

**Key issue 1 - The potential effects on marine mammals and basking shark from underwater noise generated by wave and tidal device operation and drilling activities during installation of monopiles and rock anchors**

**What are the relevant technologies and support structures?**

The following technologies and support structures were identified during the assessment process to have the potential to significantly affect marine mammals and basking shark through the generation of underwater noise and should therefore, be subject to further investigation on a project specific basis.

Relevant technologies and support structures	Relevant features, components or activities	Phase
<b>Tidal technologies</b>		
Horizontal axis turbine	Moving blades, machinery housed in floating / subsurface structures	Operation
Vertical axis turbine		
Reciprocating hydrofoils	Hydrofoils, machinery housed in subsurface structures	
<b>Wave technologies</b>		
Oscillating water column (offshore)	Machinery housed in floating / subsurface structures	Operation
Overtopping device (offshore)		
Attenuator		
Oscillating wave surge converter		
Point absorber		
Submerged pressure differential		
<b>Support structures</b>		
Rock anchors and mooring lines	Noise generated during installation by drilling (would include pinned gravity bases)	Installation
Monopile		

**What species / groups may be vulnerable?**

The following species were identified during the assessment process as being particularly sensitive to underwater noise and should, therefore, be considered further on a project specific basis.

Relevant species / groups	Possible consequences
Seals Cetaceans Otter Basking shark	<p>Installation: Underwater noise effects will potentially be most significant during drilling. Acute effects such as non-auditory/ auditory tissue damage are unlikely but behavioural effects due to disturbance are possible.</p> <p>Operation: It is unknown whether any noise generated will be at a level sufficient to disturb the animals and the effects of the disturbance are unknown and may also be site specific. There is not enough operational noise data for any device to confidently assess the potential effects at this time.</p>

## What species / groups are affected by which technologies and support structures

The following table provides a summary of the assessment results for each species or habitats in combination with each technology & Moorings/Support structures listed above.

Potentially significant at a 10MW scale	Unknown whether this will be significant at a 10 MW scale	Not Applicable	Assessed as not significant at a 10MW scale
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Common Name	Technology & Moorings and Support structures																								
	Horizontal axis turbine & Gravity/deadweight anchor and mooring lines	Horizontal axis turbine & Gravity base structure	Horizontal axis turbine & Monopile	Horizontal axis turbine & Rock anchors and mooring lines	Vertical axis turbine & Gravity/deadweight anchor and mooring lines	Vertical axis turbine & Gravity base structure	Vertical axis turbine & Rock anchors and mooring lines	Reciprocating hydrofoils & Gravity base structure	Reciprocating hydrofoils & Monopile	Oscillating water column (offshore) & Gravity/deadweight anchor and mooring lines	Oscillating water column (offshore) & Rock anchors and mooring lines	Oscillating water column (offshore) & Drag embedment anchor and mooring lines	Overtopping device (offshore) & Gravity/deadweight anchor and mooring lines	Overtopping device (offshore) & Rock anchors and mooring lines	Overtopping device (offshore) & Drag embedment anchor and mooring lines	Attenuator & Gravity/deadweight anchor and mooring lines	Attenuator & Rock anchors and mooring lines	Attenuator & Drag embedment anchor and mooring lines	Oscillating wave surge converter & Gravity base structure	Point absorber & Gravity/deadweight anchor and mooring lines	Point absorber & Rock anchors and mooring lines	Point absorber & Drag embedment anchor and mooring lines	Submerged pressure differential & Gravity base structure		
Common seal																									
Grey Seal																									
Killer whale																									
Minke whale																									
Long finned pilot whale																									
Atlantic white-sided dolphin																									
White-beaked dolphin																									
Bottlenose dolphin																									
Short-beaked common dolphin																									
Risso's dolphin																									
Harbour Porpoise																									
Otter																									
Basking Shark																									

## 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 on marine mammals and basking shark for those technologies and/or support structure, 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*

Activity	Objective	Recommendation / comment
Desk based review of existing information regarding species distribution / behaviour etc across the site	To establish the importance of the proposed development area for any potentially vulnerable species (as listed above) and screen potential impact on species present.	Undertake this work for all single deployments.  If it is possible to determine that either the area is not particularly important for the species identified or that the proposals are not likely to generate levels of noise of concern, it is possible that no further pre-deployment information is required.
Produce a 'noise profile' for the project	To identify the components / activities associated with the proposed development which may generate potentially significant levels of noise	
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).	

