective	Comment
Monitoring behaviour of marine mammals around tidal turbines, moorings and support structures.	To better understand the behaviour of marine mammals around tidal turbines; particularly with regards to detection and avoidance.	<p>Any additional monitoring that can be undertaken to better understand the behaviour of marine mammals in tidal streams and around operating tidal turbines e.g. passage rates, avoidance and evasion behaviour, may provide essential information for future impact assessment work and licence applications.</p> <p>Such information could also be used to inform, improve and refine collision risk modelling.</p> <p>It is in the developer's, researchers and the industry's best interests to gather as much relevant data and information as possible around single devices to inform future project design and consenting activities.</p>
Further development of collision risk modelling approaches	To improve the ability of collision risk modelling to predict collision risk estimates	Data gathered during monitoring studies around demonstration arrays can help improve collision risk model input parameters and therefore confidence in collision risk estimates.
Strategic baseline studies of use of tidal streams by marine mammals	For potentially vulnerable marine mammal species strategic baseline data may improve understanding of the functional importance of tidal streams and improve understanding	<p>Where baseline data is lacking, strategic studies may provide useful data that could be used to inform and improve the estimation of collision risk models.</p> <p>This may provide useful data to inform future impact assessment work and provide greater confidence in EIA (and reduce the need for adopting a precautionary approach).</p>

Activity	Objective	Comment
	of the spatial and temporal patterns of use, routes used for migration or feeding routes and improved understanding of behaviour in tidal streams e.g. diving depth, dive profiles and time spent at depth of operating turbines.	

Key issue 4 - Potential for collision between marine mammals and offshore wave energy converters and associated moorings / support structures

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to collision risk that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
<p>Wave technologies Oscillating wave surge converter Submerged pressure differential Oscillating water column (offshore) Overtopping device (offshore) Attenuator Rotating mass Point absorber</p> <p>Moorings / support structures Driven/percussion piles Drilled / grouted piles Embedment anchor and mooring lines Rock anchors / pinned gravity bases Rock anchors and mooring lines Gravity base structure Gravity anchor and mooring lines</p>	<p>Cetaceans</p>	<p>It is unknown whether an interaction between cetaceans and wave devices is possible / likely to occur. Collisions with technologies with no external moving components or stationary moorings / support structures are less likely to cause death but injuries may result.</p> <p>Assessment score: 'unknown'</p>

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential collision risk for marine mammals.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies – collision risk - wave

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA.	No significant impacts are expected from the operation of a single wave energy converter due to the low probability of a collision event occurring and the low risk of collision to cetaceans as wave machines have limited external moving components.

Baseline characterisation surveys– collision risk - wave

Activity	Objective	Comment
None recommended	N/A	No significant impacts are expected from the operation of a single wave energy converter due to the low probability of a collision event occurring and the low risk of collision to cetaceans as wave machines have limited external moving components. No baseline characterisation surveys are required to inform EIA for this issue.

Monitoring during and post installation– collision risk - wave

Activity	Objective	Comment
None recommended	N/A	No significant impacts are expected from the operation of a single wave energy converter due to the low probability of a collision event occurring and the low risk of collision to cetaceans as wave machines have limited external moving components. No post-installation monitoring of collision is required for a single wave device. However, it should be noted that monitoring behaviour of cetaceans around operational wave machines as outlined in the 'Strategic research opportunities and requirements' section (see

Activity	Objective	Comment
		below) may provide useful data to inform EIA/HRA for larger scale arrays.

Strategic research opportunities and requirements – collision risk - wave

Activity	Objective	Comment
Monitoring behaviour of cetaceans around wave energy devices, moorings and support structures.	To reduce uncertainty regarding the behaviour of cetaceans around wave energy devices.	Any additional monitoring that can be undertaken of nearfield effects using e.g. video cameras, strain gauges, acoustic cameras, or farfield effects using e.g. passive acoustic monitoring systems may provide useful information for future impact assessment work and licence applications. It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.

Demonstration arrays (up to 10MW)

Preliminary desk based studies– collision risk - wave

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA.	No significant impacts are expected from the operation of a single wave energy converter due to the low probability of a collision event occurring and the low risk of collision to cetaceans as wave machines have limited external moving components.

Baseline characterisation surveys – collision risk - wave

Activity	Objective	Comment
None recommended	N/A	No significant impacts are expected from the operation of a single wave energy converter due to the low probability of a collision event occurring and the low risk of collision to cetaceans as wave machines have limited external moving components. No baseline characterisation surveys are required to inform EIA for this issue.

Monitoring during and post installation – collision risk - wave

Activity	Objective	Comment
None recommended	N/A	<p>No significant impacts are expected from the operation of a single wave energy converter due to the low probability of a collision event occurring and the low risk of collision to cetaceans as wave machines have limited external moving components.</p> <p>No post-installation monitoring of collision is required for a demonstration array.</p> <p>However, it should be noted that monitoring behaviour of cetaceans around operational demonstration arrays as outlined in the ‘Strategic research opportunities and requirements’ section (see below) may provide useful data to inform EIA/HRA for larger scale arrays.</p>

Strategic research opportunities and requirements – collision risk - wave

Activity	Objective	Comment
Monitoring behaviour of cetaceans around wave energy devices, moorings and support structures.	To reduce uncertainty regarding the behaviour of cetaceans around wave energy devices.	<p>Any additional monitoring that can be undertaken of nearfield effects using e.g. video cameras, strain gauges, acoustic cameras, or farfield effects using e.g. passive acoustic monitoring systems may provide useful information for future impact assessment work and licence applications.</p> <p>It is in the developer’s and the industry’s best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

Key issue 5 - Potential barrier to movement for marine mammals due to the presence of wave and tidal energy converters and associated moorings / support structures

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to barrier to movement that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
Tidal technologies		
<p>Tidal technologies Axial flow turbine Cross flow turbine Reciprocating hydrofoils Archimedes screw Tidal kite</p> <p>Moorings / support structures Driven/percussion piles Drilled / grouted piles Rock anchors / pinned gravity bases Rock anchors and mooring lines Rock anchors and taut mooring lines Gravity base structure Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines</p>	<p>Cetaceans</p>	<p>The presence and operation of devices and associated moorings / support structures could potentially result in a barrier to movement to cetaceans. These devices could potentially create a barrier to movement. The significance of any impact will be site specific and will depend on whether the development is perceived as a barrier to movement and if an important route is affected e.g. frequently travelled route or between foraging sites and breeding sites, etc., and if there are alternative routes available.</p> <p>In terms of migratory routes for cetaceans, developments at this scale are not considered to present a barrier to movement for UK populations.</p> <p>Assessment score: 'unknown'</p>

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
	Seals	<p>The presence and operation of devices and associated moorings / support structures could potentially result in a barrier to movement to seals. These devices could potentially create a barrier to movement. The significance of any impact will be site specific and will depend on whether the development is perceived as a barrier to movement and if an important route is affected e.g. frequently travelled route or between foraging sites and breeding sites, etc., and if there are alternative routes available.</p> <p>Assessment score: 'unknown'</p>
Wave technologies		
<p>Wave technologies Oscillating wave surge converter</p> <p>Moorings / support structures Driven/percussion piles Drilled / grouted piles Gravity base structure Rock anchors / pinned gravity bases</p>	Seals Otters	<p>OWSCs would be located in the surge zone in shallow (10-30m) water depths in nearshore waters. This area could potentially be used by otter or seals. The significance of any impact will be site specific and will depend on whether the OWSC development is perceived as a barrier to movement and if an important route is affected e.g. frequently travelled route or between foraging sites and breeding site, etc., and if there are alternative routes available.</p> <p>Assessment score: 'unknown'</p>
<p>Oscillating water column (shoreline) Overtopping device (shoreline)</p>	Otters	<p>These devices could potentially create a barrier to movement but the impact will be site specific. The significance of any impact will be site specific and will depend on whether the development is perceived as a barrier to movement and if an important route is affected e.g. frequently travelled route or between foraging sites and breeding sites, etc., and if there are alternative routes available.</p> <p>Assessment score: 'unknown'</p>

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address barrier effects for marine mammals.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies – barrier to movement

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	<p>Undertake for all single deployments. This should follow the normal project specific EIA procedures.</p> <p>The desk-based review of existing information regarding species distribution / behaviour across the site should take into consideration important factors such as: whether or not the site is positioned between two important areas e.g. a foraging site and haul-out site (seals), between two important areas or within a known migration route (cetaceans) and the availability of alternative routes.</p>

Baseline characterisation surveys – barrier to movement

Activity	Objective	Comment
Conduct baseline marine mammal surveys	To determine the behaviour and distribution of species (as listed above) through the proposed development site to inform site design, EIA and EMMP	<p>In order to determine if barrier to movement occurs due to the presence of a single machine, baseline site characterisation data may be required to inform future impact monitoring studies.</p> <p>This work should only be undertaken for vulnerable populations where the development site is positioned between two important areas e.g. a foraging site and haul-out site (seals), or between two important areas or within a known migration route (cetaceans) and if there are no known available alternative routes for passage e.g. within a narrow tidal channel, sound, etc. Where this is not the case, no baseline surveys are considered necessary to inform this issue.</p> <p>Any baseline characterisation surveys undertaken should be designed to maximise the potential to detect any change in use of the area through future impact monitoring, should this be required.</p>

Activity	Objective	Comment
		It should be noted that in some instances, a strategic approach to baseline data collection on marine mammal density, distribution, migration routes, etc. may be beneficial to gather data to inform larger scale developments as outlined in 'Strategic research opportunities and requirements' section (see below).

Further desk based studies – barrier to movement

Activity	Objective	Comment
Impact assessment (following any necessary baseline characterisation surveys)	To determine, based on baseline characterisation surveys, whether or not there are likely to be any potentially significant effects on the species identified and to inform the development of a site specific EMMP.	<p>This work should only be undertaken if baseline survey work has been necessary for sites where the development site is positioned between two known important areas or lies within a known migration route and there is no available alternative route/s for passage e.g. within a narrow tidal channel, sound, etc.</p> <p>This should follow the normal project specific EIA procedures.</p>

Monitoring during and post installation – barrier to movement

Activity	Objective	Comment
Post-installation monitoring	To determine whether or not there is evidence of barrier to movement resulting from the development	<p>This should only be necessary where the development site is positioned between two important areas e.g. a foraging site and haul-out site (seals), or between two important areas or within a known migration route (cetaceans) and if there are no known available alternative routes for passage e.g. within a narrow tidal channel, sound, etc., and where a potentially significant impact on vulnerable populations has been identified during EIA.</p> <p>Where this is not the case, no post-installation monitoring measures are considered necessary to inform this issue.</p> <p>Any monitoring required should be detailed within a project specific EMMP and agreed with the Regulator.</p> <p>Monitoring could include; seal haul outs, site use and behaviour around devices etc.</p>

Activity	Objective	Comment
		It should also be noted that this issue could be informed by collection of marine mammal data as outlined in the 'Strategic research opportunities and requirements' section (see below).

Strategic research opportunities and requirements – barrier to movement

Activity	Objective	Comment
Monitoring presence, distribution and movement patterns of animals in the wider area around devices, moorings and support structures.	To determine whether or not there is evidence of barrier to movement resulting from the development	<p>Any additional monitoring that can be undertaken to better understand the potential impacts of wave and tidal devices on marine wildlife e.g. monitoring presence, distribution and movement patterns (passage rates, avoidance and evasion behaviour, etc.) in the wider area around devices e.g. farfield effects using widespread visual observations / PAM, etc., may also provide useful information regarding whether species perceive wave or tidal machines as a barrier to movement. This information may be important to inform EIA/HRA for larger scale developments.</p> <p>It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

Demonstration arrays (up to 10MW)

Preliminary desk based studies – barrier to movement

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	<p>Undertake for all demonstration arrays. This should follow the normal project specific EIA procedures.</p> <p>The desk-based review of existing information regarding species distribution / behaviour across the site should take into consideration important factors such as: whether or not the site is positioned between two important areas e.g. a foraging site and haul-out site (seals), between two important areas or within a known migration route (cetaceans) and the availability of alternative routes.</p>

Baseline characterisation surveys – barrier to movement

Activity	Objective	Comment
Conduct baseline marine mammal surveys	To determine the behaviour and distribution of species (as listed above) through the proposed development site to inform site design, EIA and EMMP	<p>In order to determine if barrier to movement occurs due to the presence of a demonstration array, baseline site characterisation data may be required to inform future impact monitoring studies.</p> <p>This work should only be undertaken for vulnerable populations where the development site is positioned between two important areas e.g. a foraging site and haul-out site (seals), or between two important areas or within a known migration route (cetaceans) and if there are no known available alternative routes for passage e.g. within a narrow tidal channel, sound, etc. Where this is not the case, no baseline surveys are considered necessary to inform this issue.</p> <p>Any baseline characterisation surveys undertaken should be designed to maximise the potential to detect any change in use of the area through future impact monitoring, should this be required.</p> <p>It should be noted that in some instances, a strategic approach to baseline data collection on marine mammal density, distribution, migration routes, etc. may be beneficial to gather data to inform larger scale developments as outlined in 'Strategic research opportunities and requirements' section (see below).</p>

Further desk based studies – barrier to movement

Activity	Objective	Comment
Impact assessment (following any necessary baseline characterisation surveys)	To determine, based on baseline characterisation surveys, whether or not there are likely to be any potentially significant effects on the species identified and to inform the development of a site specific EMMP.	<p>This work should only be undertaken if baseline survey work has been necessary for sites where the development site is positioned between two known important areas or lies within a known migration route and there is no available alternative route/s for passage e.g. within a narrow tidal channel, sound, etc.</p> <p>This should follow the normal project specific EIA procedures.</p>

