

A SURVEY PROTOCOL FOR ESTABLISHING THE ABUNDANCE AND DISTRIBUTION OF HARBOUR PORPOISE (*PHOCOENA* *PHOCOENA*)

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FEBRUARY 23, 2022

2168 WORDS

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1 Introduction

1.1 Rationale

Swansea Bay has been the site of multiple proposed hydroelectric schemes over the past decade, owing to the 13m tidal range of the Severn Estuary providing the ideal location for marine energy generation (Department of Energy & Climate Change, 2013). The Swansea Bay Tidal Lagoon was cancelled late in development in 2018 after lack of support from the UK Government (Hansford, 2018), but the initial Environmental Impact Assessment Scoping Report in 2013 reported limited access to long-term monitoring data for cetaceans in the Bay (Oakley et al., 2016). Outdated and inadequate information is often used in the UK as a basis for decisions on major coastal developments (MEA, 2005). Given the known issues of conflict between marine mammals and marine renewable energy devices (Wilson et al., 2007), this is a vital knowledge gap in assessing the environmental impacts of such projects on these species.

Recently, a new project in Swansea Bay has been proposed: Dragon Energy Island, a combined tidal lagoon and solar farm (Youle, 2021). The proposals have reopened the need for this baseline data. In particular, there is a lack of knowledge about the harbour porpoise (*Phocoena phocoena*), a listed Priority Species under the UK Post-2010 Biodiversity Framework whose shy nature, small size and wide-ranging behaviour makes them difficult to spot and record (Oakley et al., 2016; The Wildlife Trusts, 2022). This lack of data is similarly reflected in the lack of protected areas for porpoise in the UK (Embling et al., 2010), and makes it difficult to ascertain its conservation status.

The most recent studies show that there is a strong population of porpoise in Swansea Bay, and possibly the site is even important as a nursery or breeding/calving ground (Baines and Earl, 1999; Jenkins, Brown and Phillips, 2009; Oakley et al., 2016). In fact, Oakley et al. (2016) found that porpoise seem to be a higher relative density throughout the year in Swansea Bay than North Pembrokeshire and the Llyn Peninsula, both areas considered for Marine Protected Zones. However, the paper's findings concerning annual distribution were inconsistent with previous research (Jenkins, Brown and Phillips, 2009); similarly, these studies lack fine-scale long term data, with Oakley et al. (2016) comparing various studies of composite methodologies and thus unable to draw true scientific conclusions. This paper, therefore, sets out a protocol for a long-term monitoring study.

1.2 The Site

In accordance with the harbour porpoise's preference for shallow bays, estuaries and narrow tidal channels (Baines and Earl, 1999; Pierpoint, 2008; Oakley et al., 2016), this study area will cover

Swansea Bay and the South Gower coast, from Burry Holms in the west (OSGB 274500; 192500) to Port Talbot harbour in the east (OSGB 274500; 187200). The Severn Estuary's tidal range is around 13m, the second highest globally after the Bay of Fundy in Canada (Binnie, 2016); at Swansea Bay it runs from a 4m neap tide to a 10m spring tide, leading to well-mixed waters with high sediment loading and organic content (Mackie et al., 2007). Salinity consistently levels at 32.5ppt (Cefas, 2013).

Some coastal SSSIs are within the survey area that extend to the mean low water mark (e.g. Blackpill), but these should not affect the study. The western portion of the site, however, has some offshore protection in the form of the Carmarthen Bay and Estuaries Special Area of Conservation (see Figure 1-1), so care must be taken to ensure survey methodology is compliant with protected areas regulations.

