D3.3.3 Technical report biodiversity assessment - Methods for surveying marine mammal biodiversity around small islands.

Task 3.3 of WP3 from the MERiFIC Project

A report prepared as part of the MERiFIC Project "Marine Energy in Far Peripheral and Island Communities"

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Written by
Simon Ingram (simon.ingram@plymouth.ac.uk), Plymouth University

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The MERiFIC Project

MERiFIC is an EU project linking Cornwall and Finistère through the ERDF INTERREG IVa France (Manche) England programme. The project seeks to advance the adoption of marine energy in Cornwall and Finistère, with particular focus on the island communities of the Parc naturel marin d'Iroise and the Isles of Scilly. Project partners include Cornwall Council, University of Exeter, University of Plymouth and Cornwall Marine Network from the UK, and Conseil général du Finistère, Pôle Mer Bretagne, Technôpole Brest Iroise, IFREMER and Bretagne Développement Innovation from France.

MERiFIC was launched on 13th September at the National Maritime Museum Cornwall and runs until June 2014. During this time, the partners aim to

- Develop and share a common understanding of existing marine energy resource assessment techniques and terminology;
- Identify significant marine energy resource 'hot spots' across the common area, focussing on the island communities of the Isles of Scilly and Parc Naturel Marin d'Iroise;
- Define infrastructure issues and requirements for the deployment of marine energy technologies between island and mainland communities;
- Identify, share and implement best practice policies to encourage and support the deployment of marine renewables;
- Identify best practice case studies and opportunities for businesses across the two regions to participate in supply chains for the marine energy sector;
- Share best practices and trial new methods of stakeholder engagement, in order to secure wider understanding and acceptance of the marine renewables agenda;
- Develop and deliver a range of case studies, tool kits and resources that will assist other regions.

To facilitate this, the project is broken down into a series of work packages:

WP1: Project Preparation
WP2: Project Management
WP3: Technology Support
WP4: Policy Issues
WP5: Sustainable Economic Development
WP6: Stakeholder Engagement
WP7: Communication and Dissemination

Executive Summary

It is important that proposed renewable energy developments take into consideration potential impacts on marine fauna. Of significant concern are the potential impacts on marine mammals, cetaceans and seals, which are biodiverse in the MERiFIC region and represented by approximately 26 species. In order to understand the effects of marine renewable installations on local populations of marine mammals pre- and post-development site specific surveys are necessary. This technical report describes two survey methods suitable for surveying for marine mammals in the waters around small islands throughout the MERiFIC region; one shore based and one ‘at sea’. The waters around the small island of Lundy off the North Devon coast adjacent to the MERiFIC region were surveyed for small cetaceans and seals during November 2011 to July 2013 using a combination of shore based visual observations and remotely deployed acoustic detection devices (CPODs). Shore based surveys were conducted during June and July 2012 and 2013 using scan sampling with telescope and binoculars from preselected vantage points at cardinal locations around the island’s coast. The movements of sighted cetaceans were tracked using a surveyor’s theodolite enabling the locations of surfacing animals to be derived using spherical trigonometry from precisely surveyed observation sites. In addition to visual observations, which were restricted to summer months, continuous acoustic surveillance was also conducted at two sites off the island’s coast using moored CPODs. This report details the methods used in this study that can be usefully applied to surveys of marine mammals at other coastal and island locations within the MERiFIC region where renewable energy developments may potentially affect marine life.

1 INTRODUCTION

The impacts of marine renewable energy installations (MREI) on local biodiversity is not fully understood and there is a need for adequate research to underpin decisions on the siting and the design of future developments to maximise potential ecosystem benefits and minimise potential habitat degradation (Inger *et al*., 2009). Ideally, so called, BACI type field experiments (before, after, control, impact) are needed on case by case basis to assess the resulting effects of MREI on local populations of top predators (Thompson *et al*., 2009). In this way, changes in the distribution and/or abundance of marine megafauna can be measured with respect to the MREI development. Data collected during these surveys need to be incorporated into an integrated GIS to understand the ecosystem wide changes and affects detected during surveys. With increasing numbers of MREI developments there is an increasing demand for robust data relating to local marine mammals typically collected with the use of telemetry in the case of pinnipeds (Sparling et al., 2012), boat based surveys for cetaceans and seabirds and passive acoustic surveys for odontocetes (Evans and Hammond, 2004). Survey methods and their advantages and disadvantages for cetaceans were previously reviewed by Evans and Hammond (2004, see appendix). In this report I describe a number of methods suitable for assessing marine mammal biodiversity around islands within the MERiFIC region as part of environmental impact assessments relating to proposed MREI developments. These methods were used in surveying the marine mammals around the coast of Lundy, a small island situated approximately 18km off the North Devon coast and the full findings of this survey are available in Squires *et al*., (2014).

