

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/279885287>

Development of marine mammal observation methods for vantage Point surveys in Ramsey sound

Technical Report · May 2015

DOI: 10.13140/RG.2.1.1532.7847

CITATION

1

READS

297

2 authors:



Hanna Nuuttila

Swansea University

21 PUBLICATIONS 80 CITATIONS

[SEE PROFILE](#)



Anouska Mendzil

Swansea University

13 PUBLICATIONS 75 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Ramsey Sound Tidal Energy; Engineering and Environmental Aspects [View project](#)



Marine mammals & MRE [View project](#)

Development of marine mammal observation methods for vantage Point surveys in Ramsey sound

Field work equipment and observation methods trials

1st Draft report November 2014

Final report March 2015

*Dr Hanna K Nuuttila and Anouska Mendzil
SEACAMS Project, Swansea University
March 2015*

Please cite as: Nuuttila, H.K. and Mendzil, A. Development of marine mammal observation methods for vantage Point surveys in Ramsey sound (2014, unpublished). SEACAMS Project Report 2014-D75.

SEACAMS contract

D75

This report fulfils part of the contract “Ramsey Sound Vantage Point Trials”

Contract Partner

Powell Strong
Pembrokeshire Guided Walks

SEACAMS contact

Dr Hanna Nuuttila
Centre for Sustainable Aquatic Research
SEACAMS Project
Swansea University
Singleton Park
Swansea, SA2 8PP
UK
Email h.k.nuuttila@swansea.ac.uk
Tel +44 (0)1792 602950
<http://www.swansea.ac.uk/seacams/>



Contents

1. Summary	4
2. Introduction	4
2.1. Marine mammal monitoring.....	5
2.2. Problems with fixed vantage point surveys	6
2.3. Possible solutions.....	7
3. Methods development	8
3.1. Field equipment	8
3.2. Data collection	8
4. Project achievements.....	10
4.1. Finalised field equipment and data collection methodology	10
5. Recommendations and suggested future work.....	13
6. Acknowledgements.....	14
7. References	15

1. Summary

SEACAMS has been working on a collaborative R&D project with Pembrokeshire Guided Walks (PGW) to develop and trial equipment and methods for collecting marine mammal sightings data from fixed vantage points in Ramsey Sound. The study site has been subject to various marine mammal studies, mainly due to the planned deployment of a demonstration tidal turbine by Tidal Energy Limited (TEL).

Here we briefly cover the rationale for fixed vantage point surveys for marine mammals, their limitations and possible methodological solutions to some of the main problems identified. The report described the steps taken to build and trial fieldwork equipment to accurately collect data on animal distances for marine mammal observations, as well as one method for achieving simultaneous data from two adjacent but independent observation stations.

2. Introduction

SEACAMS has been working on a collaborative R&D project with Pembrokeshire Guided Walks (PGW) to develop and trial equipment and methods for collecting marine mammal sightings data from fixed vantage points in Ramsey Sound. The study site has been subject to various marine mammal studies, mainly due to the planned deployment of a demonstration tidal turbine by Tidal Energy Limited (TEL).

With the increased demands to achieve the European renewable energy targets by 2020 (Directive 2001/77/EC), more wind, tidal and wave technologies are being developed which have the potential to cause substantial disturbance to coastal processes, benthic communities, and fish populations (Gill 2005; Shields *et al.* 2009). These in turn can cause adverse effects on seabirds (Langton *et al.* 2011; Soanes *et al.* 2012) as well as marine mammals, in the form of reduced prey availability, noise pollution and habitat degradation or loss (Carstensen *et al.* 2006; Tougaard *et al.* 2009; Dolman & Simmonds 2010; Simmonds & Brown 2010).