Monitoring during and post installation – barrier to movement

Activity	Objective	Comment
Post-installation monitoring	To determine whether or not there is evidence of barrier to movement resulting from the development	<p>This should only be necessary where the demonstration array is positioned between two important areas e.g. a foraging site and haul-out site (seals), or between two important areas or within a known migration route (cetaceans) and if there are no known available alternative routes for passage e.g. within a narrow tidal channel, sound, etc., and where a potentially significant impact on vulnerable populations has been identified during EIA.</p> <p>Where this is not the case, no post-installation monitoring measures are considered necessary to inform this issue.</p> <p>Any monitoring required should be detailed within a project specific EMMP and agreed with the Regulator.</p> <p>Monitoring could include; seal haul outs, site use and behaviour around devices etc.</p> <p>Any monitoring should be appropriate for the scale, character and location of the project and should be included within the project EMMP. This will be informed by the EIA and any baseline survey work undertaken.</p> <p>It should also be noted that this issue could be informed by collection of marine mammal data as outlined in the 'Strategic research opportunities and requirements' section (see below).</p>

Strategic research opportunities and requirements – barrier to movement

Activity	Objective	Comment
<p>Monitoring presence, distribution and movement patterns of animals in the wider area around devices, moorings and support structures.</p>	<p>To determine whether or not there is evidence of barrier to movement resulting from the development</p>	<p>Any additional monitoring that can be undertaken to better understand the potential impacts of wave and tidal devices on marine wildlife e.g. monitoring presence, distribution and movement patterns (passage rates, avoidance and evasion behaviour, etc.) in the wider area around demonstration arrays e.g. farfield effects using widespread visual observations / PAM, etc., may also provide useful information regarding whether species perceive arrays a barrier to movement. This information may be important to inform EIA/HRA for larger scale developments.</p> <p>It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

Key issue 6 - It is unknown whether the potential exists for cetaceans to become entangled in mooring lines

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to entanglement that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant moorings / support structures	Relevant species / groups	Summary of assessment results
Tidal technologies		
Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon	Cetaceans	It is unknown whether cetaceans could become entangled in mooring lines of size and dimension required to anchor marine renewable devices. An SNH commissioned review of the potential for megafauna entanglement risk from renewable marine energy developments is currently underway by SAMS/Exeter University and is due to report in 2014. Assessment score: 'unknown'
Wave technologies		
Embedment anchor and mooring lines Gravity anchor and mooring lines Rock anchors and mooring lines		

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential entanglement risk for marine mammals.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies - entanglement

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	<p>Undertake this work for all single deployments with mooring lines.</p> <p>This should follow the normal project specific EIA procedures.</p> <p>Impact assessment should consider if entanglement is possible taking into account the number of mooring lines, the configuration of mooring lines, the dimensions and physical properties of the mooring lines and the size and behaviour of animals likely to be present in the area.</p>

Baseline characterisation surveys - entanglement

Activity	Objective	Comment
None recommended	N/A	NA

Monitoring during and post installation - entanglement

Activity	Objective	Comment
None recommended	N/A	NA

Strategic research opportunities and requirements- entanglement

Activity	Objective	Comment
Report any incidents recorded during routine maintenance inspections to the Regulator	To build up a database of information on entanglement risk of marine mammals within mooring arrays to inform future environmental assessments	Any incidents recorded during routine inspections should be reported to the Regulator.

Demonstration arrays (up to 10MW)

Preliminary desk based studies - entanglement

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	Undertake this work for all demonstration arrays with mooring lines. This should follow the normal project specific EIA procedures. Impact assessment should consider if entanglement is possible taking into account the number of mooring lines, the configuration of mooring arrays, the dimensions and physical properties of the mooring lines and the size and behaviour of animals likely to be present in the area.

Baseline characterisation surveys - entanglement

Activity	Objective	Comment
None recommended	N/A	N/A

Monitoring during and post installation - entanglement

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements- entanglement

Activity	Objective	Comment
Report any incidents recorded during routine maintenance inspections to the Regulator	To build up a database of information on entanglement risk of marine mammals within mooring arrays to inform future environmental assessments	Any incidents recorded during routine inspections should be reported to the Regulator.

Key issue 7 - Potential risk of entrapment of marine mammals within device chambers and mooring arrays

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to entrapment within device chambers and mooring arrays that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
Tidal technologies		
Arrays with mooring lines ⁸ : Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon	Large cetaceans - Killer whale, Minke whale, Long finned pilot whale	It is unknown whether large cetaceans would become entrapped within mooring arrays. Assessment score: 'unknown'
Wave technologies		
Arrays with mooring lines ⁹ with the exception of oscillating water column (offshore) and overtopping device (offshore) Embedment anchor and mooring lines Gravity anchor and mooring lines Rock anchors and mooring lines	Large cetaceans - Killer whale, Minke whale, Long finned pilot whale	It is unknown whether large cetaceans would become entrapped within mooring arrays. Assessment score: 'unknown'
Oscillating water column (offshore)	Seals	Oscillating water column devices are very large partially submerged, hollow structures, open to the sea below the water surface. 1 - 2 devices within a 10MW array. It is unknown whether the potential exists for animals to become entrapped within the device when resurfacing. This will be dependent on the size and design of the chamber and the response of the animal. It is not considered possible for seals to become entrapped within the mooring arrays due to body size relative to size and spread of mooring array.

⁸ Axial flow, Cross flow, Tidal kite

⁹ Attenuator, Point absorber, Rotating mass

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
		Assessment score: 'unknown'
Overtopping device (offshore)	Seals	<p>Overtopping device has reservoir openings (turbine inlets) at height slightly above water surface level. It is unknown whether the potential exists for animals to enter inlets or become entrapped within the reservoir. Water flows out of reservoir through a sub-surface turbine outlet. It is considered unlikely that seals would be able to enter turbine outlet against flow of water. This will be dependent on the size and design of the device and the response of the animal.</p> <p>Assessment score: 'unknown'</p>
Overtopping device (shoreline)	Seals and Otters	<p>Overtopping device has reservoir openings at height slightly above water surface level. Water flows out of reservoir through a sub-surface turbine outlet. It is unknown whether the potential exists for animals to enter inlets or become entrapped within the reservoir. This will be dependent on the size and design of the device and the response of the animal.</p> <p>Assessment score: 'unknown'</p>

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential entrapment risk for marine mammals.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployment

Preliminary desk based studies - entrapment

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	Undertake this work for all single deployments with chambers / reservoirs / mooring lines. This should follow the normal project specific EIA procedures. Impact assessment should consider if entry into chamber / reservoir / mooring array is possible by establishing size and design of chamber / configuration of mooring array in relation to size of relevant species

Baseline characterisation surveys - entrapment

Activity	Objective	Comment
None recommended	N/A	N/A

Monitoring during and post installation - entrapment

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements - entrapment

Activity	Objective	Comment
Report any incidents recorded during routine maintenance inspections to the Regulator	To build up a database of information on entrapment risk of marine mammals within chambers / reservoirs / mooring arrays to inform future environmental assessments	Any incidents recorded during routine inspections should be reported to the Regulator.

Demonstration arrays (up to 10MW)

Preliminary desk based studies - entrapment

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	<p>Undertake this work for all demonstration arrays with chambers / reservoirs / mooring lines.</p> <p>This should follow the normal project specific EIA procedures.</p> <p>Impact assessment should consider if entry into chamber / reservoir / mooring array is possible by establishing size and design of chamber / configuration of mooring array in relation to size of relevant species</p>

Baseline characterisation surveys - entrapment

Activity	Objective	Comment
None recommended	N/A	N/A

Monitoring during and post installation - entrapment

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements - entrapment

Activity	Objective	Comment
Report any incidents recorded during routine maintenance inspections to the Regulator	To build up a database of information on entrapment risk of marine mammals within chambers / reservoirs / mooring arrays to inform future environmental assessments	Any incidents recorded during routine inspections should be reported to the Regulator.

Key issue 8 - Direct loss of habitat for seals and otters due to the installation of shoreline wave energy converters

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to loss of habitat that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies	Relevant species / groups	Summary of assessment results
Wave technologies		
Oscillating water column (shoreline) Overtopping device (shoreline)	Seals Otters	Large (100m x 10m) structure, directly installed on shoreline could potentially lead to loss of habitat. The significance of any loss of habitat is unknown and will be site-specific. Significance will depend on the relative importance of the habitat, what the habitat was used for (foraging (otters), breeding, etc.) and the availability of suitable alternative habitat locally. Assessment score: 'unknown'

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential entrapment risk for marine mammals.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies – direct loss of habitat

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	Undertake this work for all shoreline projects. This should follow the normal project specific EIA procedures. To determine the importance of the proposed development area for seals /otters and to identify any particular areas of concern and to determine what/if further baseline characterisation is required (see below).

Baseline characterisation surveys – direct loss of habitat

Activity	Objective	Comment
Undertake baseline seal and otter surveys	To determine the importance of the proposed development area for seals and otters. To aid in project design / site selection to avoid important areas.	This should only be undertaken where it is known that seals and otters use the area but insufficient baseline data is available to determine the relative sensitivity of the site.

Further desk based studies – direct loss of habitat

Activity	Objective	Comment
Undertake impact assessment	To identify any particular areas of concern, using the baseline survey results, regarding the proposed development and to determine the suitability of the site for development	This should follow the normal project specific EIA procedures.

Monitoring during and post installation – direct loss of habitat

Activity	Objective	Comment
Monitor seal behaviour during construction	To monitor any potential impacts during construction	This should only be undertaken where a development lies close to a known haul out site and a potentially significant impact has been identified during EIA.

Strategic research opportunities and requirements– direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	N/A

Demonstration arrays (up to 10MW)

Preliminary desk based studies – direct loss of habitat

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	Undertake this work for all shoreline demonstration arrays. This should follow the normal project specific EIA procedures. To determine the importance of the proposed development area for seals /otters and to identify any particular areas of concern and to determine what/if further baseline characterisation is required (see below).

Baseline characterisation surveys – direct loss of habitat

Activity	Objective	Comment
Undertake baseline seal and otter surveys	To determine the importance of the proposed development area for seals and otters	This should only be undertaken where it is known that seals and otters use the area but insufficient baseline data is available to determine the suitability of the site for development.

Further desk based studies – direct loss of habitat

Activity	Objective	Comment
Undertake impact assessment	To identify any particular areas of concern, using the baseline survey results, regarding the proposed development and to determine the suitability of	This should follow the normal project specific EIA procedures.

Activity	Objective	Comment
	<p>the site for development</p> <p>To determine, based on baseline characterisation surveys, whether or not there are likely to be any potentially significant effects on the species identified</p>	

Monitoring during and post installation – direct loss of habitat

Activity	Objective	Comment
Monitor seal behaviour during construction	To monitor any potential impacts during construction	This should only be undertaken where a development lies close to a known haul out site and a potentially significant impact has been identified during EIA.

Strategic research opportunities and requirements– direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	N/A

Key issue 9 - Potential displacement of essential activities of marine mammals due to the presence of wave and tidal energy converters and associated moorings / support structures

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to displacement that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
Tidal technologies		
<p>Tidal technologies Axial flow turbine Cross flow turbine Reciprocating hydrofoils Archimedes screw Tidal kite</p> <p>Moorings / support structures Driven/percussion piles Drilled / grouted piles Rock anchors / pinned gravity bases Rock anchors and mooring lines Rock anchors and taut mooring lines Gravity base structure Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines</p>	<p>Cetaceans Seals</p>	<p>The presence and operation of devices and associated moorings / support structures could potentially result in the displacement of marine mammals out of the development site. It is unknown whether displacement will occur. The effects of displacement are unknown and will be site-specific. The impact of displacement will depend on the relative importance of the habitat, what essential activity is being displaced (foraging, migratory routes, etc.) and the availability of suitable alternative habitat elsewhere. In some cases, displacement could be a temporary issue with behaviour patterns changing over time as animals habituate to the presence of devices.</p> <p>Assessment score: 'unknown'</p>
Wave technologies		
<p>Oscillating water column (shoreline) Overtopping device (shoreline)</p> <p>Oscillating wave surge converter</p> <p>Moorings / support structures Driven/percussion piles Drilled / grouted piles Rock anchors / pinned gravity bases Gravity base structure</p>	<p>Seals Otters</p>	<p>The presence and operation of devices and associated moorings / support structures could potentially result in the displacement of marine mammals out of the development site. It is unknown whether displacement will occur. The effects of displacement are unknown and will be site-specific. The impact of displacement will depend on the relative importance of the habitat, what essential activity is being displaced (foraging, migratory routes, etc.) and the availability of suitable alternative habitat elsewhere. In some cases, displacement could be a temporary issue with behaviour patterns changing over time as animals habituate to the presence of devices.</p>

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
		Assessment score: 'unknown'

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential effects of displacement for marine mammals.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies - displacement

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	<p>Undertake this work for all single device. This should follow the normal project specific EIA procedures.</p> <p>To determine the importance of the proposed development area for potentially vulnerable species (as listed above). Important considerations will include relative importance of the development area, what essential activity is being displaced (foraging habitat, breeding area, migratory routes, etc.) and the availability of suitable alternative habitat elsewhere.</p> <p>At this scale of development, displacement is not expected to result in any significant (i.e. population level) impacts.</p>

Baseline characterisation surveys - displacement

Activity	Objective	Comment
None recommended	N/A	<p>Displacement due to the presence and operation of a single device is not expected to result in any significant impacts (i.e. population level) impacts.</p> <p>No baseline surveys are considered necessary to inform EIA for this issue.</p> <p>It should be noted that in some instances, a strategic approach to baseline data collection on marine mammal density, distribution, migration routes, etc. may be beneficial to gather data to inform larger scale developments as outlined in the 'Strategic research opportunities and requirements' section (see below).</p>

Monitoring during and post installation - displacement

Activity	Objective	Comment
None recommended	N/A	<p>Displacement due to the presence and operation of a single device is not expected to result in any significant impacts (i.e. population level) impacts.</p> <p>No post-installation monitoring of displacement is required for a single wave or tidal device.</p> <p>However, it should be noted that monitoring behaviour of marine mammals around single devices as outlined in the 'Strategic research opportunities and requirements' section (see below) may provide useful data to inform EIA/HRA for larger scale arrays.</p>