2 SHORE BASED OBSERVATIONS AND THEODOLITE TRACKING

As shown in Table 2 a where possible shore based surveys offer a cost effective method for collecting marine mammal biodiversity data close to shore. Simple scan data can be used to record the relative abundance of marine mammals and identify species (Ingram, 2000). However, the use of surveying instruments to derive precise locations of animals at sea was first pioneered in the 1970’s to track migrating southern right whales (*Eubalaena australis*) from Peninsular Valdes in Argentina (Würsig *et al*., 1991).

Shore based observations are possible where cliffs offer an elevated vantage point overlooking coastal waters of interest (Figure 1). Typically data are collected during watches conducted for several hours during periods of good weather and visibility with calm sea conditions (< force 4 Beaufort). Regular scans using a combination of telescope and binoculars of the observable water are made every 30mins in order to collect independent samples. Over a period of weeks the entire daylight and tidal cycle should be surveyed several times to collect replicated representative data. Current weather conditions, time and scan id should be recorded for each scan and entered into a data base on return from the field (see appendix for data collection sheets).

With precise surveying of the observation site and an accurately measured eye height above the surface of the water enables researchers to derive precise positions of surfacing cetaceans, seals and sitting seabirds using a surveyor’s theodolite or total station. The instrument measures precise angles in two planes; in the vertical plane the instrument measures declination below a horizontal plane and in the horizontal plane the instrument measures the angle of arc from a predetermined zero point (usually an accessible, uniquely identifiable rock or building). At the start of observations, typically at the start of a watch, the theodolite or total station must be levelled using inbuilt sensors and adjusters. In addition, the zero must be set at the beginning of each recording session by aligning the eyepiece cross-hairs with the predetermined object. The height of the eyepiece above the surface of the sea must be measured regularly (ideally every thirty minutes before each scan) throughout watches to provide a precise eye height for retrospective calculations. During watches when surfacing animals are sighted by the observers, (typically using binoculars or telescopes) the animals must be located using the cross-hairs in the theodolite eyepiece.

Figure 1. Shore based surveys for marine mammals showing an observer scanning the sea surface using a 30x telescope. The theodolite is shown set up ready for use in the foreground. (from Ingram *et al*., 2005).

The unique combination of horizontal and vertical angles displayed on the digital display are recorded, either to an internal data file using a record function button on the instrument or entered into a notebook. By following the path of the animals using the theodolite and recording the time and each set of angles for each located surfacing the track and approximate swimming speed of travelling animals can be reconstructed. The surfacing locations are calculated retrospectively using each pair of horizontal and vertical angles using spherical trigonometry (Lerczak and Hobbs 1998) (due to the curvature of the earth conventional 2d trigonometry results in a large error which increases with horizontal distance) as shown in Figure 2.

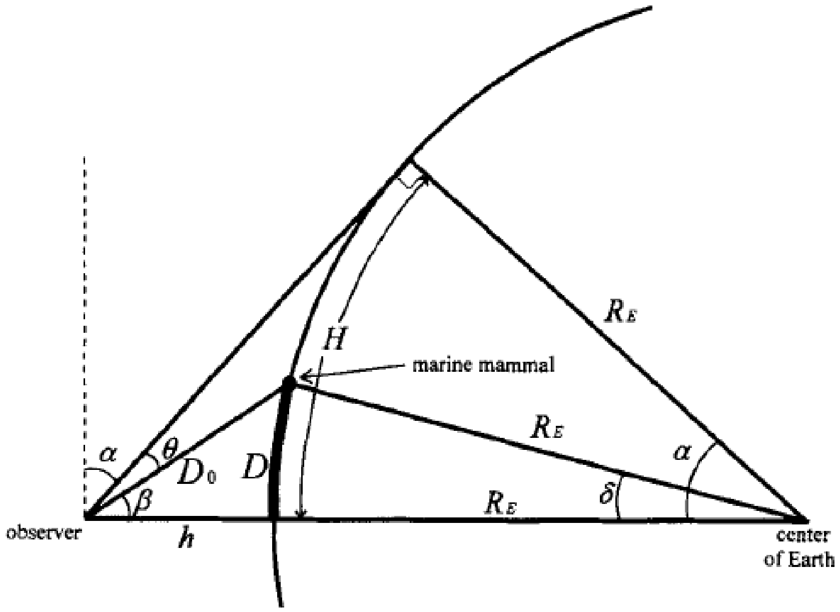

Figure 2. The calculation of the range to an animal at the water's surface from the observation location using the vertical angle (α + ϴ) obtained from the theodolite. Observer height h must be known with precision to obtain accurate locations. RE is the radius of the Earth and D the distance or range of the animal along the sea surface (from Lerczak and Hobbs, 1998).