Cetaceans, as well as many other mobile marine species, are affected by the construction and operation of various types of marine renewable energy extraction devices, which include offshore wind, wave and tidal power generators – both tidal barrages and tidal stream turbines (Carstensen *et al.* 2006; Wilson *et al.* 2007; Evans 2008; Brandt *et al.* 2011). Disturbance to cetaceans from renewable energy generators is caused by increased ambient noise, general habitat degradation from presence of the devices, potential changes in prey availability as well as the very real risk of collision with underwater devices, such as tidal turbines (Richardson *et al.* 1998; Madsen *et al.* 2006; Teilmann *et al.* 2006; Carstensen *et al.* 2006; Tougaard *et al.* 2009). With such projects expected to increase due to the UK government's commitment to the EU to increase energy sourced from renewable resources in the next eight years, there will be a real necessity (as well as a legal requirement) to monitor the impacts of such projects on protected cetacean species and habitats (DECC 2011), especially when much of the impacts and the extend of potential impacts is still relatively unknown (Inger *et al.* 2009).

The TEL Ramsey Sound development involves a deployment of one single turbine unit (DeltaStream, www.tidalenergylimited.co.uk) for 12 months (Fig.1). The project will be used to demonstrate the

capability of DeltaStream turbine as a tidal stream generator and will be providing evidence on how the device interacts with the environment around it. During its deployment, the device will be connected to the local distribution network, allowing the electricity generated by it to contribute to the renewable energy targets of the Welsh Government.



Figure 1. DeltaStream turbine at Pembroke Port (www.tidalenergylimited.co.uk)

The marine mammals most commonly encountered on the site are harbour porpoise (*Phocoena phocoena*) (Pierpoint, 2008) (Fig. 2) and grey seal (*Halichoerus grypus*), of which the harbour porpoise has been the main target species of the marine mammal studies conducted for the developer (Barradell *et al.* 2013).



Figure 2. Illustration of a harbour porpoise. Adapted from the American Cetacean Society, www.acsonline.org

The data collected so far has come from surveys with varying methodologies, data handling and analytical techniques. As a result the existing dataset has not been able to be analysed in a manner that would satisfy the regulators (Natural Resources Wales, NRW), in answering questions on animal density in the area, any changes to this in spatial and temporal scale, and specifically the extent of which distance from the observer would affect the number of sightings recorded (i.e. the detection function).

TEL were interested in trialling data from the fixed vantage points to be able to assess and estimate the detection function for harbour porpoises on the site, as well as calibrate and validate their existing dataset now spanning several years. The study was contracted to Powell Strong who also works for Pembrokeshire College. Before attempting to conduct data for estimating detection function for the site, a trial of methodologies and development of novel equipment was required. This was conducted through Pembrokeshire Guided Walks as SEACAMS R&D Project.

2.1. Marine mammal monitoring

There are various established and published methods for surveying marine mammals (Evans and Hammond, 2004; Diedrichs *et al.* 2008; Boyd *et al.*, 2010), as well as for analysing the resulting data

(Macleod et al. 2010; 2011). A 2011 report by SNH (MacLeod *et al.*, 2011) describes commonly used methodologies and their suitability for baseline characterization and impact monitoring for marine renewable energy sites, and how the methods for these two may differ, depending on the questions asked. Typically primary data of interest for characterisation monitoring related to marine renewable energy will be: species present, distribution and abundance; whereas impact monitoring seeks to detect possible change in presence, distribution, abundance or behaviour all of which may vary over different spatial and temporal scales which needs to be taken into account.

Broadly speaking most baseline and impact monitoring is conducted by visual observations (land, boat or aerial) possibly aided by video or still photographic methods; acoustic monitoring methods (towed or static passive acoustics); telemetry methods (tagging) and stranding schemes (carcass recovery and assessment). The choice of method should depend on the questions asked, and the temporal and spatial coverage required. Each technique will have its specific biases which must be taken into account. Visual surveys from boats can be very expensive and time consuming and are limited to daylight hours and calm seas, and have typically very limited temporal coverage, as they are typically conducted seasonally and often many years apart and thus have a lower ability to estimate long term trends. Land based surveys are less expensive and intrusive but still require good weather conditions and standard data collection methods (McLeod et al, 2010; 2011).