Strategic research opportunities and requirements- displacement

Activity	Objective	Comment
Monitoring presence, distribution and movement patterns of marine mammals in the wider area around devices, moorings and support structures.	To determine whether or not there is evidence of displacement resulting from the development	<p>Any additional monitoring that can be undertaken to better understand the potential impacts of wave and tidal devices on marine wildlife e.g. monitoring presence, distribution and movement patterns (passage rates, avoidance and evasion behaviour, etc.) in the wider area around single devices e.g. farfield effects using widespread visual observations / PAM, etc., may provide data to determine whether or not displacement occurs. This could include monitoring seal activity at important haul-outs adjacent to shoreline wave devices.</p>

Activity	Objective	Comment
		<p>Baseline data may be required to inform impact monitoring research studies.</p> <p>This information will help to build an evidence base to inform understanding of the behavioural response of marine mammals to operational devices which may be important to inform EIA/HRA for larger scale developments.</p> <p>It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

Demonstration arrays (up to 10MW)

Preliminary desk based studies - displacement

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	<p>Undertake this work for all demonstration arrays. This should follow the normal project specific EIA procedures.</p> <p>To determine the importance of the proposed development area for potentially vulnerable species (as listed above). Important considerations will include relative importance of the development area, what essential activity is being displaced (foraging habitat, breeding area, migratory routes, etc.) and the availability of suitable alternative habitat elsewhere.</p>

Baseline characterisation surveys - displacement

Activity	Objective	Comment
None recommended	N/A	<p>No baseline surveys are considered necessary to inform EIA for this issue.</p> <p>It should be noted that in some instances, a strategic approach to baseline data collection on marine mammal density, distribution, migration routes, etc. may be beneficial to gather data to inform larger scale developments as outlined in the 'Strategic research opportunities and requirements' section (see below).</p>

Monitoring during and post installation - displacement

Activity	Objective	Comment
None recommended	N/A	<p>No post-installation monitoring of displacement is required for demonstration arrays.</p> <p>However, it should be noted that monitoring marine mammal activity around demonstration arrays as outlined in the 'Strategic research opportunities and requirements' section (see below) may provide useful data to inform EIA/HRA for larger scale arrays.</p>

Strategic research opportunities and requirements - displacement

Activity	Objective	Comment
<p>Monitoring presence, distribution and movement patterns of marine mammals in the wider area around devices, moorings and support structures.</p>	<p>To determine whether or not there is evidence of displacement resulting from the development</p>	<p>Any additional monitoring that can be undertaken to better understand the potential impacts of wave and tidal devices on marine wildlife e.g. monitoring presence, distribution and movement patterns (passage rates, avoidance and evasion behaviour, etc.) in the wider area around demonstration arrays e.g. farfield effects using widespread visual observations / PAM, etc., may provide data to determine whether or not displacement occurs.</p> <p>Baseline data may be required to inform impact monitoring research studies.</p> <p>This information will help to build an evidence base to inform understanding of the behavioural response of marine mammals to operational devices which may be important to inform EIA/HRA for larger scale developments.</p> <p>It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

3 Basking Shark

Key issue 10 - Potential for collision between basking sharks and tidal energy converters and associated moorings / support structures

What are the relevant technologies and support structures?

The following technologies and support structures were identified during the assessment process to have the potential for collision with basking sharks and should therefore be subject to further investigation on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
<p>Tidal technologies Axial flow turbine Cross flow turbine Reciprocating hydrofoils Archimedes screw Tidal kite</p> <p>Moorings / support structures Driven/percussion piles Drilled / grouted piles Rock anchors / pinned gravity bases Rock anchors and mooring lines Rock anchors and taut mooring lines Gravity base structure Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines</p>	<p>Basking sharks</p>	<p>Avoidance of device and moorings / support structures likely, but scored 1 because contact with moving turbine blades/ moving hydrofoils / tidal kites / helices could potentially result in injury or death.</p> <p>Assessment score: '1' - potentially significant</p>

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential collision risk for basking sharks.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies – collision risk - tidal

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA.	Collision risk should be considered in all tidal project EIAs.
Develop a project specific EMMP and Adaptive Management Strategy	To ensure that suitable mitigation, monitoring and management measures are agreed and implemented.	A project EMMP should be fully informed by the best available knowledge regarding other similar projects and monitoring as well as the most up to date information available regarding collision risk from tidal turbines.

Baseline characterisation surveys – collision risk - tidal

Activity	Objective	Comment
None recommended	N/A	<p>Baseline surveys are unlikely to provide sufficient/suitable data regarding the presence and distribution of basking sharks across and around a site to inform EIA or the development of a project EMMP to such an extent that would justify undertaking these extensive studies.</p> <p>It is recommended that a sufficient EMMP can be developed for a single device deployment at this time without the use of collision risk modelling and therefore, any requirement for baseline characterisation studies.</p>

Monitoring during and post installation – collision risk - tidal

Activity	Objective	Comment
Implement project specific EMMP	To attempt to detect any possible collision events	Uncertainty with regards to the possibility, likelihood and consequence of a collision event occurring between basking sharks and a tidal turbine is one of the industry's key issues. It is essential that this issue is addressed appropriately at the earliest possible time in such a way that informs future site selection, project design and consenting activities.

Activity	Objective	Comment
		<p>Therefore, it is essential that all single device deployments develop and a robust EMMP which contains an Adaptive Management Strategy. This should include measures to attempt to detect any collision events with the device. It is also important that results are regularly shared so as to quickly understand the possible risk of such an event occurring.</p> <p>It will also be highly advantageous for developers and researchers to undertake monitoring around single devices to better understand avoidance and evasion behaviour. It is recommended that such measures are incorporated into any single device deployment EMMP. Information gathered around single devices could inform larger scale project EIAs, EMMPs and Adaptive Management Strategies.</p> <p>It should be noted that greater understanding of collision risk may be gained by undertaking additional monitoring studies as outlined in the 'Strategic research opportunities and requirements' section (see below).</p>

Strategic research opportunities and requirements - collision risk -tidal

Activity	Objective	Comment
Further development of collision risk modelling approaches	To improve the ability of collision risk modelling to predict collision risk estimates	Data gathered during monitoring studies around single devices may help improve collision risk model input parameters and therefore improve confidence in collision risk estimates.

Demonstration arrays (up to 10MW)

Preliminary desk based studies – collision risk - tidal

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA.	Collision risk should be considered in all tidal project EIAs.
Develop a project EMMP and Adaptive Management Strategy	To ensure that suitable mitigation, monitoring and management measures are agreed and implemented.	Due to current uncertainty regarding the potential for collisions to occur, the behaviour of basking sharks in tidal streams and the behaviour of basking sharks around tidal devices operating in tidal streams, it is recommended that for all demonstration arrays, a robust and site specific

Activity	Objective	Comment
		<p>EMMP should be developed. This should include any adaptive management measures as required.</p> <p>Any EMMP should be fully informed by the best available knowledge regarding other similar projects and monitoring as well as the most up to date information available regarding collision risk from tidal turbines.</p>

Baseline characterisation surveys – collision risk - tidal

Activity	Objective	Comment
None recommended	N/A	<p>All demonstration array projects require a project specific EMMP and Adaptive Management Strategy. In some instances to date, these have been informed by collision risk modelling studies that have required site specific baseline survey data.</p> <p>Given the types of mitigation and monitoring measures available at this time, and the uncertainty regarding avoidance and evasion behaviour, it is unlikely that the results from collision risk modelling studies will be a defining factor in the development of any EMMP and Adaptive Management Strategy.</p> <p>However, it may be advantageous for developers to undertake collision risk modelling to inform the development of a site specific EMMP and Adaptive Management Strategy. Any benefits of such an approach should be discussed with the Regulator on a case by case basis. Any collision risk modelling requires an estimate of basking shark density/passage rates for the development area. Site specific baseline characterisation studies may be required to provide additional data for use in collision risk modelling or to provide data where none exists.</p>

Monitoring during and post installation – collision risk - tidal

Activity	Objective	Comment
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Activity	Objective	Comment
Implement project specific EMMP	To attempt to detect any possible collision events	<p>Uncertainty with regards to the possibility, likelihood and consequence of a collision event occurring between a basking shark and a tidal turbine is one of the industry's key issues. It is essential that this issue is addressed appropriately at the earliest possible time in such a way that informs future site selection, project design and consenting activities.</p> <p>Therefore, it is essential that all projects develop a robust EMMP which contains an Adaptive Management Strategy. This should include measures to attempt to detect any collision events with a device. It is important that any results are regularly shared so as to quickly understand the possible risk of such an event occurring.</p> <p>It will also be highly advantageous for developers and researchers to undertake monitoring around single devices and demonstration arrays to better understand avoidance and evasion behaviour. It is recommended that such measures are incorporated into any demonstration array EMMP. Information gathered around demonstration arrays could inform other and larger scale project EIAs, EMMPs and Adaptive Management Strategies.</p> <p>It should be noted that greater understanding of collision risk may be gained by undertaking additional monitoring studies as outlined in the 'Strategic research opportunities and requirements' section (see below).</p>

Strategic research opportunities and requirements – collision risk - tidal

Activity	Objective	Comment
Monitoring behaviour of basking sharks around tidal turbines, moorings and support structures.	To better understand the behaviour of basking sharks around tidal turbines; particularly with regards to detection and avoidance.	<p>Any additional monitoring that can be undertaken to better understand the behaviour basking sharks in tidal streams and around operating tidal turbines e.g. passage rates, avoidance and evasion behaviour, may provide essential information for future impact assessment work and licence applications.</p> <p>Such information could also be used to inform, improve and refine collision risk modelling.</p> <p>It is in the developer's, researchers and the industry's best interests to gather as much relevant data and information as possible around single devices to inform future project design and consenting activities.</p>
Further development of collision risk modelling approaches	To improve the ability of collision risk modelling to predict collision risk estimates	Data gathered during monitoring studies around demonstration arrays can help improve collision risk model input parameters and therefore confidence in collision risk estimates.
Strategic baseline studies of use of tidal streams by basking sharks	Strategic baseline data may improve understanding of the functional importance of tidal streams for basking sharks and improve understanding of the spatial and temporal patterns of use, routes used for migration or feeding routes and improved understanding of behaviour in tidal streams.	<p>Where baseline data is lacking, strategic studies may provide useful data that could be used to inform and improve the estimation of collision risk models.</p> <p>This may provide useful data to inform future impact assessment work and provide greater confidence in EIA (and reduce the need for adopting a precautionary approach).</p>

Key issue 11 - Potential displacement of essential activities of basking sharks due to the presence of tidal energy converters and associated moorings / support structures

What are the relevant technologies and support structures?

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to displacement that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant species	Summary of assessment results
Tidal technologies		
Axial flow turbine Cross flow turbine Reciprocating hydrofoils Archimedes screw Tidal kite Moorings / support structures Driven/percussion piles Drilled / grouted piles Rock anchors / pinned gravity bases Rock anchors and mooring lines Rock anchors and taut mooring lines Gravity base structure Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines	Basking sharks	Avoidance of structures in the water / noise from device operation / installation activities may cause minor displacement of foraging or courtship behaviour. Assessment score: 'unknown'

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential effects of displacement for basking sharks.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies – displacement - tidal

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	<p>Undertake this work for all single device projects. This should follow the normal project specific EIA procedures.</p> <p>To determine the importance of the proposed development area for basking sharks. Important considerations will include relative importance of the development area, what essential activity is being displaced (foraging habitat, migratory routes, etc.) and the availability of suitable alternative habitat elsewhere.</p> <p>At this scale of development, displacement is not expected to result in any significant (i.e. population level) impacts.</p>

Baseline characterisation surveys – displacement - tidal

Activity	Objective	Comment
None recommended	N/A	<p>Displacement due to the presence and operation of a single device is not expected to result in any significant impacts (i.e. population level) impacts.</p> <p>No baseline surveys are considered necessary to inform EIA.</p> <p>It should be noted that in some instances, a strategic approach to baseline data collection on basking shark density, distribution, migration routes, etc. may be beneficial to gather data to inform larger scale developments as outlined in the 'Strategic research opportunities and requirements' section (see below).</p>

Monitoring during and post installation – displacement - tidal

Activity	Objective	Comment
None recommended	N/A	<p>Displacement due to the presence and operation of a single device is not expected to result in any significant impacts (i.e. population level) impacts.</p> <p>No post-installation monitoring of displacement is required for a single tidal device.</p> <p>However, it should be noted that monitoring behaviour of basking sharks around single devices as outlined in the ‘Strategic research opportunities and requirements’ section (see below) may provide useful data to inform EIA/HRA for larger scale arrays.</p>

Strategic research opportunities and requirements- displacement - tidal

Activity	Objective	Comment
Monitoring presence, distribution and movement patterns of basking sharks in the wider area around devices, moorings and support structures.	To determine whether or not there is evidence of displacement resulting from the development	<p>Any additional monitoring that can be undertaken to better understand the potential impacts of tidal devices on basking sharks e.g. monitoring presence, distribution and movement patterns (passage rates, avoidance and evasion behaviour, etc.) in the wider area around single devices e.g. farfield effects using widespread visual observations / PAM, etc., may provide data to determine whether or not displacement occurs.</p> <p>Baseline data may be required to inform impact monitoring research studies.</p> <p>This information will help to build an evidence base to inform understanding of the behavioural response of basking sharks to operational devices which may be important to inform EIA/HRA for larger scale developments.</p> <p>It is in the developer’s and the industry’s best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

Demonstration arrays (up to 10MW)

Preliminary desk based studies – displacement - tidal

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	<p>Undertake this work for all demonstration arrays. This should follow the normal project specific EIA procedures.</p> <p>To determine the importance of the proposed development area for basking sharks. Important considerations will include relative importance of the development area, what essential activity is being displaced (foraging habitat, migratory routes, etc.) and the availability of suitable alternative habitat elsewhere.</p>

Baseline characterisation surveys – displacement - tidal

Activity	Objective	Comment
None recommended	N/A	<p>No baseline surveys are considered necessary to inform EIA.</p> <p>It should be noted that in some instances, a strategic approach to baseline data collection on basking shark density, distribution, migration routes, etc. may be beneficial to gather data to inform larger scale developments as outlined in the 'Strategic research opportunities and requirements' section (see below).</p>

Monitoring during and post installation – displacement - tidal

Activity	Objective	Comment
None recommended	N/A	<p>No post-installation monitoring of displacement is required for demonstration arrays.</p> <p>However, it should be noted that monitoring basking shark activity around demonstration arrays as outlined in the 'Strategic research opportunities and requirements' section (see below) may provide useful data to inform EIA/HRA for larger scale arrays.</p>

Strategic research opportunities and requirements – displacement - tidal

Activity	Objective	Comment
None proposed at this time	N/A	N/A

Key issue 12 - It is unknown whether the potential exists for basking sharks to become entangled in mooring lines

What are the moorings / support structures?