The height of the observation platform can be measured using a variety of methods, either by measuring the height of the water on the face of a vertical rock using the theodolite; by reading the height from a tide gauge painted onto the face of a vertical rock; by measuring the angle of arc represented by a vertical pole of known length positioned on the face of a vertical rock (Frankel et al, 2009), or by using the theodolite to track a passing vessel equipped with a data storing GPS from which the data can be extracted and used to calculate the height (Frankel *et al*., 2009). The bearing to the animals from the observer is calculated using the horizontal angle from the reference object to the animal's position as shown in Figure 3. The observation locations must be precisely surveyed using a differential GPS and using this position as the origin the calculated range and bearings are mapped to provide the derived location of the tracked animals (Figure 4).

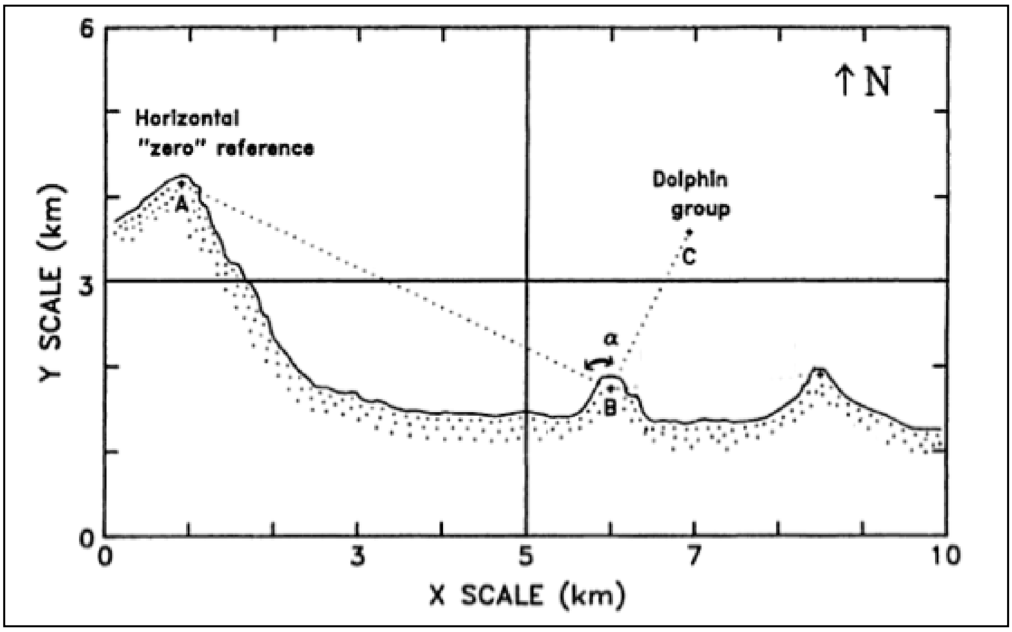

Figure 3. Plan view showing how the calculation of the bearing to sighted animals at the water's surface is derived using the theodolite angle α (from Wursig et al 1991).