2.2. Problems with fixed vantage point surveys

Land based surveys from fixed vantage points are one of the most common ways to observe coastal cetaceans, especially for development sites close to the shore. However various biases inherent land based data collection as well as the difficulty of correcting for non-uniform animal distribution around the observation point and the reduction in detection probability with distance from the observer mean that data-analysis of land-based observations can pose difficulties especially for those not familiar with advanced statistical techniques.

Biases in data can be caused by observer error and the variability between observation sites and the lack of standard survey protocols with regards to observer field of view and scan duration. Observer error can be induced and influenced by weather conditions, and observer experience and fatigue, and the effect of topography and height on the vantage point. The height of the observation station directly affects the sea area (i.e. distance) which can be surveyed and the topography of the station as well as its surrounding area and seabed features will affect the field of view both horizontally and vertically. The existence of seabed features, rocks, islands or peninsulas will affect the ability of the observers to cover the study area but also the distribution and abundance of the target species.

All these biases pose various problems when data from fixed vantage points is analysed, as most statistical analyses are assuming that animal distribution is equal over the study area and the observer can detect all animals in the survey area.

Similar problems are inherent in datasets from boat based surveys, but these are typically corrected for by double platform methods (Buckland et al.2001). Without adjusting for reduction in detection probability with distance and the non-uniform distribution of animals, it is not possible to estimate

absolute abundance in the area, and this will also make it very difficult to deduce actual change in animal distribution and abundance due to the development.

2.3. Possible solutions

Recent developments in statistical methods enable estimation of detection function from fixed point data using Spatially Explicit Capture-Recapture technique (SECR) (Borchers 2010) and the assessment of animal density when animals may not be equally distributed in the survey area (Marques et al. 2012; 2010). These methods are based on elements of distance sampling and require either several observation points, or simultaneous data collection by more than one observer in order to acquire the required data.

Measuring distance

As always with distance sampling, the distance from observer to the sighting must be accurately measured. Traditional land-based observations estimate bearings and distances to animals but this is not an adequate way to acquire distances, due to inherent errors in observer estimations.

Various methods have been developed to accurately estimate distances from observer to animals, including theodolite tracking and photogrammetric methods (Lerczak and Hobbs, 1998; Gordon, 2001; DeNardo et al. 2001; Hastie et al. 2003; Bailey and Thompson, 2006). Here we trialled a photogrammetric method to accurately measure distances to harbour porpoises.

Acquiring double observer data

In order to estimate the proportion of animals potentially missed by a single observer, a double observer method can be used where two separate observers or observation sites are used.

In this study we trialled ways to acquire simultaneous data from two pairs of observers observing from adjacent sites, surveying the same area simultaneously.

3. Methods development

3.1. Field equipment

The field equipment consisted of two sets of Canon 700D SLR cameras with 18-55 mm lenses and a remote control, attached to 7 x 50 Binolyte Searanger marine binoculars with reticules and compass. The system needed to be mounted on a 5mm thick purpose built aluminium frame modelled on a similar set-up used by SMRU Marine (Fig 3), at a marine renewable development site at Skerries, Anglesey, North Wales (Plunkett et al. 2014, unpublished). The frame prototype was drawn from photographs by the College of Science workshop engineers, Julian Kivell and Phil Hopkins, who also manufactured the frame and modified the Manfrotto ball head to it so that the entire bracket could be attached to a set of tripod legs.

Additionally Nikon Pro Forest Digital Laser range finder (Hawke LRF Pro 900) was used to estimate the height of the observation station from tideline and Casio digital watches and handheld short range radios were used to co-ordinate the observation times. A Garmin handheld GPs was used to acquire latitude and longitude coordinates of the observation stations.



Figure 3. Binocular and camera mount used by SMRU Marine at Skerries.