#### *Baseline characterisation surveys*

Activity	Objective	Recommendation / comment
Conduct baseline noise surveys	To characterise background acoustic profile of the proposed development site so as to allow a noise prediction model for the project to be produced	It is extremely difficult to accurately characterise background acoustics in an exposed offshore environment 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.
Conduct baseline marine mammal and basking shark surveys	To determine behaviour and distribution of species through and around the proposed development site	This should be undertaken where projects are expected to repeatedly generate chronic noise at levels which may injure vulnerable species in an area of high sensitivity for the species identified.

*Further desk based studies*

Activity	Objective	Recommendation / comment
Noise prediction model	To produce a detailed noise profile for the project allowing the zone of ecological effect to be predicted	This work should only be undertaken with regards to single deployments within areas of high sensitivity for the species identified.
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	This should follow the normal project specific EIA procedures.

*Monitoring during and post installation*

Activity	Objective	Recommendation / comment
Monitor noise generated during device operation	To characterise of device noise signature	<p>The work should be undertaken in all circumstances where it is proposed to deploy a device in an area deemed particularly sensitive for vulnerable species and if it is predicted that the device and associated activities will generate potentially significant levels of noise.</p> <p>Note - there is currently no standard approach for measuring underwater noise from wave and tidal devices although a number of potential options are under development.</p> <p>Measuring operational noise from machines in tidal streams and high energy wave areas is extremely difficult. It may therefore be possible to better characterise the acoustic signature of machines offsite prior to installation.</p> <p>Note – any data which can be gathered regarding the acoustic characteristics of the device could be highly beneficial to future impact assessment work and help streamline future licence application processes. It is therefore in any developer’s best interest to gather as much information as possible from test deployments.</p>

## Demonstration arrays (up to 10MW)

### *Preliminary desk based studies*

Activity	Objective	Recommendation / comment
Desk based review of existing information regarding species distribution / behaviour etc. across the site	To establish the importance of the proposed development area for any potentially vulnerable species (as listed above) and screen potential impact on species present.	If it is possible to determine that either the area is not particularly important for the species identified or that the proposals are not likely to generate levels of noise of concern, it is possible that no further pre-deployment information is required.  Data gathered during any test deployments should be used as far as possible.
Produce a 'noise profile' for the project	To identify the components / activities associated with the proposed development which may generate potentially significant levels of noise	
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).	

### *Baseline characterisation surveys*

Activity	Objective	Recommendation / comment
Conduct baseline noise surveys	To characterise background acoustic profile of the proposed development site so as to allow a noise prediction model for the project to be produced	It is extremely difficult to accurately characterise background acoustics in an exposed offshore environment 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
Conduct baseline marine mammal and basking shark surveys	To determine behaviour and distribution of species through and around the proposed development site	This should be undertaken where projects are expected to repeatedly generate chronic noise at levels which may injure vulnerable species in an area of high sensitivity for the species identified.  Additionally, it is possible that such surveys may be required in areas where data is scarce and it is anticipated that important populations may be present. It is recommended that in such instances targeted seasonal studies (spring-summer for basking sharks, summer for cetaceans) are used initially to determine the relative sensitivity of a potential deployment area.

*Further desk based studies*

<b>Activity</b>	<b>Objective</b>	<b>Recommendation / comment</b>
Noise prediction model	To produce a detailed noise profile for the project allowing the zone of ecological effect to be predicted	This work should only be undertaken with regards to arrays within areas of high sensitivity for the species identified.
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	This should follow the normal project specific EIA procedures.

*Monitoring during and post installation*

<b>Activity</b>	<b>Objective</b>	<b>Recommendation / comment</b>
Monitor marine mammal and basking shark activity around demonstration arrays	To determine response from species within the area and to validate predictions made during impact assessments  To inform ongoing and future environmental monitoring work	This should be undertaken in areas of high sensitivity and the data reviewed regularly to inform ongoing requirements.
Monitor noise from arrays to validate predictions	To validate predictions from noise modelling and to inform future site selection and project development work	This should be undertaken in areas of high sensitivity although the data gathered from any area will be valuable for future deployments.