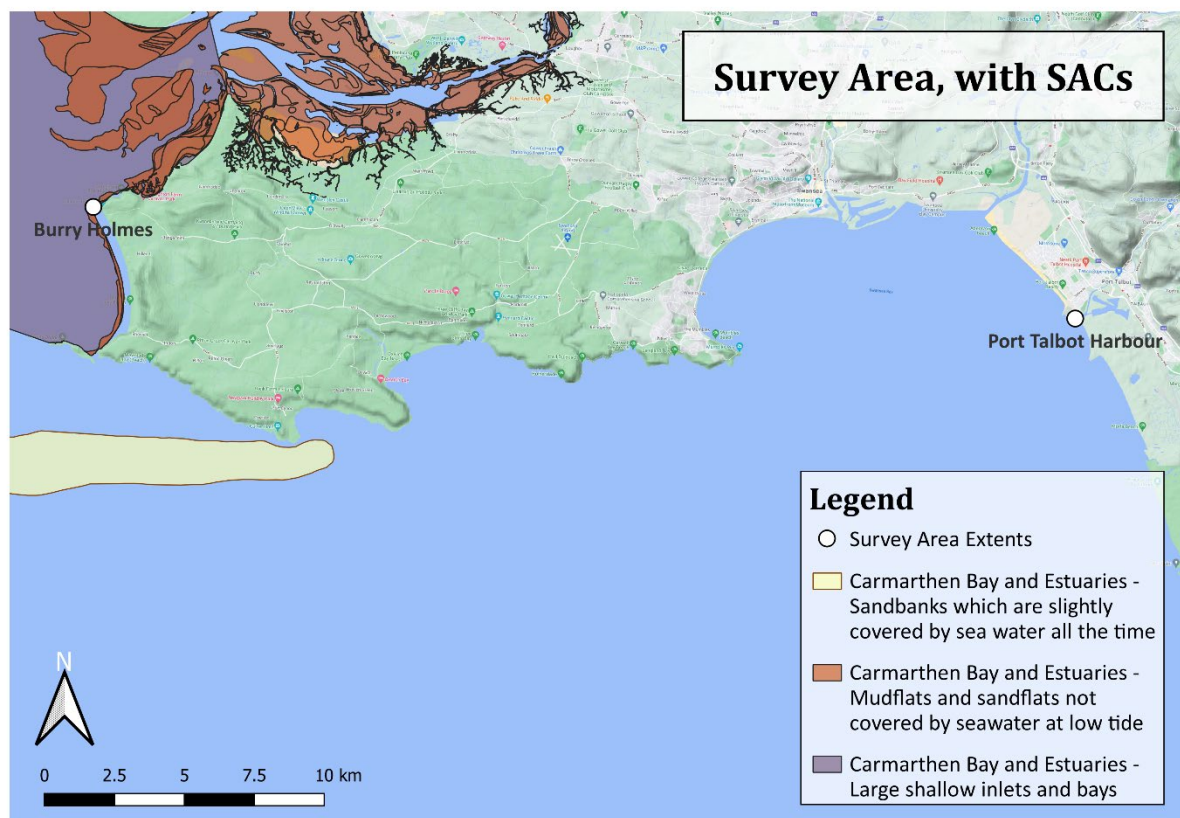


Figure 1. The proposed survey site, with protected areas marked

2 Research Aims and Objectives

2.1 Research Aims

The aims of this research are to establish more concrete data on the abundance and distribution (both temporal and spatial) of harbour porpoise in Swansea Bay, and from there to create a baseline that will inform current and future planning decisions concerning renewable energy infrastructure in the region. The study will produce a long-term dataset, something currently lacking in the research, to provide scientifically comparable data and knowledge.

2.2 Research Questions

The research poses the following questions:

- What is the current mean population size of the harbour porpoise in Swansea Bay?
- What are the spatial distribution patterns of the porpoise, and do these change throughout the year?
- In longer term, how do the abundance and distribution of the porpoise change from this baseline?

2.3 Justification

The data available on porpoise distribution and abundance in Swansea Bay is currently inconsistent, meaning there is a limited idea of their habitat use in the site. Using both vessel- and land-based surveys, Jenkins et al. (2009) found that August and September saw the highest concentrations of sightings, and November and December had the lowest. This directly contradicts Oakley et al. (2016), though, who found that November and December had the highest percentage of sightings, with a second spike in February to April. Both studies, however, agree on one fundamental assertion – there is a porpoise presence all year round. The reasons for their changed distribution nonetheless remain a mystery.

