Key issue 12 - The potential effects on diving birds from underwater noise and vibration generated by wave and tidal energy converters and during drilling activities

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 birds 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
Tidal technologies		
Horizontal axis turbine Vertical axis turbine Reciprocating hydrofoils	*Noise from presence and operation of devices is currently unknown.*	Operations
Wave technologies		
Oscillating water column (offshore) Overtopping device (offshore) Attenuator Oscillating wave surge converter Point absorber Submerged pressure differential	*Noise from presence and operation of devices is currently unknown.*	Operation
Support structures		
Monopile Rock anchors and mooring lines	*Increased / altered noise levels will also occur during installation of rock anchors and monopiles while drilling*	Installation

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
Greater Scaup (Scaup) Common Eider Long-tailed Duck Black Scoter (Common Scoter) Surf Scoter Velvet Scoter Common Goldeneye Red-breasted Merganser Goosander Red-throated Diver Black-throated Diver Great Northern Diver Yellow-billed Diver (White-billed Diver) Great Crested Grebe Red-necked Grebe Slavonian grebe Black-necked Grebe Northern Fulmar	Cory's Shearwater Great Shearwater Sooty Shearwater Manx Shearwater Balearic Shearwater Northern Gannet Great Cormorant European Shag Black-legged Kittiwake Sandwich Tern Roseate Tern Arctic Tern Common Guillemot Razorbill Black Guillemot Little Auk Atlantic Puffin	*Importance of hearing underwater / hearing thresholds for diving birds is unknown.* *Effects of increased / altered underwater noise levels on diving birds are currently unknown (displacement / avoidance, reduction in foraging success, no effect, etc).*

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

	Technology & Moorings and Support structures																						
Common Name	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
Greater Scaup (Scaup)																							
Common Eider																							
Long-tailed Duck																							
Black Scoter (Common Scoter)																							
Surf Scoter																							
Velvet Scoter																							
Common Goldeneye																							
Red-breasted Merganser																							
Goosander																							
Red-throated Diver																							
Black-throated Diver																							
Great Northern Diver																							
Yellow-billed Diver (White-billed Diver)																							
Great Crested Grebe																							

	Technology & Moorings and Support structures																						
Common Name	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
Red-necked Grebe																							
Slavonian grebe																							
Black-necked Grebe																							
Northern Fulmar																							
Cory's Shearwater																							
Great Shearwater																							
Sooty Shearwater																							
Manx Shearwater																							
Balearic Shearwater																							
Northern Gannet																							
Great Cormorant																							
European Shag																							
Black-legged Kittiwake																							
Sandwich Tern																							
Roseate Tern																							
Arctic Tern																							
Common Guillemot																							
Razorbill																							
Black Guillemot																							
Little Auk																							
Atlantic Puffin																							

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 on marine birds 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

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.
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
No activity recommended	N/A	N/A

Further desk based studies

Activity	Objective	Recommendation / comment
No activity recommended	N/A	N/A

Monitoring during and post installation

Activity	Objective	Recommendation / comment
No activity recommended	N/A	N/A

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	

Activity	Objective	Recommendation / comment
	development and to determine what/if further baseline characterisation is required (see below).	

Baseline characterisation surveys

Activity	Objective	Recommendation / comment
No activity recommended	N/A	N/A

Further desk based studies

Activity	Objective	Recommendation / comment
No activity recommended	N/A	N/A

Monitoring during and post installation

Activity	Objective	Recommendation / comment
Monitor noise generated during device operation	To characterise of device noise signature	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. 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. 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. 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.
Determine underwater noise signatures generated during drilling installation activities	To establish operational noise level and frequency for drilling technology in different operational modes	