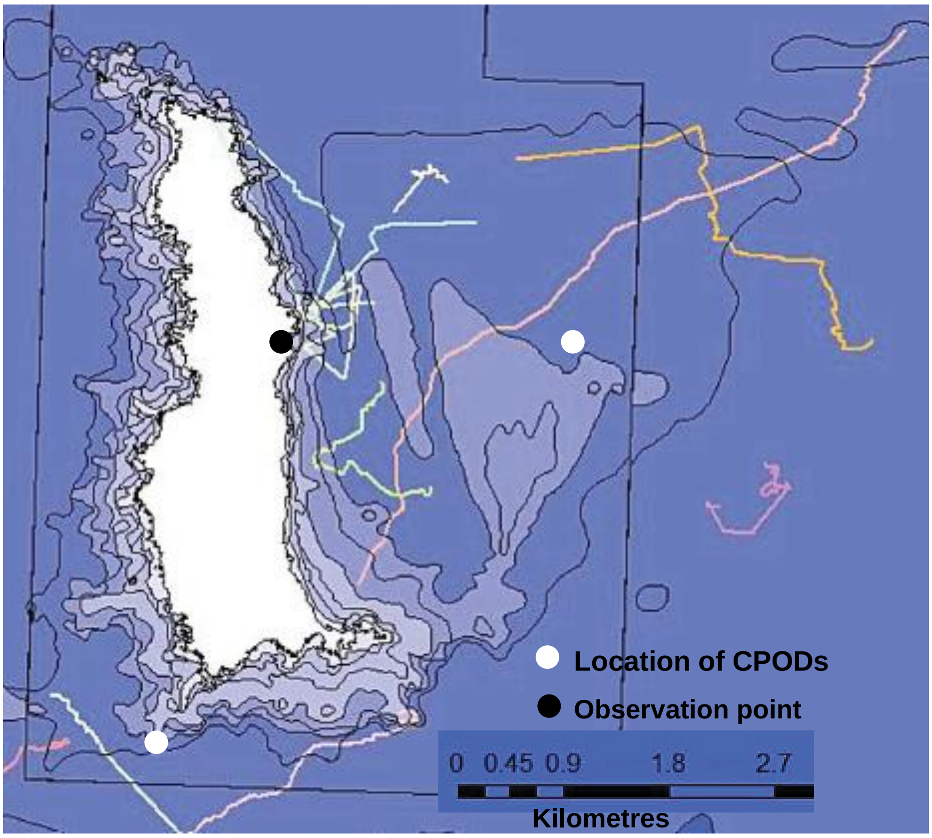

Figure 4. Plotted paths of common dolphin schools tracked using a theodolite from the cliffs on the Island of Lundy (adapted from Squires et al., 2014).

3 PASSIVE ACOUSTIC SURVEILLANCE

In tandem with shore based visual observations we deployed two passive acoustic detectors in the nearshore waters of Lundy to record the presence/absence of small odontocetes over extended periods of time between November 2011 and July 2013 (data collection was not continuous during the deployment period). These CPODs (Chelonia Ltd) were attached by divers to the wrecks of the MV Robert, approximately 1 km off the eastern coast of the island and the Ethel located in a tide race at the southern end of the island (Figure 4). Cpods do not record full bandwidth sounds but instead use onboard hardware to filter an acoustic signal streamed from an integrated hydrophone element. User controlled filter settings are set to detect the click trains characteristic of echolocating odontocetes (Philpott et al 2007). C-PODs log the timing and frequency of clicks, together with the click duration and bandwidth. Dolphinid and porpoise click trains can be distinguished by their characteristic dominant click frequencies but it is currently not possible to distinguish between delphinid species due to overlapping echolocation click parameters. Harbour porpoises have an average peak frequency of 128 kHz, and a bandwidth of 16 kHz and short beaked common dolphin, *Delphinus delphis* for example have peak frequencies of 23-67 kHz, and bandwidths of 17- 45 kHz (Au, 1993). The devices can remain deployed for several months before battery life and sd card memory constraints require retrieval, servicing and redeployment (Squires et al 2014). CPods are designed to be deployed from small vessels and remain moored during deployment (Figure 5), providing a cost effective means for conducting protracted presence/absence surveys for small cetaceans.

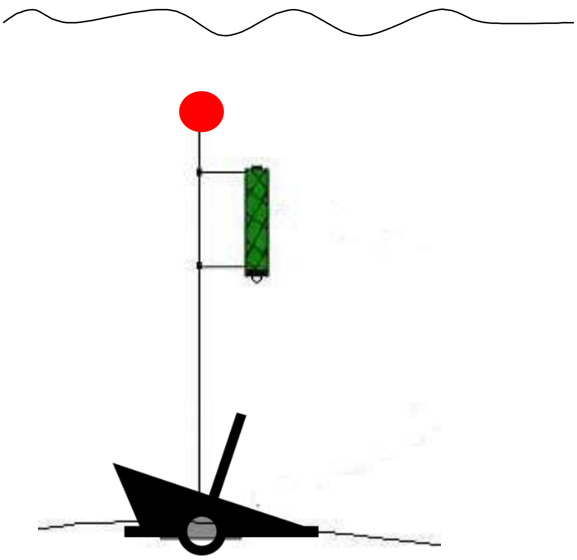

Figure 5. The deployment arrangement of the CPODs deployed on the MV Robert and MV Ethel near the coast of Lundy. The CPODS were attached to chain wrapped around stations on the wreck and the mooring line was suspended in the water column using a subsurface bouy.

