Department of Energy & Climate Change

Sonar detection of marine mammals - Completed Project

A project undertaken by SMRU Limited, funded by the Department of Energy and Climate Change (DECC) Offshore Energy Strategic Environmental Assessment (OESEA) programme. For further information, contact the Project Coordinator at jph@hartleyanderson.com

Context

Currently, there is an important information gap on the environmental impacts of tidal stream marine renewable energy devices on marine mammals (seals, whales and dolphins) as few of these devices have been installed in the sea. A principal environmental concern is the potential for physical injury to marine mammals through direct contact with rotating turbine blades and there is a need to improve understanding of this risk. The ability to detect and track marine mammals (or other large animals such as basking sharks) around devices would assist with such understanding. The information will aid environmental impact assessments and permitting decisions, including European Protected Species licensing and assessments of plans or projects under the Habitats Regulations.

DECC has previously funded initial phases of research by SMRU Ltd on the tracking of marine mammals around marine renewable energy devices using active sonar which showed that new generation imaging sonar systems have the capacity to produce acoustic images of marine mammals, and may be suitable for this application. However, the acoustic signals of a system initially selected for trial elicited overt behavioural responses by grey and harbour seals.

Project Objectives & Scope

The four-phase project involved collaborations between marine mammal specialists, marine renewable developers, and sonar engineers to develop a user-friendly sonar system for the marine renewable industry.

Figure 1: Image showing the turbine with the cross arm raised out of the water (left). The mounting location of a sonar transducer on the centre of the crossbeam is shown on the right.

The detection of marine mammals by sonar

- Phase 1 – Identification of the requirements of a generic sonar monitoring system for the renewable energy industry
- Phase 2 - Formal trials with captive seals to test the system prior to any further development and subsequent field deployment
- Phase 3 - Development and upgrading of selected system based on the findings of the previous phase
- Phase 4 - Upgraded sonar deployed on the SeaGen tidal turbine in Strangford Lough (Figure 1) for a period of several months to evaluate the efficiency and reliability of the system. Sonar images were collected on a total of 42 days between the 20th May and 29th July 2011.

A secondary objective was to evaluate the frequency of encounters between marine mammals and the tidal turbine, and to measure potential behavioural responses to turbine operation.

Project Outcomes & Outputs

A final report of the project (Hastie 2012) was published in September 2012. Key project outcomes included:

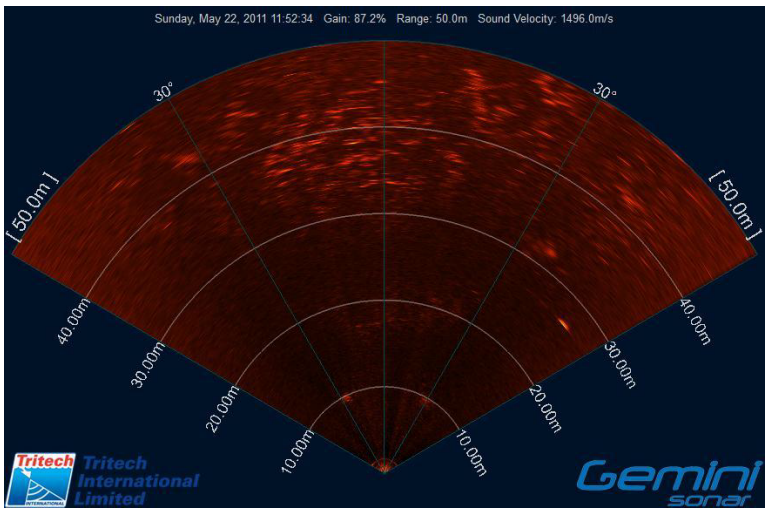

Figure 2: Sonar image of a detection that was classified as being a high probability marine mammal; the 'marine mammal' can be seen at a range of approximately 27m at an angle of 50 degrees to the right of centre.

- With respect to the sonar system developed, analysis of the software 'detection efficiency' suggested that there was a significant negative relationship between range and probability of detection; the probability of the software automatically detecting a seal was greater than 0.9 for ranges up to around 37m and dropped to below 0.1 at ranges greater than 56m.

- Detection ranges at sites with different hydrographic conditions varied, and hydrographic conditions and levels of turbulence should be reviewed when considering sonar at new tidal sites.