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to entanglement that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant moorings / support structures	Relevant species / groups	Summary of assessment results
Tidal technologies	Basking sharks	<p>It is unknown whether basking sharks could become entangled in mooring lines of size and dimension required to anchor marine renewable devices.</p> <p>An SNH commissioned review of the potential for megafauna entanglement risk from renewable marine energy developments is currently underway by SAMS/Exeter University and is due to report in 2014.</p> <p>Assessment score: 'unknown'</p>
Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon		
Wave technologies		
Embedment anchor and mooring lines Gravity anchor and mooring lines Rock anchors and mooring lines		

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential entanglement risk for basking sharks.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies - entanglement

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	<p>Undertake this work for all single deployments with mooring lines.</p> <p>This should follow the normal project specific EIA procedures.</p> <p>Impact assessment should consider if entanglement is possible taking into account the number of mooring lines, the configuration of mooring lines, the dimensions and physical properties of the mooring lines and the size and behaviour of animals likely to be present in the area.</p>

Baseline characterisation surveys - entanglement

Activity	Objective	Comment
None recommended	N/A	N/A

Monitoring during and post installation - entanglement

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements- entanglement

Activity	Objective	Comment
Report any incidents recorded during routine maintenance inspections to the Regulator	To build up a database of information on entanglement risk of basking sharks within mooring arrays to inform future environmental assessments	Any incidents recorded during routine inspections should be reported to the Regulator.

Demonstration arrays (up to 10MW)

Preliminary desk based studies - entanglement

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	Undertake this work for all demonstration arrays with mooring lines. This should follow the normal project specific EIA procedures. Impact assessment should consider if entanglement is possible taking into account the number of mooring lines, the configuration of mooring arrays, the dimensions and physical properties of the mooring lines and the size and behaviour of animals likely to be present in the area.

Baseline characterisation surveys - entanglement

Activity	Objective	Comment
None recommended	N/A	N/A

Monitoring during and post installation - entanglement

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements- entanglement

Activity	Objective	Comment
Report any incidents recorded during routine maintenance inspections to the Regulator	To build up a database of information on entanglement risk of basking sharks within mooring arrays to inform future environmental assessments	Any incidents recorded during routine inspections should be reported to the Regulator.

Key issue 13 - Potential risk of entrapment of basking sharks from mooring arrays

The following table provides a summary of the results from the assessments undertaken during this study. It lists any mooring systems and support structures relevant to the potential issue of entrapment risk to basking sharks that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant moorings / support structures	Relevant species / groups	Summary of assessment results
<p>Tidal technologies Arrays with mooring lines¹⁰:</p> <p>Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon</p>	Basking sharks	<p>Potential for entrapment within mooring arrays is unknown.</p> <p>Assessment score: 'unknown'</p>
<p>Wave technologies Arrays with mooring lines¹¹ with the exception of oscillating water column (offshore) and overtopping device (offshore)</p> <p>Embedment anchor and mooring lines Gravity anchor and mooring lines Rock anchors and mooring lines</p>		

¹⁰ Axial flow, Cross flow, Tidal kite

¹¹, Attenuator, Point absorber, Rotating mass

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential entrapment risk for basking sharks within mooring arrays.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific proportionate approach to EIA and impact monitoring.

Single test deployment

Preliminary desk based studies - entrapment

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	Undertake this work for all single deployments with mooring lines. This should follow the normal project specific EIA procedures. Impact assessment should consider if entry in to mooring array is possible by establishing the number of mooring lines and the size and configuration of the mooring array in relation to the size of a basking shark.

Baseline characterisation surveys - entrapment

Activity	Objective	Comment
None recommended	N/A	N/A

Monitoring during and post installation - entrapment

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements - entrapment

Activity	Objective	Comment
Report any incidents recorded during routine maintenance inspections to the Regulator	To build up a database of information on entrapment risk of basking sharks within mooring arrays to inform future environmental assessments	Any incidents recorded during routine inspections should be reported to the Regulator.

Demonstration arrays (up to 10MW)

Preliminary desk based studies - entrapment

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site specific impacts during EIA	<p>Undertake this work for all demonstration arrays with mooring lines.</p> <p>This should follow the normal project specific EIA procedures.</p> <p>Impact assessment should consider if entry in to mooring array is possible by establishing the number of mooring lines and the size and configuration of the mooring array in relation to the size of a basking shark.</p>

Baseline characterisation surveys - entrapment

Activity	Objective	Comment
None recommended	N/A	N/A

Monitoring during and post installation - entrapment

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements- entrapment

Activity	Objective	Comment
Report any incidents recorded during routine maintenance inspections to the Regulator	To build up a database of information entrapment risk of basking sharks within mooring arrays to inform future environmental assessments	Any incidents recorded during routine inspections should be reported to the Regulator.

4 Marine Birds

Key issue 14 - Potential displacement of essential activities of marine birds due to the physical and visual presence of wave and tidal energy converters and associated moorings / support structures

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to displacement that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant species	Summary of assessment results
Displacement of essential activities		
<p>Tidal technologies Axial flow turbine Cross flow turbine Reciprocating hydrofoils Archimedes screw Tidal kite</p> <p>Moorings / support structures Driven/percussion piles Drilled / grouted piles Rock anchors / pinned gravity bases Rock anchors and mooring lines Rock anchors and taut mooring lines Gravity base structure Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines</p>	<p>Scottish breeding species (that use coastal waters, except gull species): Arctic Tern Atlantic Puffin Black Guillemot Black-legged Kittiwake Common Eider Common Guillemot Common Tern European Shag European Storm-petrel Great Cormorant Leach's Storm-petrel Little Tern Manx Shearwater Northern Fulmar Northern Gannet Razorbill Red-breasted Merganser Red-throated Diver Roseate Tern Sandwich Tern</p> <p>Other Diver species: Black-throated Diver Great Northern Diver</p>	<p>The presence and operation of devices and associated moorings / support structures could potentially result in the displacement of birds out of the development site. The impact of displacement will depend on the relative importance of the habitat, what essential activity is being displaced (foraging, moulting, maintenance activities, etc.) and the availability of suitable alternative habitat elsewhere. Greater potential impact for breeding species. In some cases, displacement could be a temporary issue with behaviour patterns changing over time as birds habituate to the presence of devices.</p> <p>Assessment score: 'unknown'</p>
<p>Wave technologies Attenuator Oscillating water column (offshore) Oscillating water column (shoreline) Oscillating wave surge converter Overtopping device (offshore) Overtopping device (shoreline) Point absorber Rotating mass Submerged pressure differential</p> <p>Moorings / support structures Drilled / grouted piles Driven/percussion piles</p>		

Relevant technologies and moorings / support structures	Relevant species	Summary of assessment results
Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity base structure Rock anchors and mooring lines Rock anchors / pinned gravity bases Shoreline structure		
Visual disturbance		
Tidal technologies Axial flow, Cross flow Reciprocating hydrofoils Moorings / support structures Drilled / grouted piles Driven/percussion piles Gravity anchor, mooring lines and floating pontoons Rock anchors, mooring lines and floating pontoons	Scottish breeding species (that use coastal waters, except gull species): Arctic Tern Atlantic Puffin Black Guillemot Black-legged Kittiwake Common Eider Common Guillemot Common Tern European Shag European Storm-petrel Great Cormorant Leach's Storm-petrel Little Tern Manx Shearwater Northern Fulmar Northern Gannet Razorbill Red-breasted Merganser Red-throated Diver Roseate Tern Sandwich Tern Other Diver species: Black-throated Diver Great Northern Diver	Devices have no surface piercing components. Relevant for moorings and support structures with surface piercing components. Greater potential impact for breeding birds that use coastal areas for foraging. Disturbance has potential to cause increased energy expenditure due to increase in flushing and/or avoidance of areas affected by disturbance. Assessment score: 'unknown'
Wave technologies Attenuator Oscillating water column (offshore) Oscillating wave surge converter Overtopping device (offshore) Point absorber Rotating mass Moorings / support structures Drilled / grouted piles Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity base structure Rock anchors and mooring lines Rock anchors / pinned gravity bases	(Continuation of species list from the previous row)	Relevant for devices with surface piercing components. Moorings and support structures have no surface piercing components. Greater potential impact for breeding birds that use coastal areas for foraging. Disturbance has potential to cause increased energy expenditure due to increase in flushing and/or avoidance of areas affected by disturbance. Assessment score: 'unknown'
Oscillating water column (shoreline) Overtopping device (shoreline)	Scottish breeding species (that use coastal waters, except gull species): Arctic Tern Atlantic Puffin Black Guillemot Black-legged Kittiwake	Greater potential impact for coastal breeding species and breeding birds that use coastal areas for foraging. Disturbance has potential to cause increased energy expenditure due to increase in flushing and/or avoidance of areas affected by

Relevant technologies and moorings / support structures	Relevant species	Summary of assessment results
	Common Eider Common Guillemot Common Tern European Shag European Storm-petrel Great Cormorant Leach's Storm-petrel Little Tern Manx Shearwater Northern Fulmar Northern Gannet Razorbill Red-breasted Merganser Red-throated Diver Roseate Tern Sandwich Tern	disturbance. Assessment score: 'unknown'

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential effects of displacement of essential activities for marine birds.

This information is not prescriptive and should be used as a platform for discussion on a project and site specific basis to develop a proportionate site-specific approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies - displacement

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site-specific impacts during EIA	<p>Undertake this work for all single device projects. This should follow the normal project specific EIA procedures.</p> <p>To determine the importance of the proposed development area for potentially vulnerable species (as listed above). Important considerations will include relative importance of the development area, what essential activity is being displaced (foraging, moulting, maintenance activities, etc.) and the availability of suitable alternative habitat elsewhere.</p> <p>At this scale of development, displacement is not expected to result in any significant (i.e. population level) impacts.</p>

Baseline characterisation surveys - displacement

Activity	Objective	Comment
None recommended	N/A	<p>Displacement due to the presence and operation of a single wave or tidal device is not expected to result in any significant impacts (i.e. population level) impacts.</p> <p>Therefore, no baseline surveys are considered necessary to inform EIA for this issue.</p>

Monitoring during and post installation - displacement

Activity	Objective	Comment
None recommended	N/A	<p>Displacement due to the presence and operation of a single wave or tidal device is not expected to result in any significant impacts (i.e. population level) impacts.</p> <p>No post-installation monitoring of displacement is</p>

Activity	Objective	Comment
		<p>required for a single wave or tidal device.</p> <p>However, it should be noted that monitoring behaviour of birds around single devices as outlined in the 'Strategic research opportunities and requirements' section (see below) may provide useful data to inform EIA/HRA for larger scale arrays.</p>

Strategic research opportunities and requirements- displacement

Activity	Objective	Comment
<p>Undertake monitoring of bird presence, distribution and behaviour around devices</p>	<p>To build an evidence base to inform understanding of the behavioural response of marine birds to the presence and operation of devices.</p>	<p>Monitoring around single devices may establish if there is the potential for displacement to occur or if species are attracted into the area around devices e.g. to roost on devices or to exploit new foraging opportunities that may arise if prey species of fish are found to gather around structures.</p> <p>Baseline data may be required to inform impact monitoring research studies.</p> <p>This is strategically valuable information that would reduce uncertainty regarding the behaviour of birds around devices, moorings and support structures.</p> <p>Any additional monitoring that can be undertaken may provide useful information to inform future impact assessment work and licence applications and to inform commercial scale EIA / HRA.</p> <p>It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

Demonstration arrays (up to 10MW)

Preliminary desk based studies - displacement

Activity	Objective	Comment
Undertake desk-based impact assessment using existing information	To identify and assess any potential site-specific impacts during EIA	<p>Undertake this work for all demonstration arrays. This should follow the normal project specific EIA procedures.</p> <p>To determine the importance of the proposed development area for potentially vulnerable species (as listed above). Important considerations will include relative importance of the development area, what essential activity is being displaced (foraging, moulting, maintenance activities, etc.) and the availability of suitable alternative habitat elsewhere.</p>

Baseline characterisation surveys - displacement

Activity	Objective	Comment
Conduct baseline surveys	To determine the presence, abundance and distribution of species (as listed above) in the proposed development site to inform site design and EIA	<p>This work should only be undertaken for vulnerable populations where there is a lack of existing data available to inform EIA or if the site is known to be within an important area for essential activities e.g. foraging, moulting, etc.</p> <p>Where this is not the case, no baseline surveys are considered necessary to inform EIA for this issue.</p> <p>Any baseline characterisation surveys undertaken should be designed to maximise the potential to detect any change in use of the area through future impact monitoring, should this be required.</p> <p>It should be noted that in some instances, a strategic approach to baseline data collection on use of wave and tidal areas may be beneficial to gather data to inform larger scale developments as outlined in the 'Strategic research opportunities and requirements' section (see below).</p>

Further desk based studies - displacement

Activity	Objective	Comment
Impact assessment (following any necessary baseline characterisation surveys)	To determine, based on baseline characterisation surveys, whether or not there are likely to be any potentially significant effects on the species identified and to inform the development of a site specific EMMP.	This work should only be undertaken if baseline survey work has been necessary. This should follow the normal project specific EIA procedures.

