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MARINE MAMMALS AND TIDAL TURBINES: UNDERSTANDING TRUE COLLISION RISK

C.E. Sparling[1], C.G. Booth
SMRU Marine Ltd, University of St Andrews, St Andrews, Scotland, UK.

G.D. Hastie, D. Gillespie, J. MacAulay
Sea Mammal Research Unit, Scottish Oceans Institute, University of St Andrews, St Andrews, Scotland, UK.

ABSTRACT

Understanding how animals may be able to avoid collisions is crucial in determining the true risk of collision between marine mammals and tidal turbines. SMRU Marine and the Sea Mammal Research Unit (SMRU) are driving the development of innovative monitoring techniques on several tidal energy projects to collect data on near-field behavioural responses and to determine true encounter rates. One of these projects is at Marine Current Turbines' (MCT) SeaGen tidal turbine in Strangford Lough, NI. MCT have secured a license to operate the turbine without the precautionary marine mammal shutdown mitigation that was originally implemented to protect the Strangford Lough harbour seal population (a qualifying feature of the Strangford Lough SAC designation). This paper presents an update on the latest studies currently planned around the UK and highlights how data will be collected to provide evidence for evasion or avoidance capabilities of marine mammals; currently a key barrier to unlocking the future potential of marine energy.

INTRODUCTION

In the last 5 years the wave and tidal industry has seen a period of rapid expansion. There has been a strong focus on developer-led provision of environmental information and assessments, to inform consenting, as well as post consent monitoring of environmental impacts in areas where devices (mostly test devices) have been installed. In addition, research, often undertaken by the academic community (e.g. Natural Environmental Research Council's ('NERC') Marine Renewable Energy Knowledge Exchange ('MREKE') research programme, Scottish and Welsh Government funded research), has focused on developing monitoring methodologies, understanding marine mammals' functional use of high energy marine environments and measuring animals' responses to underwater noise.

There is still, however, significant uncertainty regarding the level of true impacts that may arise from the construction, operation and maintenance phases of tidal projects in particular. One of the key perceived environmental risks associated with tidal energy is the potential for wildlife species to be injured by moving parts of tidal turbines. Predictions of risk are generally informed by modelling the encounter rate between marine mammals and turbines based on the physical characteristics of turbines (rotor number, size and speed), estimates of local density of animals (or passage rate) and their physical and behavioural characteristics (e.g. body size, swim speed etc). The assessment, understanding and quantification of these impacts have remained a key challenge due to a lack of empirical data to validate or inform such models. It is of utmost importance that early developments do as much as possible to address these uncertainties in the short term, in order to reduce future consenting risk, reduce regulatory burdens and focus monitoring requirements in the future. Here we provide an update on current and future monitoring projects which aim to provide 1) empirical measures of close range encounter rates, which can be compared against theoretical encounter rates to inform the degree of avoidance and 2) evidence for any close range evasive responses, which can be also used to inform the degree of evasion that should be factored into collision risk models.

ACTIVE ACOUSTIC MONITORING OF MARINE MAMMALS AROUND TIDAL TURBINES

Using data from Active Sonar mitigation at Strangford Lough to inform collision risk

There has been an Active Sonar marine mammal detection system in place at the SeaGen tidal turbine in Strangford Lough, Northern Ireland since 2009. The current mitigation consists of a team of sonar operators continually monitoring this system which provides a view of any potential marine mammals approaching the turbine from upstream during turbine operation. Under this scenario the turbine is shut-down if a potential marine mammal is detected within 30m of the rotors (see Figure 1). As part of a move towards removing this shutdown mitigation, SMRU Marine were commissioned to analyse the data collected to date from the sonar system with a view to quantifying collision risk. Over 6500 hours of sonar data were

[1] Corresponding author: ces@smrumarine.com

examined (between January 2010 and November 2012). The average close range detection rate (within 30m) was 0.094 per hour. Assuming a precautionary 50% detection efficiency for the active sonar (Hastie, 2009) this equates to an average encounter rate of 0.188 per hour. Encounter rate was highest in the summer months, likely a reflection of higher numbers of seals present in the Lough during the breeding and moulting periods. Information on the dive distribution of harbour seals from telemetry studies at Strangford Lough was used to calculate the rate of passage at the depth of the turbine rotors. Data indicated this to be approximately $1/10^{th}$ of the total passage rate. Finally, incorporating precautionary avoidance rates of 50% assuming that seals can take some degree of evasive action and incorporating a physical collision probability model averaged across the whole tidal cycle, final estimates of collision risk were approximately 1 seal per month during the summer months.

Application of the PBR (Potential Biological Removal) model to the harbour seal population based on population size and status estimates from monthly haul out counts resulted in a PBR of between 3 and 4 seals per year. Therefore, given the calculated collision risk rates, and an assessment of the current status and trajectory of the population, a trial period (with no shutdown in place) of three months duration during the summer months is unlikely to present a risk to the sustainability of the harbour seal population. Consequently a license can be issued to MCT to allow a trial period of operation without the shutdown mitigation in place. This trial is currently in the planning stages.