Adjustments to the equipment

- Sturdier tripod legs were purchased to replace the lightweight version
- Bag with a rock weighing approximately 2 kg was attached to the centre of tripod to add stability
- A remote control for the camera was purchased to facilitate fast picture taking
- Ball head tripod was replaced with a pan head attachment to eliminate the unknown error associated with the vertical range and jerky movement of the camera during the survey scans
- A bracket was fixed to the frame to allow more accurate centring of the camera and binoculars.

3.2. Data collection

A total of eight days of simultaneous data collection were conducted at Ramsey sound, between June and September 2014. Observations were conducted initially from Penmaenmawr site but moved to Pen Pedol to maximised sightings (Fig 4). The observations were conducted using two teams of two observers based on adjacent sites, approximately 50 m apart.

All the watches were conducted at high water slack times to maximise chances of encounters (Barradell et al. 2013).

The observation team was divided into two, the recorder making notes of the scans and the observer, using the binocular and camera set up. It was considered imperative that the two teams worked simultaneously and observed the same area of water at the same time, so the start and end of the scans were coordinated between the two teams using the radios. This was done to maximise matched sightings between the two observation stations. The teams had to continuously revise their scanning and reporting methodologies, particularly on the field of views and exact scanning techniques to ensure that same coverage was achieved simultaneously. In addition a system of landmarks was devised to ensure the scanning pace was same in both teams.

HW +12: Very few porpoise sighted in the Sound at this stage of the tidal cycle although they are occasionally seen in the vicinity of the Turbine Site.

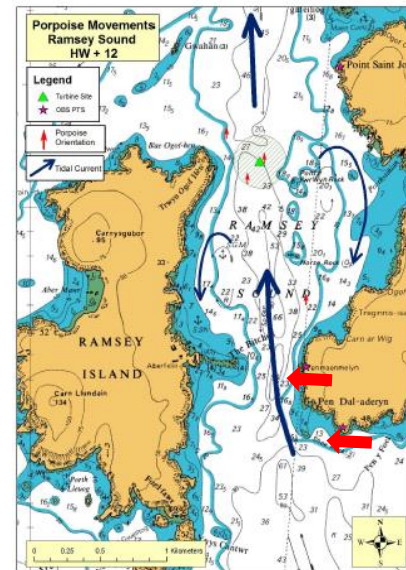


Figure 4. Map showing Ramsey sound and the observation sites with red arrows: Penmaemlyn (further north) and Pen Pedol (southernmost tip). From Barradell et al.2013.

Adjustments to the methodology (in order of implementation)

- Initial site location at centre of Ramsay Sound was re-located to Pen Pedol to increase the number of sightings achieved per watch
- Still photography was replaced with videography as a number of assumptions were made using photographs. Not all photographs captured marine mammals in the frame due to human error; equipment delay; and assuming the porpoise or its track were captured in the centre of the frame. Using videography eliminated some of these errors and allowed video playback. Still photographs can be taken from the video footage if required.
- Survey scan times were experimented with in the early stages from 5 minutes and 1 minute before a 2 minute survey scan deemed the most effective observation timing.
- Aligning the binocular reticule was changed a few times for the waterline and horizon in order to take into account cropping and changes during playback.
- Reference shots were captured prior and following each survey scan using still photography to verify focal lengths.
- It was found that on hazy days the horizon was unclear hence problems with extrapolation/distance.

4. Project achievements

4.1. Finalised field equipment and data collection methodology

Equipment set up

The time of each of the two cannon cameras were synchronised before surveys began, this would allow the length of battery and hence survey periods to be the same between each station and video/photograph file storage times to be accurate. For consistency and good practice the same equipment was used at the same vantage point on each fieldwork day, this was achieved by labelling each piece of equipment with the same colour for each vantage station. A tripod was fitted with a pan tripod head and levelling bubbles. The same location for equipment set-up at each vantage point was ensured by centring the equipment over a ground peg placed in the ground for the duration of the fieldwork and covered with a large rock. The tripod was stabilised and weighted down using a canvas bag filled with rocks that was placed around the tripod. A frame was secured to the pan tripod head to allow the co-mounting of the camera and the binoculars with a screw fitting. A shutter button was fitted for any photographs/reference shots taken also fitted to the frame/bracket.

