Acute Risks to Marine Mammals from Pile Driving: an Assessment of Mitigation Procedures, Knowledge Gaps and Research Requirements

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The construction of offshore wind-farms generates a range of high-level underwater noise to which marine mammals, which have acute underwater hearing and use acoustics as their primary sensory modality, are especially vulnerable. The most intense sound, from pile driving of monopiles, is at levels that could cause hearing or physical damage. Risks will rise as pile diameter increases. We explore the risks posed by pile driving to the hearing of marine mammals found in the vicinity of UK offshore wind farms using a cumulative exposure model incorporating animal movement and simple propagation models. Runs of these models showed that marine mammals' hearing could be affected at ranges of several kms and highlight animal movement and sound propagation as poorly measured parameters with a major influence on the risk of damage.

There are several approaches that can be used in mitigation to reduce these risks and we review their likely efficacy. Direct surveillance of the "danger zone" is made difficult by the extensive range to which it extends in some conditions. Monitoring can use both visual and passive acoustic methods (PAM). A fundamental shortcoming of visual methods is that they aren't effective at night and are severely compromised by weather conditions. PAM enhances detection for some odontocete species but provides little if any detection of seals. We use data from marine mammal surveys to indicate the levels of effort required to substantially reduce risk and conclude that most existing mitigation exercises fall well short of this. To effectively minimise risk, surveillance for cetaceans and seals will need to be substantial and very costly undertakings.

The use of alerting signals, acoustic stimuli that in themselves pose no risk to hearing but would cause animals to move out of at-risk zones before pile driving starts, could underpin mitigation procedures that are potentially effective, day and night, in all weather conditions as well as being inexpensive. We review information on marine mammal responses to different underwater signal types and identify some signal classes and acoustic devices that show promise. We also consider the legal implications of intentionally disturbing cetaceans in this way. Permits would be required but there is a strong case and president for them being granted. To have confidence on alerting signals as a mitigation measure however, research is required to develop systems and quantify their effectiveness. This will involve measuring behavioural responses of wild marine mammals in representative field conditions. Although the necessary research is straightforward a substantial effort will be required to measure important variables and provide data to give regulators confidence in the procedure. This would , however, be an investment soon repayed by more reliable and cost-effective mitigation.

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