Monitoring during and post installation - displacement

Activity	Objective	Comment
Post-installation monitoring	To determine whether or not there is evidence of displacement resulting from the development	This should only be necessary where a potentially significant impact on vulnerable populations has been identified during EIA. Where this is not the case, no post-installation monitoring measures are considered necessary to inform EIA for this issue. It should also be noted that this issue could also be informed by collection of strategic data as outlined in the 'Strategic research opportunities and requirements' section (see below).

Strategic research opportunities and requirements - displacement

Activity	Objective	Comment
Undertake monitoring of bird presence, distribution and behaviour around devices	To build an evidence base to inform understanding of the behavioural response of marine birds to the presence and operation of devices.	Monitoring around demonstration arrays may establish if there is the potential for displacement to occur or if species are attracted into the area around devices e.g. to roost on devices or to exploit new foraging opportunities that may arise if prey species of fish are found to gather around structures. Any monitoring that can be undertaken to better understand the potential impacts of wave and tidal devices on marine wildlife e.g. monitoring presence, distribution and behaviour in the wider area around demonstration arrays e.g. farfield effects using widespread visual observations, etc., may also provide useful information regarding as to whether displacement occurs.

Activity	Objective	Comment
		<p>This information may be important to inform EIA/HRA for larger scale developments.</p> <p>Baseline data may be required to inform impact monitoring research studies.</p> <p>It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

Key issue 15 - The potential effects on diving birds from underwater noise and vibration generated during driven / percussion piling activities

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to noise generated during driven / percussion piling activities that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant support structures	Relevant species / groups	Summary of assessment results
Driven / percussion piles	<p>Diving birds</p> <p>Arctic Tern Atlantic Puffin Balearic Shearwater Black Guillemot Black-legged Kittiwake Black-necked Grebe Black-throated Diver Common Eider Common Goldeneye Common Guillemot Common Scoter Common Tern Cory's Shearwater European Shag Goosander Great Cormorant Great Crested Grebe Great Northern Diver Great Shearwater Greater Scaup Little Auk Little Tern Long-tailed Duck Manx Shearwater Northern Fulmar Northern Gannet Razorbill Red-breasted Merganser Red-necked Grebe Red-throated Diver Roseate Tern Sandwich Tern Slavonian grebe Sooty Shearwater Surf Scoter Velvet Scoter</p>	<p>Increased/altered noise levels will occur temporarily during installation activities (pile-driving), up to 10 devices in 10MW array. The effects of pile-driving noise on diving birds are currently unknown (injury, displacement/avoidance, reduction in foraging success, no effect, etc).</p> <p>Assessment score: 'unknown'</p>

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the effects of underwater noise and vibration generated from driven / percussion piling activities on diving birds.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis to develop a site specific, proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies – underwater noise

Activity	Objective	Comment
Desk-based review of existing information regarding species distribution / behaviour across the site to inform EIA	To establish the importance of the proposed development area for any potentially vulnerable species (as listed above) and to identify and assess any potential site specific impacts	Undertake this work for all single devices. There is likely to be sufficient data available on noise levels from piling activities (particularly from the offshore wind industry).

Baseline characterisation surveys – underwater noise

Activity	Objective	Comment
None recommended	N/A	Increased/altered noise levels will occur temporarily during driven / percussion piling and would affect a limited area around the activity. No significant impacts are expected from the installation of a single driven / percussion pile. No baseline surveys are considered necessary to inform EIA for this issue.

Monitoring during and post installation – underwater noise

Activity	Objective	Comment
None recommended	N/A	Increased/altered noise levels will occur temporarily during driven / percussion piling and would affect a limited area around the activity. No significant impacts are expected from the installation of a single driven / percussion pile; therefore no monitoring is required during piling activities. However, it should be noted that this issue may be informed by monitoring data as outlined in the

Activity	Objective	Comment
		'Strategic research opportunities and requirements' section (see below).

Strategic research opportunities and requirements – underwater noise

Activity	Objective	Comment
Acoustic monitoring during driven / percussion piling	To determine underwater noise signatures generated during driven / percussion piling activities to inform future and larger scale project design and consenting activities.	Any data that can be gathered regarding noise levels of piling activities in wave / tidal high energy environments and behaviour of diving birds during piling activities will help to build an evidence base. This evidence base could be highly beneficial to inform future impact assessment work and help streamline future licence application processes and inform commercial scale EIA / HRA.
Monitor distribution and behaviour of diving birds during driven / percussion piling activity	To inform knowledge gap of the effects of driven / percussion piling noise from construction activities on diving birds (behavioural changes, disturbance and displacement effects)	It is therefore in any developer's best interest to gather as much information as possible from test deployments. This data should be gathered with a view as to how the data will be analysed and used to inform future developments, consenting activities and research.

Demonstration arrays (up to 10MW)

Preliminary desk based studies – underwater noise

Activity	Objective	Comment
Desk-based review of existing information regarding species distribution / behaviour across the site to inform EIA	To establish the importance of the proposed development area for any potentially vulnerable species (as listed above) and to identify and assess any potential site specific impacts	Undertake this work for all demonstration arrays. There is likely to be sufficient data available on noise levels from piling activities (particularly from the offshore wind industry).

Baseline characterisation surveys – underwater noise

Activity	Objective	Comment
None recommended	N/A	Increased/altered noise levels will occur temporarily during driven / percussion piling and would affect a limited area around the activity. Baseline surveys are not considered necessary to inform EIA for this issue.

Monitoring during and post installation – underwater noise

Activity	Objective	Comment
None recommended	N/A	Increased/altered noise levels will occur temporarily during driven / percussion piling and would affect a limited area around the activity. Monitoring during piling activities is not considered a requirement to inform EIA for this issue. However, it should be noted that useful data could be gathered as outlined in the 'Strategic research opportunities and requirements' section (see below).

Strategic research opportunities and requirements– underwater noise

Activity	Objective	Comment
Acoustic monitoring during driven / percussion piling	To determine underwater noise signatures generated during driven / percussion piling activities to inform future and larger scale project design and consenting activities.	Any data that can be gathered regarding noise levels of piling activities in wave / tidal high energy environments and behaviour of diving birds during piling activities will help to build an evidence base. This evidence base could be highly beneficial to inform future impact assessment work and help streamline future licence application processes and inform commercial scale EIA / HRA.
Monitor distribution and behaviour of diving birds during driven / percussion piling activity	To inform knowledge gap of the effects of driven / percussion piling noise from construction activities on diving birds (behavioural changes, disturbance and displacement effects)	It is therefore in any developer's best interest to gather as much information as possible from test deployments. This data should be gathered with a view as to how the data will be analysed and used to inform future developments, consenting activities and research.

Key issue 16 - Potential for collision between diving birds and tidal energy converters and associated moorings / support structures

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to collision risk that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
<p>Tidal technologies Archimedes screw Axial flow turbine Cross flow turbine Reciprocating hydrofoil Tidal kite</p> <p>Moorings / support structures Driven/percussion piles Drilled / grouted piles Rock anchors / pinned gravity bases Rock anchors and mooring lines Rock anchors and taut mooring lines Gravity base structure Gravity anchor, mooring lines and floating pontoon Gravity anchor and taut mooring lines</p>	<p>Diving birds Arctic Tern Atlantic Puffin Balearic Shearwater Black Guillemot Black-necked Grebe Black-throated Diver Common Eider Common Goldeneye Common Guillemot Common Scoter Common Tern Cory's Shearwater European Shag Goosander Great Cormorant Great Crested Grebe Great Northern Diver Great Shearwater Greater Scaup Little Auk Little Tern Long-tailed Duck Manx Shearwater Northern Gannet Razorbill Red-breasted Merganser Red-necked Grebe Red-throated Diver Roseate Tern Sandwich Tern Slavonian grebe Sooty Shearwater Surf Scoter Velvet Scoter</p>	<p>It is unknown whether an interaction between the species and technology is possible/likely to occur. There is potential for collision with moving turbine blades if diving birds can dive to depths of moving blades. If moving blades are positioned deeper in the water column, no risk of collision with moving blades. Static mooring structures present no/minimal collision risk to diving birds. Birds that forage in strong tidal currents are likely to be strong, agile divers capable of manoeuvring around static objects. If surface-piercing floating pontoons are present, they would have low profiles above the water surface presenting a low collision risk to birds in flight. If surface-piercing monopiles are present they would be large, highly visible structures with high profiles above the water surface presenting a low collision risk to birds in flight.</p> <p>Assessment score: 'unknown'</p>

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the potential risk of collision for diving birds.

This information is not prescriptive and should be used as a platform for discussion on a project by project basis in order to develop a site-specific proportionate approach to EIA and impact monitoring.

Single test deployments

Preliminary desk based studies – collision risk - tidal

Activity	Objective	Comment
Desk-based review of existing information regarding species distribution / behaviour across the site to inform EIA	To establish the importance of the proposed development area for any potentially vulnerable species (as listed above) and to identify and assess any potential site specific impacts	Undertake this work for all single tidal devices.

Baseline characterisation surveys – collision risk - tidal

Activity	Objective	Comment
None recommended	N/A	There is likely to be sufficient existing data to inform EIA for a single device. Baseline characterisation surveys are not considered necessary to inform EIA for this issue.

Monitoring during and post installation – collision risk - tidal

Activity	Objective	Comment
None recommended	N/A	Monitoring around single devices is not considered a requirement. However, it should be noted that useful data could be gathered as outlined in the 'Strategic research opportunities and requirements' section (see below).

Strategic research opportunities and requirements– collision risk - tidal

Activity	Objective	Comment
Post-installation monitoring of behaviour of diving birds in the vicinity of the tidal device and associated moorings / support structure	To investigate the behavioural response of diving birds to tidal devices	Any monitoring that can be undertaken to better understand the real level of risk of collisions for diving birds e.g. using video cameras, acoustic cameras, etc. to monitor behaviour in the vicinity of devices may provide useful information to reduce uncertainty and inform future impact assessment

Activity	Objective	Comment
		<p>work and licence applications and to inform demonstration scale EIA / HRA.</p> <p>This may provide data on encounter rates and avoidance and evasion behaviour and may provide a better understanding of the probability of collisions occurring.</p> <p>It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

Demonstration arrays (up to 10MW)

Preliminary desk based studies – collision risk - tidal

Activity	Objective	Comment
Desk-based review of existing information regarding species distribution / behaviour across the site to inform EIA	To establish the importance of the proposed development area for any potentially vulnerable species (as listed above) and to identify and assess any potential site specific impacts	This should be undertaken for all demonstration arrays.

Baseline characterisation surveys – collision risk - tidal

Activity	Objective	Comment
Conduct baseline surveys	To determine the presence, abundance and behaviour of species (as listed above) in the proposed development site to inform site design and EIA	<p>This work should only be undertaken for vulnerable populations where there is a lack of existing data available to inform EIA or if the site is known to be within an important area for essential activities e.g. foraging, moulting, etc.</p> <p>Where this is not the case, no baseline surveys are considered necessary to inform EIA for this issue.</p> <p>Any baseline characterisation surveys undertaken should be designed to maximise the potential to detect any change in use of the area through future impact monitoring, should this be required.</p> <p>It should be noted that in some instances, a</p>

Activity	Objective	Comment
		strategic approach to baseline data collection on use of tidal areas by diving birds may be beneficial to inform larger scale developments as outlined in the 'Strategic research opportunities and requirements' section (see below).

Further desk based studies – collision risk - tidal

Activity	Objective	Comment
Impact assessment (following any necessary baseline characterisation surveys)	To determine, based on baseline characterisation surveys, whether or not there are likely to be any potentially significant effects on the species identified and to inform the development of a site specific EMMP.	This work should only be undertaken if baseline survey work has been necessary. This should follow the normal project specific EIA procedures.

Monitoring during and post installation – collision risk - tidal

Activity	Objective	Comment
Post-installation monitoring	To better understand risk of collision	This should only be necessary where a potentially significant impact on vulnerable populations has been identified during EIA. Where this is not the case, no post-installation monitoring measures are considered necessary to inform EIA for this issue. It should also be noted that this issue could also be informed by collection of strategic data as outlined in the 'Strategic research opportunities and requirements' section (see below).

Strategic research opportunities and requirements– collision risk - tidal

Activity	Objective	Comment
Post-installation monitoring of behaviour of diving birds in the vicinity of demonstration arrays and associated moorings / support structures	To investigate the behavioural response of diving birds to demonstration arrays	Strategic monitoring studies to better understand the real level of risk of collisions for diving birds and to reduce uncertainty e.g. using video cameras, acoustic cameras, etc. to monitor behaviour in the vicinity of devices and arrays may provide useful data to inform future impact assessment work and licence applications and to inform larger scale EIA / HRA.

Activity	Objective	Comment
		<p>This may provide data on encounter rates and avoidance and evasion behaviour and may provide a better understanding of the probability of collisions occurring.</p> <p>It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>
Use of tidal streams by diving birds	To establish the functional importance of tidal streams for potentially vulnerable diving bird species and to improve understanding of the spatial and temporal patterns of use of tidal stream areas (and relative importance of these areas).	<p>Strategic studies may provide data on which species use tidal streams and therefore which species may potentially be at risk of collision.</p> <p>This may provide useful data to inform future impact assessment work and provide greater confidence in EIA (and reduce the need for adopting a precautionary approach).</p>

Key issue 17 - Direct loss of breeding habitat for marine bird species due to the installation of shoreline wave energy converters

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to loss of habitat that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant species / groups	Summary of assessment results
<p>Wave technologies Oscillating water column (shoreline) Overtopping device (shoreline)</p>	<p>Coastal breeding species that could potentially breed in rocky shore habitats</p> <p>(Western) herring gull (Western) Lesser black-backed gull Black guillemot European shag Great black-backed gull Great Cormorant Northern fulmar</p>	<p>Large (100m x 10m) structure, directly installed on shoreline. Potential loss of breeding habitat for coastal nesting species that could potentially breed in rocky shore habitats. Impact will depend on the availability of suitable alternative habitat in the surrounding area.</p> <p>Assessment score: 'unknown'</p>

Single test deployments

Preliminary desk based studies – direct loss of habitat

Activity	Objective	Comment
Desk-based review of existing information regarding species distribution / behaviour across the site to inform EIA	To identify and assess any potential site specific impacts during EIA	Undertake this work for all single shoreline devices. To establish the importance of the proposed development area for any potentially vulnerable species (as listed above) and to identify and assess any potential site specific impacts. To determine what/if further baseline characterisation is required (see below).