Similarly, strandings data analysed by Oakley et al. (2016) found that calves were only recorded in the eastern part of the study area, from Mumbles to Port Talbot harbour; neonates, on the other hand, were only found in the western section, and during June and July (likely born May-June). Porpoise calves are notoriously hard to survey, and often get under-reported. These findings, though, imply some significant use of the area during calving season; possibly, evidence of parents bringing young

calves to shallow waters to learn to forage (Evans and Prior, 2012). However, without more consistent data, these hypotheses are currently untested.

3 Proposed Protocol

3.1 Protocol Outline

The protocol will use a series of combined visual and acoustic surveys across Swansea Bay, carried out from a vessel such as the R.V. *Song of the Whale* (Marine Conservation Research, 2022) travelling at 5.8 knots. Where possible (i.e. barring safety/navigational constraints; these may occur, for example, around the Carmarthen Bay sandbar shown in Figure 1-1) acoustic sampling will be achieved using a towed hydrophone containing two broadband elements (2 to 200 kHz bandwidth), towed 20-100m behind the vessel; where not possible, a hydrophone of the same specifications will be mounted ahead of the keel on the ship itself, 1m below the waterline, as trialled in the Thames (Cucknell et al., 2020). Acoustic sampling will be gathered continuously and then assessed for the target frequencies associated with porpoise (115-160kHz) using PAMGuard (Sea Mammal Research Unit, 2022).

Visual data will be gathered during the same trips. When the sea state is three or below on the Beaufort Scale, during daylight, two researchers at a time will record marine mammal sightings from a 2m raised platform on deck, for a total eye height of around 5.5m above sea level. In rougher sea states, the observers will be on deck for safety reasons. Group size and behaviour will be logged, along with an estimate of distance and relative angle (an angle board will be used for this). Environmental data and GPS locations will be recorded via data logger.

The surveys will use transects, according to Buckland (2001)'s distance sampling survey methodology. These will be plotted using Distance 7.3 (Thomas et al., 2010), in order to achieve equal coverage probability.

Surveying the whole area is predicted to take between 1-2 weeks. For the first year, to establish a baseline, the process will be repeated every two months. Over the following five years, surveyors will return once a season (every three months) to repeat the surveys, to monitor changes.

3.2 Evaluation

Typically a long-term monitoring project would use mark-recapture or tag and track methodology, to better track individuals of a population; however, marine mammals, especially cetaceans, are difficult to safely capture, and marking techniques are not highly successful (Boyd, Bowen and Iverson, 2010). This becomes particularly true of harbour porpoise, whose shy nature makes capture difficult in the first instance. Most tagging studies on porpoise are carried out on animals that have been accidentally caught in gillnets or pound nets as bycatch, and thus need to be handled for release anyway (Eskesen et al., 2009; Boyd et al., 2010); none of which are particularly in use in Swansea Bay. Additionally,

studies into stress responses of various porpoise species to tagging show high levels of individuality between animals, making generalised methodology to prioritise welfare difficult (Hanson & Baird, 1998; Eskesen et al., 2009). Indeed, Hanson & Baird (1998) used a non-invasive method of pole-deploying suction cup tags onto bow-riding Dall's porpoises (*Phocoenoides dalli*), and still found this variability in individual response (along with a very short lifespan of the tags; the longest lasted just 41 minutes.) On top of this, there is high risk associated with capturing wild cetaceans that would necessitate extensive trained veterinary experience to guard against fatalities (Wells, 2005; Boyd, Bowen and Iverson, 2010). As such, the risk to the animals' welfare cannot be justified where other less invasive methods are available.

Towed hydrophones are a tried-and-tested method for harbour porpoise surveys (Gillespie and Chappell, 2002; Gillespie et al., 2005; Cucknell et al., 2016; 2020), and the number of individuals detected by them may be up to ten times more than by visual surveys alone (Cucknell et al., 2017).

3.2.1 Existing Protocols

While towed hydrophones may be common, the fixed hydrophone array on the vessel suggested in areas with safety/navigational constraints is more unusual. It has been trialled recently, however, in the Thames (Cucknell et al., 2020); while it did report a lower encounter rate than the towed array (4.2 vs 6.7/100km, likely owing to the reduced range of <250m compared with the towed array's <400m), this nonetheless did provide data in areas that otherwise would have been excluded entirely from the results. For the most part, however, Swansea Bay is considerably less constrained than the Thames River, so it's likely the towed array will be usable over the vast majority of the area.