The camera was centred on the frame and adjusted to line up with the bracket. The binoculars and the camera were set up to scan at the same drop angle at the 5th binocular reticule on the shoreline at 270°. The camera was aligned to the 'white house' on Ramsay Island using the reticule/cross hairs for vertical alignment. Still photography reference shots were taken of this. See Figure 5 of the equipment set up at Ramsey.

As the focal length of the camera used for video footage is not stored in the file setting properties, reference shots using still photography were taken every 5° in the field of view before and after the survey in order for focal length of the video to be known. This would ensure that the focal length had not changed during the course of the survey scan and so that the horizon could be extrapolated. The focal lengths of the camera on the 05/09/2014 were set at 85mm and 105mm. "The aspect ratio for video was 16:9 when on automatic setting. Still photography was 4:3. The video footage was effectively cropped top and bottom compared to the still photography images."

A particular problem encountered during the final methodology development was that during the course of the surveys as the observer were looking through the binoculars the camera was auto-focussing meaning that during playback this was also captured in the video and therefore blur appears.



Figure 5. Camera and binocular set up

Effort Form

An effort form was undertaken approximately every 20 minutes to 30 minutes in-between surveys to assess the current environmental conditions during surveys. These environmental conditions included; glare, swell height (approximate), weather, boat activity and sea state. The sound was divided into sectors (A to J) to accurately assess the sea state. Of these sea sectors, within our field of view at the vantage point (Pen Pedol), only A, B, E F and I were relevant sea state sectors and therefore recorded. Binoculars were used to assess the sea states within Ramsay Sound.

Elevation above sea level was recorded using a laser rangefinder at a set location next to the tripod at the North station (PPN). At the end of the survey session, the range finder was also used to calculate the difference in elevation between the two stations i.e. PPN and PPS. This was undertaken from PPN towards PPS pointing at a specific object such as a clipboard/paper. Three elevation readings were taken between the two vantage points for the mean to be calculated. A GPS position was also taken using a handheld Garmin on each fieldwork day.

Recorder

For consistency, the recorder remained the same during all fieldwork surveys at PPN i.e. Christine Gray, this varied for PPS.

The Recorder carried out the Effort Form and recording associated with the marine mammal surveys. The recorder was also responsible for providing the timings and countdowns for the observer and at the other station through hand-held radios. A digital stopwatch was used.

The recorder recorded the scan time, scan method (i.e. photography or video), Photo ID (referring to the frame number), bearing to animal (narrated by the observer from the binoculars), number of

animals in the frame (as indicated by the observer), field of view (this remained constant in all surveys), Scan period (this remained constant in all surveys), estimated focal length (see equipment set-up), Glare and any notes from the recorder or indicated by the observer.

Observing

For consistency, the observer remained the same during all fieldwork surveys days, (i.e. Anouska Mendzil at PPN) with one recorder and one observer for each vantage station during watches (Figure 6).

Field of view was set for both vantage points from 270° to 210° using 2 minute video scans using playback video footage. The scan was a single sweep within the field of view without stopping. To ensure consistency between the two vantage stations and to ensure the scan rate between the observers remained the same/similar i.e. PPN and PPS, the field of view was divided into 20 second intervals to ensure that each section of the field of view had an equal amount of scan time and each observer was reaching a specific landmark/reference point by a certain time period. The landmarks e.g. visual reference points for each time period were decided between the two observers.

The observers at both stations synchronised start and end times of the survey using hand held radios. The recorder at PPN also provided a 10 second countdown to the start of the survey to ensure that observers were ready and any narration for the video footage was provided. The recorder also provided the 20 second intervals throughout to ensure a constant scan rate.