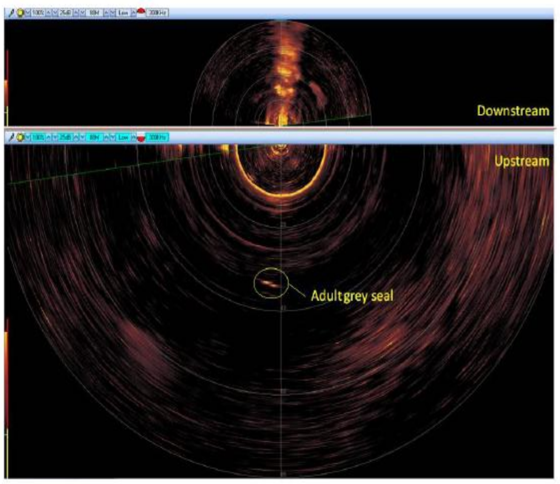

Figure 1 Example image from sonar monitoring showing an adult grey seal approximately 35m from the turbine

Removing the shutdown mitigation at SeaGen

It is absolutely crucial that during this trial that the learning opportunities are maximized; monitoring needs to be in place to collect data on the near field behavioural responses of seals to the operating turbine. SMRU Marine have been successful in securing funding from the Department of Energy and Climate Change (DECC) to install a number of multibeam sonar devices to directly image the area around the rotors to collect information on close range marine mammal passages and to detect any near field evasion repsonses. Automatic detection software which discriminates between marine mammal and non-marine mammal targets based on shape, size and movement patterns will be used to identify potential marine mammal targets (Hastie, 2013). This deployment will also collect data which can be used to further train automatic marine mammal detection and classification algorithms to reduce the rate of false positives and to decrease the degree of post-processing required.

In parallel to this trial, SMRU are proposing a seal tagging study to measure the fine scale behavior of tagged harbour seals around the operating turbine. This dataset will be compared with three previous tagging studies: one before the turbine was installed in 2006; one during installation in 2008 and one during mitigated operation in 2010 (Lonergan et al., in review).

It is expected that this trial will start in Spring/Summer 2014.

INTEGRATING PASSIVE AND ACOUSTIC MONITORING AROUND TIDAL TURBINES

In areas where both seals and cetaceans are of concern regarding collision risk, passive and active acoustic monitoring systems combined in an integrated system can, if appropriately designed, complement each other by compensating for the weaknesses in each individual system. For example passive acoustic monitoring (PAM) works well for the detection and classification of the vocalisations of small cetaceans such as porpoises and dolphins, however it is not appropriate for animals which don't reliably vocalize (such as seals). Active sonar on the other hand will detect all species of marine mammal but cannot currently reliably discriminate to species. There is a danger, however, of system incompatibility, for example, because of interference within a passive acoustic monitoring system from the powerful acoustic signals of some active systems. A degree of prior assessment and careful design is necessary to minimise the potential for negative interactions. SMRU Marine and SMRU, working with Tidal Energy Limited (TEL) have designed a combined Active/Passive monitoring system for TEL's DeltaStream deployment Ramsey Sound, Pembrokeshire, Wales. This deployment is likely to be the first example of the monitoring of near field interactions of marine mammals with tidal turbines from such a system. More details of the PAM system are described in the next section.

PASSIVE ACOUSTIC MONITORING OF CETACEANS AROUND TIDAL TURBINES

SMRU Marine, working closely with researchers at SMRU, are developing passive acoustic methodologies to detect and track vocalizing cetaceans (such as harbour porpoise and dolphins) around tidal turbines. As part of TEL's operational monitoring strategy we have designed a turbine mounted, integrated PAM system which consists of an array of hydrophones with the capability to detect, localise and track harbour porpoise clicks in 3D around the structure. Simulation of errors and the performance of different array configurations suggest that very accurate localization should be obtained at reasonable ranges (many tens of metres; see Figure 2). Whilst only a minimum of four hydrophones are required to localise individual clicks, reliability and redundancy is built in by having up to 12 hydrophones mounted on the structure in an array. Algorithm development which has been possible as a result of Scottish Government funded work at SMRU will allow the detection and localisation of porpoises to run in real time and will allow the identification of small cetaceans which come in close proximity to the turbine. The wider aim is also to collect data on near field encounter rates and on the behavior of porpoises around operating devices, to understand the extent to which they detect and avoid devices, and to parameterize collision risk models.

(a)

(b)

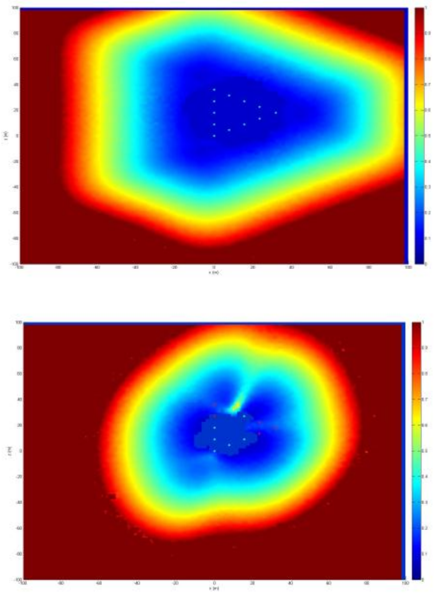

Figure 2 Examples of modelled localization accuracy from a 12 hydrophone array mounted on a single plane on a triangular structure. Vertical and horizontal scale represents 100m and the colour ramp has 1m accuracy as a maximum value. (a) Porpoise click is detected on all 12 hydrophones (b) demonstrates reduced accuracy if click is only detected on 7 hydrophones.

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