Land-based visual surveys are an option, but their fixed vantage point make them less reliable than vessel-based counterparts (Oakley et al., 2016). Aerial surveys are sometimes used on cetaceans, to great effect (Boyd, Bowen and Iverson, 2010; Lauriano et al., 2014; Oakley et al., 2016). These, however, would be more expensive to repeatedly conduct, given the long-term nature of this study.

Strandings data can be very effectively used to assess numerous aspects of cetacean ecology, but their ad hoc nature makes them at best opportunistically observational data, and not suitable for detailed abundance/distribution studies (Jenkins, Brown and Phillips, 2009; Oakley et al., 2016).

4 Anticipated Data

4.1 Data Storage

Visual data will be recorded via recording sheet (see Appendix A), and on the Mergin app (assuming a signal is possible!) Acoustic data will be logged on the data loggers. On returning to land, all will be immediately transferred to a backed-up master copy, and checked by a second researcher for entry errors. Mergin data will be transferred to computer for use in a GIS programme such as QGIS, for detailed maps to be made of porpoise distribution.

All data will be shared with local universities and research institutions, and with Natural Resources Wales.

4.2 Analysis

The data will be assessed to for porpoise click trains (four or more clicks) and those identified as 'certain' by two independent analysts will be included for analysis. In order to determine if a click train is 'distinct' (i.e. not an animal already detected), a time threshold will be applied of six minutes and twenty five seconds, estimated using the speed of the survey vessel (5.8 knots) relative to the 0.9 m sec⁻¹ average swimming speed of a harbour porpoise (Otani et al., 2000). This will be corrected for the maximum acoustic detection difference of 400m (Villadsgaard, Wahlberg and Tougaard, 2007). Therefore, if there is no corresponding click train or sighting within six minutes and twenty five seconds of one being detected, it will be considered distinct. PAMGuard can use target motion analysis to estimate slant distances in vocalising animals, so this will be used where possible.

If the towed hydrophone array needs to be altered in length to help with navigational constraints then this data can only be used to determine presence/absence, as it will not be directly comparable. The hull-mounted array, however, can also estimate a relative encounter rate throughout. If the tow line does not need altering, then the towed array can also provide this function. To reduce the risk of duplicated readings between the arrays, a detection on the towed array occurring within six minutes and twenty five seconds of the hull array will again be removed from the dataset.

According to Buckland et al. (2001, pp78-80), variance will be calculated, using days as the sampling units, according to the following equation:

Equation 4-1. Calculating variance

$$\hat{var}(n) = \sum_{i=1}^k l_i \left(\frac{n_i}{l_i} - \frac{n}{L} \right)^2 / (k - 1)$$

Where:

i = transect number 1-k,

l_i = length of transect i

L = sum of all transect lengths

Then, $\hat{var}(n)$ is divided by L^2 and multiplied by 100 to get the variance of the detection rate per 100km².

A 0.05 degree grid, using the WGS84 coordinate system, will be used to map the data across the survey area.

5 References

Baines, M.E. and Earl, S., 1999. *Analysis of Sightings Data for Indications of Harbour Porpoise Breeding off the Welsh Coast. Report 379.*

Binnie, C., 2016. Tidal energy from the severn estuary, uk. *Proceedings of the Institution of Civil Engineers: Transport*, 169. <https://doi.org/10.1680/jener.14.00025>.

Boyd, I.L., Bowen, W.D. and Iverson, S.J., 2010. *Marine Mammal Ecology and Conservation: A Handbook of Techniques*. Oxford: Oxford University Press.

Buckland, S.T., 2001. *Introduction to distance sampling: estimating abundance of biological populations*. Oxford: Oxford University Press.