A basic interpretation of behaviour is possible by analysis of Inter Click Intervals (ICI) as shorter interclick interval sounds known as ‘buzzes’ have been associated with prey capture events (Carlström, 2005; Pirotta *et al*, 2013).

3.1 ACOUSTIC DATA ANALYSIS

C-POD data can be analysed using the custom written program C-POD.exe (chelonian Ltd.). CPOD.exe categorises trains into one of four classifications in order of their confidence that the train was produced by a cetacean: hi (high) mo (moderate) lo (low) and ‘?’ (doubtful). Only trains in the category of hi and mod are usually used in subsequent analyses (Philpott et al, 2007; Pirotta *et al*., 2013; Squires *et al*., 2014). In locations and/or tidal phases with rapid tidal flow it is common for elevated levels of tonal high frequency ultrasound associate with sediment transport to saturate the ability of the C-PODs to log dolphin or porpoise clicks creating ‘maxed out’ periods during which detections can be masked (Squires et al., 2014). The internal tilt switch enables analysts to estimate water flow conditions C-POD sites for the duration of the deployment period and to match saturation periods with flow conditions.

Three parameters extracted by C-POD.exe are often used to describe cetacean activity; detection positive hours (DPH) per day used at large temporal scales to compare acoustic activity between months/seasons; Detection Positive Minutes (DPM) for shorter temporal scales , such as tidal cycles, and Minimum Inter-Click Interval (MICI) to infer foraging behaviour (Carlström 2005; Brandt *et al*., 2009; Pirotta et al., 2013).

4 CONCLUSIONS

Sensitivity to the impacts of MRE developments on local mobile marine mammal populations must be a priority during planning and development stages. Gathering data on marine mammals is difficult and time consuming, however, and often existing site specific data are poor and limited. Here I have presented a technical review of two appropriate methods for surveying marine mammals at fine scales over extended periods of time in the waters around remote coasts and small islands applicable to areas within the MERiFIC project region. These methods have proved to yield reliable and useful data for assessing seasonal and spatial data relating to biodiversity and distribution of marine mammals and are applicable throughout and beyond the MERiFIC region.

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APPENDIX 1.

A summary of the advantages and limitations of various methods for surveying coastal cetaceans (from Evans and Hammond, 2004).

Category	Advantages	Potential disadvantages
Survey techniques		
Visual	*For estimation of absolute abundance*	
	Data collection and analysis methods that take potential problems into account are well established	Need to take account of animals missed on the transect line and any responsive movement
		Limited temporal coverage
		Need sufficient data to estimate detection function
Visual	*For estimation of relative abundance*	
	Not labour intensive and relatively cheap	Need to account for sighting efficiency varying with distance from vessel, observer abilities, group size, sea conditions, platform type
	Wide spatial and temporal coverage possible	Estimation of group size
	Suitable for platforms of opportunity	Responsive movement of animals
	Minimum equipment requirements	For platforms of opportunity – little or no control over survey design
Acoustic	Not labour intensive	Relies upon animals being vocal
	Less affected by sea conditions 24-hour coverage possible	Methods to relate sounds to abundance of animals are not well developed
	Easier to standardize and automate data collection	Requires specialist data collection equipment
	Suitable for platforms of opportunity	Ideally requires quiet vessels
		For platforms of opportunity – little or no control over survey design
Photo-ID	Not labour intensive and	Only applicable for species with long-lasting

	relatively cheap	identifiable natural marks
	Abundance estimation through mark-recapture methods	Natural marks must be unique, recognisable and not change
	Additional information on life history (birth and death rates, movements)	Definition of population being estimated not always clear
		Heterogeneity of capture probability
Survey platforms		
Headland/ installation	Non-intrusive	Limited to small detection area
	Usually inexpensive	Information that requires close proximity to animals is hard to collect
	Not labour intensive	
Vessel	Ocean going vessels can cover wide areas over long periods	Large vessels are expensive and may be labour intensive to operate
	Ancillary information (environmental and biological) can be collected	Small vessels are limited to coastal areas
Aircraft	Can cover large areas quickly	Collection of ancillary information limited
	Can make efficient use of windows of good weather	Logistical limitations
	Not labour intensive	Expensive to charter but little flying time may be required