Approximately 5 seconds before each survey the observer started the video recording to communicate the survey details to ensure that this did not interrupt any observations during the start of the survey.



The observer narrated before each scan the; observer name, time of survey, compass bearing start point and survey start. The length of each video survey was recorded on the recorder form at PPN.

During each survey, and once a sighting was observed the observer would narrate the number of marine mammals observed, if possible the species observed and the bearings they were seen at. This can be played back on the video footage. The recorder

recorded the observer narration. If a marine mammal was observed outside of the field of view this was narrated as out of field of view/out of sight, this was often as a compass bearing could not be associated with it.

Figure 6. Observer at Pen Pedol North.

At the end of each survey the observer narrated the end compass bearings, approximate number of sightings and end of survey.

5. Recommendations and suggested future work

The finalised survey equipment set up (as described above) was found useful and practical for the purposes of this project. Future work will include collection of simultaneously collected sightings data with accurate animal distances, to be used for studies assessing the effect of distance and observer on the detection probability. This work will be undertaken by Powell Strong of Pembrokeshire Guided Walks through Pembrokeshire College in the near future.



6. Acknowledgements

Acknowledgements to all the people involved in the project

Equipment development	Powell Strong	Pembrokeshire Guided Walks
	Julian Kivell	Swansea University, CoS Workshop
	Phil Hopkins	Swansea University, CoS Workshop
	Alex Essex	Pembrokeshire College Photography department
Survey design	Powell Strong	Pembrokeshire Guided Walks
	Carol Spalding	SMRU Marine
Fieldwork trials	Powell Strong	Pembrokeshire Guided Walks
	Anouska Mendzil	SEACAMS, Swansea University
	Christine Gray	SEACAMS, Swansea University
	Chiara Bertelli	
	Anna Sutcliffe	
	Tina Martin Weavers	
	Kate Strong	
	Jane Quinton	
	Steve Quinton	

7. References

- Bailey, H. and Thompson, P. (2006) Quantitative analysis of bottlenose dolphin movement patterns and their relationship with foraging. *Journal of Animal Ecology* **75**: 456–465
- Barradell, M.G., Morris, S.R., Quinton, S., Lake, T and Strong, P.G. (2013) Harbour porpoise (*Phocoena phocoena*) in Ramsey Sound, the four year period, 2009 to 2013. How many, when and where? Report by Pembrokeshire College for Swansea University as part of The Low Carbon Research Institute. 38pp
- Boyd, I. L, Bowen, W. D and Iverson, S. J. (Eds.) 2010. *Marine Mammal Ecology and Conservation: A Handbook of Techniques*. Oxford University Press.
- Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L., Borchers, D. L., & Thomas, L. (2001). *Introduction to Distance Sampling*. Oxford: Oxford University Press.
- Carstensen, J., Henriksen, O.D. & Teilmann, J. (2006). Impacts of offshore wind farm construction on harbour porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs). *Marine Ecology Progress Series*, 321, 295–308.
- DeNardo, C., Dougherty, M., Hastie, G., Leaper, R., Wilson, B. and Thompson, P. (2001). A new technique to measure spatial relationships within groups of free-ranging coastal cetaceans. *Journal of Applied Ecology* 2001, 38: 888–895
- Diederichs, A., Gruenkorn, T. & Nehlts, G. (2003). Do porpoise detectors detect porpoises? *Proceedings of the European Cetacean Society Annual Meeting* Las Palmas, The Canary Islands.
- Dolman, S. & Simmonds, M. (2010). Towards best environmental practice for cetacean conservation in developing Scotland's marine renewable energy. *Marine Policy*, 34, 1021–1027.
- Evans, P.G.H. & Hammond, P., S. (2004). Monitoring cetaceans in European waters. *Mammal Review*, **34**, 131–156.
- Gill, A.B. (2005). Offshore renewable energy: ecological implications of generating electricity in the coastal zone. *Journal of Applied Ecology*, **42**, 605–615.
- Gordon, J. (2001) Measuring the range to animals at sea from boats using photographic and video 413 images. *Journal of Applied Ecology*, 38, 879–887
- Hastie, G.D., Wilson, B., Thompson, P.M. (2003) Fine-scale habitat selection by coastal bottlenose dolphins: application of a new land-based video-montage technique. *Can. J. Zool.* **81**: 469–478
- Inger, R., Attrill, M.J., Bearhop, S., Broderick, A.C., Grecian, W.J. & Hodgson, D.J. (2009). Marine renewable energy: potential benefits to biodiversity? An urgent call for research. *Journal of Applied Ecology*, **46**, 1145–1153.
- Langton, R., Davies, I.M. & Scott, B.E. (2011). Seabird conservation and tidal stream and wave power generation: Information needs for predicting and managing potential impacts. *Marine Policy*, 35, 623–630.
- Lerczak, J. A., and Hobbs, R. C. (1998) "Calculating sighting distances from angular readings during shipboard, aerial, and shore-based marine mammal surveys," *Mar. Mamm. Sci.* 14, 590–599.