Cefas, 2013. *Sanitary Survey of Oxwich Bay. Cefas report on behalf of the Food Standards Agency, to demonstrate compliance with the classification of bivalve mollusc production areas in England and wales under EC Regulation Number 854/2004.*

Cucknell, A., Moscrop, A., Boisseau, O. and McLanaghan, R., 2020. Confirmation of the presence of harbour porpoise (*Phocoena phocoena*) within the tidal Thames and Thames Estuary. *Mammal Communications*, 6, pp.21–28.

Cucknell, A.C., Boisseau, O., Leaper, R., McLanaghan, R. and Moscrop, A., 2017. Harbour porpoise (*Phocoena phocoena*) presence, abundance and distribution over the Dogger Bank, North Sea, in winter. *Journal of the Marine Biological Association of the United Kingdom*, 97(7). <https://doi.org/10.1017/S0025315416000783>.

Cucknell, A.C., Frantzis, A., Boisseau, O., Romagosa, M., Ryan, C., Tonay, A.M., Alexiadou, P., Öztürk, A.A. and Moscrop, A., 2016. Harbour porpoises in the Aegean Sea, Eastern Mediterranean: The species' presence is confirmed. *Marine Biodiversity Records*, 9(1). <https://doi.org/10.1186/s41200-016-0050-5>.

Department of Energy & Climate Change, 2013. *UK renewable energy roadmap: 2013 update. Department of Energy & Climate Change.*

Embling, C.B., Gillibrand, P.A., Gordon, J., Shrimpton, J., Stevick, P.T. and Hammond, P.S., 2010. Using habitat models to identify suitable sites for marine protected areas for harbour porpoises (*Phocoena phocoena*). *Biological Conservation*, 143(2). <https://doi.org/10.1016/j.biocon.2009.09.005>.

Eskesen, I.G., Teilmann, J., Geertsen, B.M., Desportes, G., Riget, F., Dietz, R., Larsen, F. and Siebert, U., 2009. Stress level in wild harbour porpoises (*Phocoena phocoena*) during satellite tagging measured

by respiration, heart rate and cortisol. *Journal of the Marine Biological Association of the United Kingdom*, 89(5). <https://doi.org/10.1017/S0025315408003159>.

Evans, P.G.H. and Prior, J.S., 2012. *Protecting the Harbour Porpoise in UK Seas: Identifying a Network of Draft SACs for the Harbour Porpoise in the UK*.

Gillespie, D., Berggren, P., Brown, S., Kuklik, I., Lacey, C., Lewis, T., Matthews, J., McLanaghan, R., Moscrop, A. and Tregenza, N., 2005. Relative abundance of harbour porpoises (*Phocoena phocoena*) from acoustic and visual surveys of the Baltic Sea and adjacent waters during 2001 and 2002. *Journal of Cetacean Research and Management*, 7(1).

Gillespie, D. and Chappell, O., 2002. An automatic system for detecting and classifying the vocalisations of harbour porpoises. *Bioacoustics*, 13(1). <https://doi.org/10.1080/09524622.2002.9753485>.

Hansford, M., 2018. Tidal lagoon boss slams 'pathetic' government. *New Civil Engineer*. [online] 26 Jun. Available at: <<https://www.newcivilengineer.com/latest/tidal-lagoon-boss-slams-pathetic-government-26-06-2018/?blocktitle=most-popular&contentid=-1>> [Accessed 12 February 2022].

Hanson, M.B. and Baird, R.W., 1998. Dall's Porpoise Reactions to Tagging Attempts Using A Remotely-Deployed Suction-Cup Tag. *Marine Technology Society Journal*, 32(2).

Jenkins, R.E., Brown, R.D.H. and Phillips, M.R., 2009. Harbour porpoise (*Phocoena phocoena*) conservation management: A dimensional approach. *Marine Policy*, 33(5). <https://doi.org/10.1016/j.marpol.2009.02.003>.

Lauriano, G., Pierantonio, N., Donovan, G. and Panigada, S., 2014. Abundance and distribution of *Tursiops truncatus* in the Western Mediterranean Sea: An assessment towards the Marine Strategy Framework Directive requirements. *Marine Environmental Research*, 100. <https://doi.org/10.1016/j.marenvres.2014.04.001>.