Baseline characterisation surveys – direct loss of habitat

Activity	Objective	Comment
Undertake baseline breeding bird surveys	To establish which species use the site and the number of individuals breeding at the site and if any bird breeding sites could be affected by the proposed scheme.	This should only be undertaken if there is suitable breeding habitat present and if there is insufficient existing data.

Further desk based studies – direct loss of habitat

Activity	Objective	Comment
Undertake impact assessment	To determine, based on baseline characterisation surveys, whether or not there are likely to be any potentially significant effects on the species identified and to determine the suitability of the site for development.	This should follow the normal project specific EIA procedures.

Monitoring during and post installation – direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	The impact assessment process would identify any key sensitivities to be avoided during the siting and installation of the development. It is not expected that monitoring during or post-installation would be required.

Strategic research opportunities and requirements– direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	The impact assessment process would identify any key sensitivities to be avoided during the siting and installation of the development. No supplementary research opportunities have been identified to investigate potential loss of coastal breeding habitat.

Demonstration arrays (up to 10MW)

Preliminary desk based studies – direct loss of habitat

Activity	Objective	Comment
Desk-based review of existing information regarding species distribution / behaviour across the site to inform EIA	To identify and assess any potential site specific impacts during EIA	Undertake this work for all demonstration arrays. To establish the importance of the proposed development area for any potentially vulnerable species (as listed above) and to identify and assess any potential site specific impacts. To determine what/if further baseline characterisation is required (see below).

Baseline characterisation surveys – direct loss of habitat

Activity	Objective	Comment
Undertake baseline breeding bird surveys	To establish which species use the site and the number of individuals breeding at the site and if any bird breeding sites could be affected by the proposed scheme.	This should only be undertaken if there is suitable breeding habitat present and if there is insufficient existing data.

Further desk based studies – direct loss of habitat

Activity	Objective	Comment
Undertake impact assessment	To determine, based on baseline characterisation surveys, whether or not there are likely to be any potentially significant effects on the species identified and to determine the suitability of the site for development.	This should follow the normal project specific EIA procedures

Monitoring during and post installation – direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	The impact assessment process would identify any key sensitivities to be avoided during the siting and installation of the development. It is not expected that monitoring during or post-installation would be required.

Strategic research opportunities and requirements– direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	The impact assessment process would identify any key sensitivities to be avoided during the siting and installation of the development. No strategic research opportunities have been identified to investigate potential loss of coastal breeding habitat.

Key issue 18 - Potential effects of changes in turbulence on foraging success of diving birds due to the presence of wave and tidal energy converters and associated moorings / support structures

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to changes in turbulence that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies	Relevant species / groups	Summary of assessment results
Tidal technologies		
Archimedes screw Axial flow turbine Cross flow turbine Reciprocating hydrofoil Tidal kite Moorings / support structures Drilled / grouted piles Driven/percussion piles Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity bases Rock anchors, mooring lines and floating pontoons	Diving birds: Arctic Tern Atlantic Puffin Balearic Shearwater Black Guillemot Black-legged kittiwake Black-necked Grebe Black-throated Diver Common Eider Common Goldeneye Common Guillemot Common Scoter Common Tern Cory's Shearwater European Shag Goosander Great Cormorant Great Crested Grebe Great Northern Diver Great Shearwater Greater Scaup Little Auk Little Tern Long-tailed Duck Manx Shearwater Northern fulmar Northern Gannet Razorbill Red-breasted Merganser Red-necked Grebe Red-throated Diver Roseate Tern Sandwich Tern Slavonian grebe Sooty Shearwater Surf Scoter Velvet Scoter	Localised changes in turbulence due to the presence and operation of devices and presence of support structures in the water column. It is unknown what effect localised changes in turbulence will have on the foraging success of marine birds. Assessment score: 'unknown'
Axial flow turbine Tidal kite (Moorings / support structures Rock anchors and taut mooring lines)	Little Auk Little Tern Long-tailed Duck Manx Shearwater Northern fulmar Northern Gannet Razorbill Red-breasted Merganser Red-necked Grebe Red-throated Diver Roseate Tern Sandwich Tern Slavonian grebe Sooty Shearwater Surf Scoter Velvet Scoter	Localised changes in turbulence due to the presence and operation of devices. No changes in turbulence due to moorings / support structures are anticipated. It is unknown what effect localised changes in turbulence will have on the foraging success of marine birds. Assessment score: 'unknown'
Wave technologies		
Attenuator Oscillating water column (offshore) Oscillating wave surge converter Overtopping device (offshore) Point absorber	Sandwich Tern Slavonian grebe Sooty Shearwater Surf Scoter Velvet Scoter	Localised changes in turbulence due to the presence and operation of devices and presence of support structures in the water column. It is unknown what effect

Relevant technologies	Relevant species / groups	Summary of assessment results
Rotating mass Submerged pressure differential Moorings / support structures Drilled / grouted piles Driven/percussion piles Gravity anchor and mooring lines Gravity base structure Rock anchors / pinned gravity bases		localised changes in turbulence will have on the foraging success of marine birds. Assessment score: 'unknown'
Attenuator Oscillating water column (offshore) Overtopping device (offshore) Point absorber Rotating mass (Moorings / support structures Embedment anchors and mooring lines Rock anchors and taut mooring lines)		Localised changes in turbulence due to the presence and operation of devices. No changes in turbulence due to moorings / support structures are anticipated. It is unknown what effect localised changes in turbulence will have on the foraging success of marine birds. Assessment score: 'unknown'

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the effects of changes in turbulence on foraging success of marine birds due to the presence of wave and tidal energy converters and associated moorings / support structures, assessed as significant in the assessment.

This information is not prescriptive and should be used as a platform for discussion on a project and site specific basis in order to develop an appropriate impact assessment strategy and monitoring programme for the project.

Single test deployment

Preliminary desk based studies - turbulence

Activity	Objective	Comment
Desk-based review of existing information regarding species distribution / behaviour across the site to inform EIA	To identify and assess any potential site-specific impacts during EIA	Undertake this work for all single devices. To establish the importance of the proposed development area for any potentially vulnerable species (as listed above) and to identify and assess any potential site specific impacts

Baseline characterisation surveys - turbulence

Activity	Objective	Comment
None recommended	N/A	There is likely to be sufficient existing data to inform EIA for a single device. Baseline characterisation surveys are not considered necessary to inform EIA for this issue.

Monitoring during and post installation - turbulence

Activity	Objective	Comment
None recommended	N/A	Effects of turbulence due to the presence and operation of a single wave or tidal device is not expected to result in any significant impacts (i.e. population level) impacts. No post-installation monitoring of turbulence is required for a single wave or tidal device. However, it should be noted that monitoring behaviour of birds around single devices as outlined in the 'Strategic research opportunities and requirements' section (see below) may provide useful data to inform EIA/HRA for larger scale arrays.

Strategic research opportunities and requirements- turbulence

Activity	Objective	Comment
Undertake monitoring of bird presence, distribution and behaviour around devices	To build an evidence base to inform understanding of the behavioural response of marine birds to the presence and operation of devices.	<p>Strategic research studies around single devices may increase understanding of effects of turbulence on behaviour of diving birds.</p> <p>Any monitoring that can be undertaken e.g. with video cameras, acoustic cameras, etc. may provide useful information for future impact assessment work and licence applications.</p> <p>This is strategically valuable information that would reduce uncertainty regarding the behaviour of birds around devices, moorings and support structures.</p> <p>It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

Demonstration arrays (up to 10MW)

Preliminary desk based studies - turbulence

Activity	Objective	Comment
Desk-based review of existing information regarding species distribution / behaviour across the site to inform EIA	To identify and assess any potential site-specific impacts during EIA	Undertake this work for all demonstration arrays. To establish the importance of the proposed development area for any potentially vulnerable species (as listed above) and to identify and assess any potential site specific impacts

Baseline characterisation surveys - turbulence

Activity	Objective	Comment
None recommended	N/A	There is likely to be sufficient existing data to inform EIA for this issue. Baseline characterisation surveys are not considered necessary to inform EIA for this issue.

Further desk Monitoring during and post installation - turbulence

Activity	Objective	Comment
None recommended	N/A	No post-installation monitoring of effects of turbulence is considered necessary for a demonstration array. However, it should be noted that monitoring behaviour of birds around demonstration arrays as outlined in the 'Strategic research opportunities and requirements' section (see below) may provide useful data to inform EIA/HRA for larger scale arrays.

Strategic research opportunities and requirements - turbulence

Activity	Objective	Comment
Undertake monitoring of bird presence, distribution and behaviour around devices	To build an evidence base to inform understanding of the behavioural response of marine birds to the presence and operation of devices.	Strategic research studies around demonstration arrays may increase understanding of effects of turbulence on behaviour of diving birds. Any monitoring that can be undertaken e.g. with video cameras, acoustic cameras, etc. may provide useful information for future impact assessment work and licence applications. This is strategically valuable information that would reduce uncertainty regarding the behaviour of birds around devices, moorings and

Activity	Objective	Comment
		<p>support structures.</p> <p>It is in the developer's and the industry's best interests to gather as much relevant data and information as possible to inform future project design and consenting activities.</p>

5 Benthic Species and Habitats

Key issue 19 - Direct loss of protected or sensitive sub-littoral seabed communities due to the presence of wave and tidal energy converters and associated moorings / support structures on the seabed

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive to loss of habitat and direct abrasion that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
Direct abrasion		
Moorings / support structures Drilled and Grouted piles Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon	High and moderate energy Infralittoral rock habitats: A3.1 : Atlantic and Mediterranean high energy infralittoral rock Including BAP Habitat 'Tidal swept channels' A3.2 : Atlantic and Mediterranean moderate energy infralittoral rock Including BAP Habitat 'Tidal swept channels', 'Sabellaria spinulosa reefs'	Refer to individual justifications in the electronic database
Moorings / support structures Drilled and Grouted piles Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base Rock anchors and mooring lines Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon	High and moderate energy circalittoral rock habitats: A4.1 : Atlantic and Mediterranean high energy circalittoral rock Including BAP Habitat 'Tidal swept channels' A4.2 : Atlantic and Mediterranean moderate energy circalittoral rock	Assessment score: '1' (potentially significant).

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
<p>Moorings / support structures Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure</p>	<p>Sublittoral sediment A5.1 : Sublittoral coarse sediment including BAP habitats 'Subtidal sands and gravel', 'Horse mussel beds' A5.2 : Sublittoral sand including BAP habitat 'Subtidal sands and gravel', 'Blue mussel beds' A5.4 : Sublittoral mixed sediments including BAP Habitat 'Horse mussel beds', 'File Shell Beds' A5.5 : Sublittoral macrophyte-dominated sediment including BAP habitats 'Maerl beds', 'Tidal swept channels', 'Horse mussel beds', 'Blue mussel beds' A5.6 : Sublittoral biogenic reefs including BAP Habitats 'Horse mussel beds', 'Cold-water coral reefs', 'Blue mussel beds'</p>	
Loss of seabed habitat		
<p>Moorings / support structures Drilled and Grouted piles Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base</p>	<p>High and moderate energy Infralittoral rock habitats: A3.1 Atlantic and Mediterranean high energy infralittoral rock Including BAP Habitat 'Tidal swept channels' A3.2 : Atlantic and Mediterranean moderate energy infralittoral rock Including BAP Habitat 'Tidal swept channels', 'Sabellaria spinulosa reefs'</p>	<p>Refer to individual justifications in the electronic database</p>
<p>Moorings / support structures Drilled and Grouted piles Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base</p>	<p>High and moderate energy circalittoral rock habitats: A4.1 : Atlantic and Mediterranean high energy circalittoral rock Including BAP Habitat 'Tidal swept channels' A4.2 : Atlantic and Mediterranean moderate energy circalittoral rock A4.7 : Features of circalittoral</p>	<p>Assessment score: '1' (potentially significant).</p>

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
<p>Moorings / support structures Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure</p>	<p>rock</p> <p>Sublittoral habitats: A5.1 : Sublittoral coarse sediment including BAP habitats 'Subtidal sands and gravel', 'Horse mussel beds' A5.2 : Sublittoral sand including BAP habitat 'Subtidal sands and gravel', 'Blue mussel beds' A5.4 : Sublittoral mixed sediments including BAP Habitat 'Horse mussel beds', 'File Shell Beds' A5.5 : Sublittoral macrophyte-dominated sediment including BAP habitats 'Maerl beds', 'Tidal swept channels', 'Horse mussel beds', 'Blue mussel beds' A5.6 : Sublittoral biogenic reefs including BAP Habitats 'Horse mussel beds', 'Cold-water coral reefs', 'Blue mussel beds'</p>	

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the effects of habitat loss and abrasion on seabed communities for those technologies and/or support structures, and species / habitats, assessed as significant in the assessment.

This information is not prescriptive and should be used as a platform for discussion on a project and site specific basis in order to develop an appropriate impact assessment strategy and monitoring programme for the project.

Single test deployments

Preliminary desk based studies – direct loss of habitat

Activity	Objective	Comment
Review of existing information regarding seabed conditions and communities in the proposed development area	To inform baseline survey plans and predict the presence / absence of any habitats and species identified as particularly vulnerable	This should be undertaken in all instances although data and information is likely to be largely generic and sparse in most unsurveyed areas.
Undertake impact assessment	To identify any particular areas of concern regarding the proposed development and to determine what/if further baseline characterisation is required (see below).	This should follow the normal project specific EIA procedures.