Macleod, K., Lacey, C., Quick, N., Hastie, G. and Wilson J. (2011). Guidance on survey and monitoring in relation to marine renewables deployments in Scotland. Volume 2. *Cetaceans and Basking Sharks*. Unpublished draft report to Scottish Natural Heritage and Marine Scotland.

Macleod, K., Du Fresne, S., Mackey, B., Faustino, C. and Boyd, I., 2010. Approaches to marine mammal monitoring at marine renewable energy developments. MERA 0309 TCE Final Report prepared by SMRU Ltd for The Crown Estate. 110 pp.

Marques TA, Buckland ST, Bispo R, Howland B (2013) Accounting for animal density gradients using independent information in distance sampling surveys *Stat Methods Appl* 1(22)

Marques TA, Buckland ST, Borchers DL, Tosh D, McDonald RA (2010) Point transect sampling along linear features. *Biometrics* 66:1247–1255

Nuuttila, H., Thomas, L., Hiddink, J., Meier, R., Turner, J., Bennell, J., et. al. (2013). Acoustic detection probability of bottlenose dolphins, *Tursiops truncatus*, with static acoustic dataloggers in Cardigan Bay, Wales. *The Journal of the Acoustical Society of America* 134(3), 2596

Pierpoint, C. (2008) Harbour porpoise (*Phocoena phocoena*) foraging strategy at a high energy, near-shore site in south-west Wales, UK. *Journal of the Marine Biology Association of United Kingdom*, 88(6):1167-1173

Plunkett, R., Sparling, C., Kidney, D. (2014) Anglesey Skerries Marine Mammal Monitoring: Land based vantage point survey trail. Report Number SMRUM-MCT-2014-012 Provided to MCT, November 2014 (unpublished).

Simmonds, M.P. & Brown, V.C. (2010). Is there a conflict between cetacean conservation and marine renewable-energy developments? *Wildlife Research*, 37, 688–694.

Shields, M.A., Dillon, L.J., Woolf, D.K. & Ford, A.T. (2009). Strategic priorities for assessing ecological impacts of marine renewable energy devices in the Pentland Firth (Scotland, UK). *Marine Policy*, 33, 635–642.

Soanes, L.M., Atkinson, P.W., Gauvain, R.D. & Green, J.A. (2012). Individual consistency in the foraging behaviour of Northern Gannets: Implications for interactions with offshore renewable energy developments. *Marine Policy*. 38,507-514

Tougaard, J., Carstensen, J., Teilmann, J., Skov, H. & Rasmussen, P. (2009). Pile driving zone of responsiveness extends beyond 20 km for harbor porpoises (*Phocoena phocoena* (L.)). *The Journal of the Acoustical Society of America*, 126, 11–14.