Mackie, A.S.T., James, J.W.C., Rees, E.I.S., Darbyshire, T., Jenkins, G.O. and Morando, A., 2007. The Outer Bristol Channel Marine Habitat Study. Studies in Marine Biodiversity and Systematics from the National Museum of Wales. *BIOMÔR*, 4, pp.40–48.

Marine Conservation Research, 2022. *R.V. Song of the Whale*. [online] Available at: <<https://www.marineconservationresearch.co.uk/rv-song-of-the-whale/>> [Accessed 21 February 2022].

MEA, 2005. *MEA - Millenium Ecosystem Assessment, 2005. Ecosystem and Human Well-being: Biodiversity Synthesis*. World Resources Institute, Washington, DC.

Oakley, J.A., Jenkins, R.E., Thomas, T., Williams, A.T. and Phillips, M.R., 2016. Assessing harbour porpoise populations in south-west Wales, data issues and implications for conservation and management. *Ocean and Coastal Management*, 119. <https://doi.org/10.1016/j.ocecoaman.2015.09.011>.

Otani, S., Naito, Y., Kato, A. and Kawamura, A., 2000. *Diving behavior and swimming speed of a free-ranging harbor porpoise, Phocoena phocoena*. *Marine Mammal Science*, <https://doi.org/10.1111/j.1748-7692.2000.tb00973.x>.

Pierpoint, C., 2008. *A Two-year Pre-construction Baseline of Harbour Porpoise Activity at Scarweather Sands Offshore Wind Farm*.

Sea Mammal Research Unit, 2022. *PAMGuard*. Available at: <<https://www.pamguard.org/>> [Accessed 13 February 2022].

The Wildlife Trusts, 2022. *Harbour porpoise*. [online] Available at: <<https://www.wildlifetrusts.org/wildlife-explorer/marine/marine-mammals-and-sea-turtles/harbour-porpoise>> [Accessed 12 February 2022].

Thomas, L., Buckland, S.T., Rexstad, E.A., Laake, J.L., Strindberg, S., Hedley, S.L., Bishop, J.R.B., Marques, T.A. and Burnham, K.P., 2010. *Distance software: Design and analysis of distance sampling surveys for estimating population size*. *Journal of Applied Ecology*, <https://doi.org/10.1111/j.1365-2664.2009.01737.x>.

Villadsgaard, A., Wahlberg, M. and Tougaard, J., 2007. Echolocation signals of wild harbour porpoises, *Phocoena phocoena*. *Journal of Experimental Biology*, 210(1). <https://doi.org/10.1242/jeb.02618>.

Wells, R.S., 2005. *Report to the Marine Mammal Commission on the Small Cetacean Electronic Tag Attachment Workshop*. [online] Sarasota. Available at: <<https://sarasotadolphin.org/wp-content/uploads/2021/09/2005-Wells-MMC-Tag-Attachment-Rept.pdf>> [Accessed 14 February 2022].

Wilson, B., Batty, R.S., Daunt, F. and Carter, C., 2007. Collision risks between marine renewable energy devices and mammals, fish and diving birds. *Water*, (March).

Youle, R., 2021. Swansea council pushes ahead with Dragon Energy island plan. *Wales Online*. [online] 21 Sep. Available at: <<https://www.walesonline.co.uk/news/wales-news/swansea-bay-lagoon-tidal-council-21621592>> [Accessed 12 February 2022].

6 Appendix

6.1 Example Data Sheet

Swansea Bay Porpoise Survey Data Sheet

Observer		Wind Direction	
Transect Number		Wind Speed	
Date		Start Time	
Sea State		End Time	

Time Spotted	Group Size (No. of calves)	Left/Right of Trackline	Distance (GPS)	Angle Board	Behaviour (see index)
Additional Notes:					

Behavioural Index Key			
Surfacing	1	Tail Slap	9
Slow Swimming	2	Sky Hop	10
Medium Swimming	3	Bow Riding	11
Fast Swimming	4	Resting/Logging	12
Blowing	5	Milling	13
Feeding/Foraging	6	Sexual Behaviour	14
Suspected Feeding	7	Aggression	15
Breach or Leap (Full/Partial)	8	Socialising	16