Baseline characterisation surveys – direct loss of habitat

Activity	Objective	Comment
Pre-installation baseline survey using swathe bathymetry with photo / video ground-truthing. If any sensitive species / habitats are found to be present, wider survey to establish distribution of that species in the wider area.	To determine the relative sensitivity of the proposed development area and to inform the impact assessment	This should be undertaken in all previously unsurveyed areas.

Further desk based studies – direct loss of habitat

Activity	Objective	Comment
Undertake impact assessment	To determine whether or not there are likely to be any potentially significant effects on the habitats and species identified	This should follow normal EIA procedures.

Monitoring during and post installation – direct loss of habitat

Activity	Objective	Comment
Post-installation survey	To gauge any impacts, validate assumptions made during the impact assessment process and to inform future impact assessment and consenting activities	This should be undertaken in all circumstances.
Post-decommissioning survey	To gauge any impacts, validate assumptions made during the impact assessment process and to inform future impact assessment and consenting activities	This should be undertaken in all circumstances.

Strategic research opportunities and requirements– direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	N/A

Demonstration arrays (up to 10MW)

Preliminary desk based studies – direct loss of habitat

Activity	Objective	Comment
Review of existing information regarding seabed conditions and communities in the proposed development area	To inform baseline survey plans and predict the presence / absence of any habitats and species identified as particularly vulnerable	This should be undertaken in all instances although data and information is likely to be largely generic and sparse in most unsurveyed areas.
Undertake impact assessment	To identify any particular areas of concern regarding the proposed development and to determine what/if further baseline characterisation is required (see below).	This should follow the normal project specific EIA procedures.

Baseline characterisation surveys – direct loss of habitat

Activity	Objective	Comment
Pre-installation baseline survey using swathe bathymetry with photo / video ground-truthing. If any sensitive species / habitats are found to be present, wider survey to establish distribution of that species in the wider area.	To determine the relative sensitivity of the proposed development area and to inform the impact assessment	This should be undertaken in all previously unsurveyed areas.

Further desk based studies – direct loss of habitat

Activity	Objective	Comment
Undertake impact assessment	To determine whether or not there are likely to be any potentially significant effects on the habitats and species identified	This should follow normal EIA procedures.

Monitoring during and post installation– direct loss of habitat

Activity	Objective	Comment
Post-installation survey	To gauge any impacts, validate assumptions made during the impact assessment process and to inform future impact assessment and consenting activities	This should be undertaken in all circumstances.
Post-decommissioning survey	To gauge any impacts, validate assumptions made during the impact assessment process and to inform future impact assessment and consenting activities	This should be undertaken in all circumstances.

Strategic research opportunities and requirements – direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	N/A

Key issue 20 - The potential wider or secondary effects on protected or sensitive sub-littoral seabed communities due to installation and operation of wave and tidal energy converters and associated moorings or support structures

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive wider or secondary effects (including Change in sediment dynamics, Smothering, Increased/reduced deposition, Scour, Change in tidal flows and fluxes, Dissipation of wave energy) on protected or sensitive sub-littoral seabed communities that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
Change in sediment dynamics		
<p>Moorings / support structures Drilled and Grouted piles Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base Rock anchors and mooring lines Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon</p> <p>Wave technologies Oscillating water column (shoreline) Overtopping device (shoreline)</p>	<p>High and moderate energy Infralittoral rock habitats:</p> <p>A3.1 : Atlantic and Mediterranean high energy infralittoral rock Including BAP Habitat 'Tidal swept channels'</p> <p>A3.2 : Atlantic and Mediterranean moderate energy infralittoral rock Including BAP Habitat 'Tidal swept channels', 'Sabellaria spinulosa reefs'</p>	<p>Refer to individual justifications in the electronic database</p> <p>Assessment score: '1' (potentially significant).</p>

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
<p>Moorings / support structures Drilled and Grouted piles Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base Rock anchors and mooring lines Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon</p> <p>Wave technologies Oscillating water column (shoreline) Overtopping device (shoreline)</p>	<p>High and moderate energy circalittoral rock habitats: A4.1 : Atlantic and Mediterranean high energy circalittoral rock Including BAP Habitat 'Tidal swept channels' A4.2 : Atlantic and Mediterranean moderate energy circalittoral rock A4.7 : Features of circalittoral rock</p> <p>Sublittoral habitats: A5.1 : Sublittoral coarse sediment including BAP habitats 'Subtidal sands and gravel', 'Horse mussel beds' A5.2 : Sublittoral sand including BAP habitat 'Subtidal sands and gravel', 'Blue mussel beds' A5.4 : Sublittoral mixed sediments including BAP Habitat 'Horse mussel beds', 'File Shell Beds' A5.5 : Sublittoral macrophyte-dominated sediment including BAP habitats 'Maerl beds', 'Tidal swept channels', 'Horse mussel beds', 'Blue mussel beds' A5.6 : Sublittoral biogenic reefs including BAP Habitats 'Horse mussel beds', 'Cold-water coral reefs', 'Blue mussel beds'</p>	
Smothering		
<p>Moorings / support structures Drilled and Grouted piles Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base</p> <p>Wave technologies Oscillating water column (shoreline) Overtopping device (shoreline)</p>	<p>High and moderate energy Infralittoral rock habitats: A3.1 : Atlantic and Mediterranean high energy infralittoral rock Including BAP Habitat 'Tidal swept channels' A3.2 : Atlantic and Mediterranean moderate energy infralittoral rock Including BAP Habitat 'Tidal swept channels', 'Sabellaria spinulosa reefs'</p>	<p>Refer to individual justifications in the electronic database</p>
<p>Moorings / support structures Drilled and Grouted piles Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon</p>	<p>Circalittoral rock habitats: A4.1 : Atlantic and Mediterranean high energy circalittoral rock Including BAP Habitat 'Tidal swept channels' A4.2 : Atlantic and Mediterranean moderate energy circalittoral rock A4.7 : Features of circalittoral rock</p>	<p>Assessment score: '1' (potentially significant).</p>

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
Gravity base structure Rock anchors / pinned gravity base		
Moorings / support structures Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure	Sublittoral habitats: A5.1 : Sublittoral coarse sediment including BAP habitats 'Subtidal sands and gravel', 'Horse mussel beds' A5.2 : Sublittoral sand including BAP habitat 'Subtidal sands and gravel', 'Blue mussel beds' A5.4 : Sublittoral mixed sediments including BAP Habitat 'Horse mussel beds', 'File Shell Beds' A5.5 : Sublittoral macrophyte-dominated sediment including BAP habitats 'Maerl beds', 'Tidal swept channels', 'Horse mussel beds', 'Blue mussel beds' A5.6 : Sublittoral biogenic reefs including BAP Habitats 'Horse mussel beds', 'Cold-water coral reefs', 'Blue mussel beds'	
Increased/reduced deposition		
Moorings / support structures Drilled and Grouted piles Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base Rock anchors and mooring lines Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon Wave technologies Oscillating water column (shoreline) Overtopping device (shoreline)	High and moderate energy Infralittoral rock habitats: A3.1 : Atlantic and Mediterranean high energy infralittoral rock Including BAP Habitat 'Tidal swept channels' A3.2 : Atlantic and Mediterranean moderate energy infralittoral rock Including BAP Habitat 'Tidal swept channels', 'Sabellaria spinulosa reefs' Circalittoral rock habitats: A4.1 : Atlantic and Mediterranean high energy circalittoral rock Including BAP Habitat 'Tidal swept channels' A4.2 : Atlantic and Mediterranean moderate energy circalittoral rock A4.7 : Features of circalittoral rock Sublittoral habitats: A5.1 : Sublittoral coarse sediment including BAP habitats 'Subtidal sands and gravel', 'Horse mussel beds' A5.2 : Sublittoral sand including BAP habitat 'Subtidal sands and gravel', 'Blue mussel beds' A5.4 : Sublittoral mixed sediments including BAP Habitat 'Horse mussel beds', 'File Shell Beds'	Refer to individual justifications in the electronic database Assessment score: '1' (potentially significant).

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
	<p>A5.5 : Sublittoral macrophyte-dominated sediment including BAP habitats 'Maerl beds', 'Tidal swept channels', 'Horse mussel beds', 'Blue mussel beds'</p> <p>A5.6 : Sublittoral biogenic reefs including BAP Habitats 'Horse mussel beds', 'Cold-water coral reefs', 'Blue mussel beds'</p>	
Scour		
<p>Moorings / support structures</p> <p>Driven/percussion piles</p> <p>Gravity anchor and mooring lines</p> <p>Gravity anchor and taut mooring lines</p> <p>Gravity anchor, mooring lines and floating pontoon</p> <p>Gravity base structure</p>	<p>Sublittoral habitats:</p> <p>A5.1 : Sublittoral coarse sediment including BAP habitats 'Subtidal sands and gravel', 'Horse mussel beds'</p> <p>A5.2 : Sublittoral sand including BAP habitat 'Subtidal sands and gravel', 'Blue mussel beds'</p> <p>A5.4 : Sublittoral mixed sediments including BAP Habitat 'Horse mussel beds', 'File Shell Beds'</p> <p>A5.5 : Sublittoral macrophyte-dominated sediment including BAP habitats 'Maerl beds', 'Tidal swept channels', 'Horse mussel beds', 'Blue mussel beds'</p> <p>A5.6 : Sublittoral biogenic reefs including BAP Habitats 'Horse mussel beds', 'Cold-water coral reefs', 'Blue mussel beds'</p>	<p>Refer to individual justifications in the electronic database</p> <p>Assessment score: '1' (potentially significant).</p>
Change in tidal flows and fluxes		
<p>Moorings / support structures</p> <p>Drilled and Grouted piles</p> <p>Driven/percussion piles</p> <p>Gravity anchor and mooring lines</p> <p>Gravity anchor and taut mooring lines</p> <p>Gravity anchor, mooring lines and floating pontoon</p> <p>Gravity base structure</p> <p>Rock anchors / pinned gravity base</p> <p>Rock anchors and taut mooring lines</p> <p>Rock anchors, mooring lines and floating pontoon</p>	<p>Sublittoral habitats:</p> <p>A5.1 : Sublittoral coarse sediment including BAP habitats 'Subtidal sands and gravel', 'Horse mussel beds'</p> <p>A5.2 : Sublittoral sand including BAP habitat 'Subtidal sands and gravel', 'Blue mussel beds'</p> <p>A5.4 : Sublittoral mixed sediments including BAP Habitat 'Horse mussel beds', 'File Shell Beds'</p> <p>A5.5 : Sublittoral macrophyte-dominated sediment including BAP habitats 'Maerl beds', 'Tidal swept channels', 'Horse mussel beds', 'Blue mussel beds'</p> <p>A5.6 : Sublittoral biogenic reefs including BAP Habitats 'Horse mussel beds', 'Cold-water coral reefs', 'Blue mussel beds'</p>	<p>Refer to individual justifications in the electronic database</p> <p>Assessment score: '1' (potentially significant).</p>

Dissipation of wave energy		
Moorings / support structures Drilled and Grouted piles Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base Rock anchors and mooring lines Rock anchors, mooring lines and floating pontoon Wave technologies Oscillating water column (shoreline) Overtopping device (shoreline)	Sublittoral habitats: A5.1 : Sublittoral coarse sediment including BAP habitats 'Subtidal sands and gravel', 'Horse mussel beds' A5.2 : Sublittoral sand including BAP habitat 'Subtidal sands and gravel', 'Blue mussel beds' A5.4 : Sublittoral mixed sediments including BAP Habitat 'Horse mussel beds', 'File Shell Beds' A5.5 : Sublittoral macrophyte-dominated sediment including BAP habitats 'Maerl beds', 'Tidal swept channels', 'Horse mussel beds', 'Blue mussel beds' A5.6 : Sublittoral biogenic reefs including BAP Habitats 'Horse mussel beds', 'Cold-water coral reefs', 'Blue mussel beds'	Refer to individual justifications in the electronic database Assessment score: '1' (potentially significant).

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the effects of *changes in sediment dynamics, smothering, deposition, scour, changes in tidal flows and fluxes and dissipation of wave energy* on seabed communities for those technologies and/or support structures, and species / habitats, assessed as significant in the assessment.

This information is not prescriptive and should be used as a platform for discussion on a project and site specific basis in order to develop an appropriate impact assessment strategy and monitoring programme for the project.

Single test deployments

Preliminary desk based studies – wider / secondary effects

Activity	Objective	Comment
None recommended	N/A	No significant impacts are expected from the presence and operation of a single wave or tidal energy device and associated moorings / support structures.

Baseline characterisation surveys – wider / secondary effects

Activity	Objective	Comment
None recommended	N/A	N/A

Monitoring during and post installation – wider / secondary effects

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements– wider / secondary effects

Activity	Objective	Comment
None recommended	N/A	N/A

Demonstration arrays (up to 10MW)

Preliminary desk based studies – wider / secondary effects

Activity	Objective	Comment
Review of existing information regarding seabed conditions and communities in the proposed development area	To inform baseline survey plans and predict the presence / absence of any habitats and species identified as particularly vulnerable	This should be undertaken in all instances although data and information is likely to be largely generic and sparse in most unsurveyed areas.
Undertake impact assessment	To identify any particular areas of concern regarding the proposed development and to determine what/if further baseline characterisation is required (see below)	This should follow the normal project specific EIA procedures.

Baseline characterisation surveys – wider / secondary effects

Activity	Objective	Comment
Pre-installation baseline survey using swathe bathymetry with photo / video ground-truthing. If any sensitive species / habitats are found to be present, wider survey to establish distribution of that species in the wider area.	To determine the relative sensitivity of the proposed development area and to inform the impact assessment	This should be undertaken in all previously unsurveyed areas.