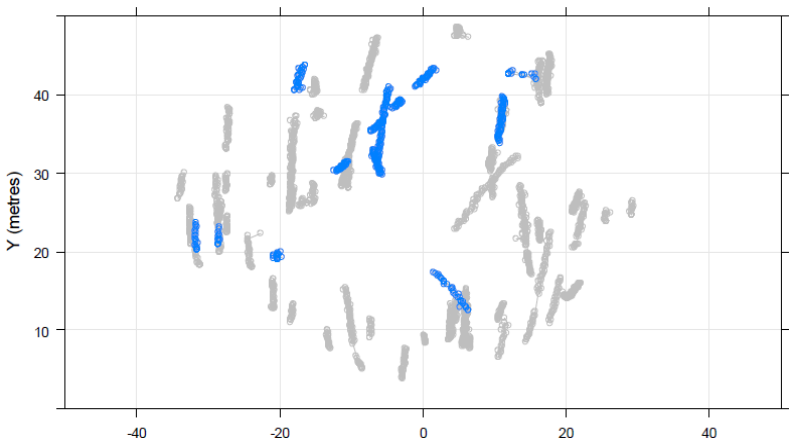

Figure 3: X-Y plot of the tracks of 'marine mammals' around SeaGen between the 20th May and 29th July 2011; the plot shows the X-Y location of all detections for tracks with a high probability of being a marine mammal when the turbine was operating (blue) and not operating (grey).

- The results of the 2 month deployment suggested that there were 109 'high probability marine mammals' in the data (e.g. Figure 2). A manual review of the data associated with these 'marine mammal' detections confirmed that they were marine mammals with only 3 of the targets being obviously non-marine mammals. Detection rate of 'high probability marine mammals' was approximately 5.9 per day. Detection capabilities were validated by visual observations close to a seal haul out (but not at the tidal turbine).

The detection of marine mammals by sonar

- The ranges that 'marine mammals' were detected at Strangford Lough suggested that marine mammals move in close proximity to the tidal turbine both when it was operational (minimum range=9.9m) and non-operational (minimum=8.4m) (Figure 3).
- The results of the modelling of 'marine mammal' detections suggested that the occurrence of 'marine mammals' changed with time of day. Detections generally decreased during early morning with a minimum at approximately 05:00. In contrast, there was no significant variation in 'marine mammal' detections in relation to tidal speed and turbine operation.
- Recommendations for future work arising from the study included the use of visual observations and/or seal tagging to assist in validating that the mobile targets detected were marine mammals, further work in developing detection algorithms which are less conservative, reducing post hoc analysis, and the ability to detect the depth of targets leading to a 3D sonar system.

DECC Offshore Energy SEA

The SEA process aims to help inform licensing and leasing decisions by considering the environmental implications of a plan/programme and the activities which could result from its implementation. Since 1999, DECC has conducted a series of offshore energy SEAs, the latest covering wind, tidal stream and range, CO_2 and hydrocarbon gas storage, and oil & gas – see right.

	Area	Sector
SEA 1	The deep water area along the UK and Faroese boundary	Oil & Gas (19th Licensing Round, 2001)
SEA 2	The central spine of the North Sea which contains the majority of existing UK oil and gas fields	Oil & Gas (20th Licensing Round, 2002)
SEA 2 Extension	Outer Moray Firth	Oil & Gas (20th Licensing Round, 2002)
SEA 3	The remaining parts of the southern North Sea	Oil & Gas (21st Licensing Round, 2003)
R2	Three strategic regions off the coasts of England and Wales in relation to a second round of offshore wind leasing	Offshore wind (R2 of Leasing, 2003)
SEA 4	The offshore areas to the north and west of Shetland and Orkney	Oil & Gas (22nd Licensing Round, 2004)
SEA 5	Parts of the northern and central North Sea to the east of the Scottish mainland, Orkney and Shetland	Oil & Gas (23rd Licensing Round, 2005)
SEA 6	Parts of the Irish Sea	Oil & Gas (24th Licensing Round, 2006)
SEA 7	The offshore areas to the west of Scotland	Oil & Gas (25th Licensing Round, 2008)
OESEA	UK offshore waters*	Oil & Gas (26th Licensing Round, 2009) Gas storage Offshore wind (R3 of Leasing, 2009)
OESEA2	UK offshore waters*	Oil & Gas (27th Licensing Round, 2012) Gas storage Carbon dioxide transport and storage Offshore wind, wave and tidal energy

*For renewable energy included potential leasing in the UK Renewable Energy Zone (REZ) and the territorial waters of England and Wales but not the Scottish Renewable Energy Zone and Northern Irish waters within the 12 nautical mile territorial sea limit

Since the first SEA, the associated research programme has targeted key information gaps on the marine environment and potential industrial impacts, to inform the SEA process, developers, consenting bodies and others. Research priorities are discussed with the SEA Steering Group and a range of other stakeholders.

For more information on the OESEA programme, visit the offshore SEA web pages on https://www.gov.uk/ or email oep@decc.gsi.gov.uk

A data portal for previous SEA reports and data is at http://www.bgs.ac.uk/data/sea