Further desk based studies – wider / secondary effects

Activity	Objective	Comment
Undertake impact assessment	To determine whether or not there are likely to be any potentially significant effects on the habitats and species identified	This should follow normal EIA procedures

Monitoring during and post installation – wider / secondary effects

Activity	Objective	Comment
Carry out repeated post-installation surveys using photo / video / quadrant studies to monitor effects	To monitor any changes in seabed communities, validate predictions, inform environmental monitoring and future site selection and project development work	This should only be undertaken where a development proceeds within a particularly sensitive area (as determined by the baseline characterisation work and the EIA). Long-term studies may be required to detect any change.
	To monitor any change in hydrographic conditions following installation	

Strategic research opportunities and requirements– wider / secondary effects

Activity	Objective	Comment
Measure the level and extent of changes in wave action and tidal flows and fluxes using appropriate equipment such as waverider buoys or Acoustic Doppler Current Profilers	To monitor any change in hydrographic conditions following installation	This should only be undertaken where a development proceeds within a particularly sensitive area (as determined by the baseline characterisation work and the EIA). Long-term studies may be required to detect any change.

Key issue 21 - Direct loss of protected or sensitive littoral coastal communities due to the placement of shoreline or nearshore wave energy converters

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be sensitive to direct loss of protected or sensitive littoral coastal communities that should be considered on a project specific basis. For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
Wave technologies Oscillating water column (shoreline) Overtopping device (shoreline)	A1.1 : High energy littoral rock Including BAP Habitat "Tidal swept channels" A1.2 : Moderate energy littoral rock Including BAP habitat "Under boulder communities" A2.7 : Littoral biogenic reefs Including BAP habitat "Blue mussel beds" A2.8 : Features of littoral sediment Including BAP habitat "Blue mussel beds"	Refer to individual justifications in the electronic database Assessment score: '1' (potentially significant).

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the effects of habitat loss on littoral coastal communities for those technologies and/or support structures, and species/habitats, assessed as significant in the assessment. This information is not prescriptive and should be used as a platform for discussion on a project and site specific basis in order to develop an appropriate impact assessment strategy and monitoring programme for the project.

Single test deployments

Preliminary desk based studies – direct loss of habitat

Activity	Objective	Comment
Review of existing information regarding coastal communities in the proposed development area	To inform baseline survey plans and predict the presence / absence of habitats or species identified	This work should be undertaken for all projects.
Undertake impact assessment	To identify any particular areas of concern regarding the proposed development and to determine what/if further baseline characterisation is	This should follow the normal project specific EIA procedures.

Activity	Objective	Comment
	required (see below)	

Baseline characterisation surveys – direct loss of habitat

Activity	Objective	Comment
Baseline survey using Phase 1 Habitat Mapping along coastline	To identify any particularly sensitive habitats / species within and adjacent to the proposed development area	This work should be undertaken for all projects (in unsurveyed areas). If sensitive a species / habitat is found to be present, wider survey to establish distribution of that species in the wider area.

Further desk based studies – direct loss of habitat

Activity	Objective	Comment
Impact assessment	To determine the suitability of the proposed deployment site in terms of the habitats and species present within and adjacent to the proposed development area. To determine, based on baseline characterisation surveys, whether or not there are likely to be any potentially significant effects on the species identified	This should follow the normal project specific EIA procedures.

Monitoring during and post installation – direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements– direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	N/A

Demonstration arrays (up to 10MW)

Preliminary desk based studies – direct loss of habitat

Activity	Objective	Comment
Review of existing information regarding coastal communities in the proposed development area	To inform baseline survey plans and predict the presence / absence of habitats or species identified	This work should be undertaken for all projects.

Activity	Objective	Comment
Undertake impact assessment	To identify any particular areas of concern regarding the proposed development and to determine what/if further baseline characterisation is required (see below)	This should follow the normal project specific EIA procedures.

Baseline characterisation surveys – direct loss of habitat

Activity	Objective	Comment
Baseline survey using Phase 1 Habitat Mapping along coastline	To identify any particularly sensitive habitats / species within and adjacent to the proposed development area	This work should be undertaken for all projects (in unsurveyed areas). If sensitive a species / habitat is found to be present, wider survey to establish distribution of that species in the wider area.

Further desk based studies – direct loss of habitat

Activity	Objective	Comment
Impact assessment	To determine the suitability of the proposed deployment site in terms of the habitats and species present within and adjacent to the proposed development area. To determine, based on baseline characterisation surveys, whether or not there are likely to be any potentially significant effects on the species identified	This should follow the normal project specific EIA procedures.

Monitoring during and post installation – direct loss of habitat

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements – direct loss of habitat

Activity	Objective	Comment
None proposed at this time	N/A	N/A

Key issue 22 - The potential wider or secondary effects on protected or sensitive littoral coastal communities due to installation and/or operation of wave and tidal energy converters and associated moorings or support structures

The following table provides a summary of the results from the assessments undertaken during this study. It lists any technologies, mooring systems and support structures relevant to this particular key issue and those species/groups that were concluded to be potentially sensitive wider or secondary effects (including scour, increased/reduced deposition, changes in sediment dynamics, smothering, dissipation of wave energy) on protected or sensitive sub-littoral seabed communities that should be considered on a project specific basis: For definitions of the scoring criteria, refer to Section 0.

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
Scour		
Drilled and Grouted piles Driven/percussion piles Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base	A2.7 : Littoral biogenic reefs Including BAP habitat "Blue mussel beds" A2.8 : Features of littoral sediment Including BAP habitat "Blue mussel beds"	Refer to individual justifications in the electronic database Assessment score: '1' (potentially significant).
Increased/reduced deposition		
Drilled and Grouted piles Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base Rock anchors and mooring lines Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon	A1.2 : Moderate energy littoral rock Including BAP habitat "Under boulder communities" A2.7 : Littoral biogenic reefs Including BAP habitat "Blue mussel beds" A2.8 : Features of littoral sediment Including BAP habitat "Blue mussel beds"	Refer to individual justifications in the electronic database Assessment score: '1' (potentially significant).
Wave technologies		
Oscillating water column		

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
(shoreline) Overtopping device (shoreline)		
Changes in sediment dynamics		
Drilled and Grouted piles Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity anchor and taut mooring lines Gravity anchor, mooring lines and floating pontoon Gravity base structure Rock anchors / pinned gravity base Rock anchors and mooring lines Rock anchors and taut mooring lines Rock anchors, mooring lines and floating pontoon Wave technologies Oscillating water column (shoreline) Overtopping device (shoreline)	A1.1 : High energy littoral rock Including BAP Habitat "Tidal swept channels" A1.2 : Moderate energy littoral rock Including BAP habitat "Under boulder communities" A2.7 : Littoral biogenic reefs Including BAP habitat "Blue mussel beds" A2.8 : Features of littoral sediment Including BAP habitat "Blue mussel beds"	Refer to individual justifications in the electronic database Assessment score: '1' (potentially significant).
Smothering		
Wave technologies Oscillating water column (shoreline) Overtopping device (shoreline)	A1.1 : High energy littoral rock Including BAP Habitat "Tidal swept channels" A1.2 : Moderate energy littoral rock Including BAP habitat "Under boulder communities" A2.7 : Littoral biogenic reefs Including BAP habitat "Blue mussel beds" A2.8 : Features of littoral sediment Including BAP habitat "Blue mussel beds"	Refer to individual justifications in the electronic database Assessment score: '1' (potentially significant).
Dissipation of wave energy		
Drilled and Grouted piles Driven/percussion piles Embedment anchor and mooring lines Gravity anchor and mooring lines Gravity anchor, mooring lines and floating pontoon	A1.1 : High energy littoral rock Including BAP Habitat "Tidal swept channels" A2.7 : Littoral biogenic reefs Including BAP habitat "Blue mussel beds" A2.8 : Features of littoral sediment Including BAP habitat "Blue mussel beds"	Refer to individual justifications in the electronic database

Relevant technologies and moorings / support structures	Relevant habitats	Summary of assessment results
Gravity base structure Rock anchors / pinned gravity base Rock anchors and mooring lines Rock anchors, mooring lines and floating pontoon Wave technologies Oscillating water column (shoreline) Overtopping device (shoreline)		Assessment score: '1' (potentially significant).

How could the issue be addressed on a project and site specific basis?

The following tables provide a series of suggested activities and recommendations that may be taken forward to address the effects changes in sediment dynamics, smothering, deposition, scour, changes in coastal processes or dissipation of wave energy on benthic species and communities for those technologies and/or support structures, and species / habitats, assessed as significant in the assessment.

This information is not prescriptive and should be used as a platform for discussion on a project and site specific basis in order to develop an appropriate impact assessment strategy and monitoring programme for the project.

Single test deployments

Preliminary desk based studies – wider / secondary effects

Activity	Objective	Comment
None recommended	N/A	No significant impacts are expected from the presence and operation of a single wave or tidal energy device and associated moorings / support structures.

Baseline characterisation surveys – wider / secondary effects

Activity	Objective	Comment
None recommended	N/A	N/A

Monitoring during and post installation – wider / secondary effects

Activity	Objective	Comment
None recommended	N/A	N/A

Strategic research opportunities and requirements– wider / secondary effects

Activity	Objective	Comment
None recommended	N/A	N/A

Demonstration arrays (up to 10MW)

Preliminary desk based studies – wider / secondary effects

Activity	Objective	Comment
Review of existing information regarding coastal communities in the proposed development area	To inform baseline survey plans and predict the presence / absence of habitats or species identified	This work should be undertaken for all projects.
Undertake impact assessment	To identify any particular areas of concern regarding the proposed development and to determine what/if further baseline characterisation is required (see below)	This should follow the normal project specific EIA procedures.

Baseline characterisation surveys – wider / secondary effects

Activity	Objective	Comment
Baseline survey using Phase 1 Habitat Mapping along coastline	To identify any particularly sensitive habitats / species within and adjacent to the proposed development area	This work should be undertaken for all projects (in unsurveyed areas). If sensitive a species / habitat is found to be present, wider survey to establish distribution of that species in the wider area.

Further desk based studies – wider / secondary effects

Activity	Objective	Comment
Undertake impact assessment	To determine the suitability of the proposed deployment site in terms of the habitats and species present within and adjacent to the proposed development area. To determine, based on baseline characterisation surveys, whether or not there are likely to be any potentially significant effects on the species identified	This work should be undertaken for all projects

Monitoring during and post installation – wider / secondary effects

Activity	Objective	Comment
Carry out repeated post-installation surveys	To monitor any changes in coastal communities, validate predictions, inform environmental monitoring and future site selection and project development work	This should only be undertaken where a development proceeds within a particularly sensitive area (as determined by the baseline characterisation work and the EIA). Long-term studies may be required to detect any change.
Measure the level and extent of changes in wave action and tidal flows and fluxes using appropriate equipment such as waverider buoys or Acoustic Doppler Current Profilers	To monitor any change in hydrographic conditions following installation	

Strategic research opportunities and requirements– wider / secondary effects

Activity	Objective	Comment
None proposed at this time	N/A	N/A

Appendix A - Scoring criteria for assessing significance of interactions

Score	Marine birds	Marine mammals	Fish and shellfish	Benthic habitats and species
1	There is a reasonable hypothesis that the potential exists to cause death/injury or to affect behaviour in a way that has negative consequences for energy intake that could lead to a change in the stability of the regional population or within an SPA population	There is a reasonable hypothesis that: <ul style="list-style-type: none"> the development of a 10MW array may potentially lead to the death/severe injury of an individual cetacean; or the development of a 10MW array may lead to the death/injury/disturbance of a significant number of seals/otters to the extent that would result in a change in stability of the local/regional population or an SAC population. 	There is a reasonable hypothesis that a 10MW array would result in a change in the stability of the Scottish population bearing in mind that some species may already be under pressure due to other factors (e.g. climate change, fisheries pressures)	There is a reasonable hypothesis that the impact from a 10 MW array will cause: <ul style="list-style-type: none"> the habitat to be fully or partially destroyed; or major and larger-scale (beyond the seabed footprint of the array) effects on the survival or viability of species that characterise the habitat, that provide key structure or function for the habitat or that are of natural heritage importance in that habitat (i.e. those in Biodiversity Action Plans).
0	There is a reasonable hypothesis that a 10MW array will not result in a change in the stability of the regional population or within an SPA population	There is a reasonable hypothesis that: <ul style="list-style-type: none"> the development of a 10MW array will not lead to the death/severe injury of an individual cetacean; or the installation of a 10MW array will not lead to the death/injury/disturbance of a significant number of seals/otters to the extent that would result in a change in stability of the local/regional population or an SAC population. 	There is a reasonable hypothesis that a 10MW array would not result in a change in the stability of the Scottish population bearing in mind that some species may already be under pressure due to other factors (e.g. climate change, fisheries pressures)	There is a reasonable hypothesis that the impact from a 10 MW array has, at most, only minor and local effects (within the actual seabed footprint of the array) on the survival or viability of species that characterize the habitat, that provide key structure or function for the habitat or that are of natural heritage importance in that habitat (i.e. those in Biodiversity Action Plans)
NA	Not Applicable	Not Applicable	Not Applicable	Not Applicable

Score	Marine birds	Marine mammals	Fish and shellfish	Benthic habitats and species
Unknown	<p>It is unknown at this time:</p> <ul style="list-style-type: none"> • whether an interaction between the species and technology/mooring /support structure is possible/likely to occur; or • if the effect on the species concerned is likely to result in a change in stability of the local/regional population 	<p>It is unknown at this time:</p> <ul style="list-style-type: none"> • whether an interaction between the species and technology/mooring system/support structure is possible/likely to occur; • if the effect of a particular environmental pressure or a combination of pressures on the species concerned is likely to result in a change in stability of the local/regional population; or • whether the removal of a single individual from a population is significant and likely to result in a change in stability of the local/regional population. 	<p>It is unknown at this time: whether a 10MW array would or would not result in a change in the stability of the Scottish population bearing in mind that some species may already be under pressure due to other factors (e.g. climate change, fisheries pressures)</p>	<p>Category not used for benthic habitats/species</p>