Environmental Statement
Chapter 10. Marine Mammals and Turtles

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Contents

10.0 Marine Mammals and Turtles

10.1 Introduction

10.1.0.1 This chapter provides an assessment of the likely significant effects of the Project on marine mammals and turtles. The following sections detail: the methodology by which this assessment has been carried out; provide a baseline description of marine mammal and turtle distribution and ecology; and offer an assessment of the likely significant effects on marine mammals and turtles that could arise from the construction, operation and decommissioning phases of the Project.

10.2 Legislation, planning policy and guidance

10.2.0.1 All cetaceans (whales and dolphins) are protected under Schedule 5 of the Wildlife and Countryside Act 1981 (and amendments), under which it is an offence to take, injure or kill these species. Disturbance in their place of rest, shelter or protection is also prohibited. All species of cetacean are protected under the EU Habitats Directive 1992 at Annex IV and under the Bern Convention. Harbour porpoise and bottlenose dolphin are also protected under Annex II of the Habitats Directive 1992. In addition, harbour porpoise are also listed as an OSPAR threatened species listed in Appendix II of the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) 1982.

10.2.0.2 Pinnipeds (seals) are protected under the Conservation of Seals Act 1970 (taking effect in England, Scotland, Wales). Grey and common seals are also listed in Annex II of the EU Habitats Directive 1992 and are protected from disturbance both inside and outside the designated sites. In addition, grey seal is listed as an Appendix III species under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 1979, which prohibits the deliberate disturbance/capture/killing of species and disturbance of their breeding grounds.

10.2.0.3 Cheloniids (turtles) are protected under the Wildlife and Countryside Act 1981 (and amendments), under which it is an offence to take, injure or kill these species. Species of turtle are also protected under the EU Habitats Directive (1992) in Annex II and IV of the Bern Convention, 1979.

10.3 Assessment methodology

10.3.1 Study area

10.3.1.1 In order to highlight and compare different populations and habitats which might be affected by the Project, data have been analysed at three different spatial scales in an iterative manner for each species. First, information on the distribution in the wider Irish Sea and Celtic Sea area is summarised. This is followed by a summary of abundance levels and distribution in the Bristol Channel. Finally, data on mammal numbers and distributions within Swansea Bay and the surrounding area is presented. The general extent of each of these areas can be seen in Figure 10.1 (Volume 2). Together they form the Study Area.

10.3.2 Data sources

10.3.2.1 Numerous sources of information were reviewed to inform the marine mammal baseline description. These include a number of national and regional studies to provide information on marine mammal distribution and ecology. These data were used to inform the understanding of the relative importance and functionality of the Bristol Channel and Swansea Bay in the context of the wider Celtic Sea area. These main data sources include:

i. ***Management Units for Marine Mammals in UK waters*****:** The Inter-Agency Marine Mammal Working Group (IAMMWG) study sets out the agreed Management Units (MUs) for the seven most common cetacean species and the two seal species in UK waters (IAMMWG, 2013);

ii. ***The Atlas of the Marine Mammals of Wales*****:** The most comprehensive information on the distribution of marine mammals in Welsh waters is provided in the *Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012). The study compiled and analysed data from sixteen projects including a total of 216,031 km of effort from vessel and aerial surveys and 13,399 hours of land-based effort, spanning the 20-year period 1990-2009. It includes data collected by the Sea Watch Foundation (SWF), JNCC (Joint Nature Conservation Committee) and the WDCS (Whale and Dolphin Conservation Society). Data from the Gower Marine Mammal Project (GMMP*)* and Scarweather Sands Offshore Wind Farm baseline monitoring were also included as part of the Atlas (see below);

iii. ***Small Cetacean Abundance in the European Atlantic and North Sea programmes (SCANS and SCANS-II*****):** The surveys undertook widespread ship-based and aerial surveys of cetaceans in UK and adjacent waters in the summers of 1994 and 2005 (SCANS-II, 2008). The programme provides detailed wide-scale survey data on cetacean abundance, distribution and density in North West European waters. The survey areas of particular relevance to the current baseline are the Celtic Shelf (which was surveyed using boat-based methods) and the Irish Sea (which was surveyed using aerial methods). Unless otherwise stated, abundance estimates used in this report derived from the SCANS-II are for these two areas combined. SCANS and SCANS-II data are also included in *The Atlas of the Marine Mammals of Wales* described above;

iv. ***Atlas of Cetacean Distribution in North West European Waters*****:** Comprehensive information on cetacean distribution in North West European waters is presented in Reid *et al*. (2003). This report provides a compilation of cetacean sighting records from a variety of systematic surveys and opportunistic sightings amounting to over 2,500 days of observation carried out since 1973;

v. ***Offshore Energy Strategic Environmental Assessment (SEA):*** Detailed reviews of marine mammal distribution and ecology in UK waters have also been carried out by the Sea Mammal Research Unit (SMRU), University of St. Andrews, as a contribution to the Department of Energy and Climate Change (DECC) Offshore Energy Strategic Environmental Assessment (SEA) (DECC, 2009);

vi. ***Towards Marine Protected Areas for Cetaceans in Scotland, England and Wales***: The WDCS (Whale and Dolphin Conservation Society) additionally undertook a review identifying critical habitat for cetaceans to help highlight potential Marine Protected Areas (MPA's) for cetacean species (Clark *et al.* 2010);

vii. ***Special Committee on Seals Annual Report***: Information on the status of seals around the UK coast is reported annually by the SMRU-advised Special Committee on Seals (SCOS) (SCOS, 2013);

viii. ***Studies of Marine Mammals in Welsh High Tidal Waters:*** Research on the movements of seals from haul-out sites in Wales undertaken as part of the Welsh Marine Renewable Energy Strategic Framework (MRESF) (Thompson, 2012; Gordon *et al*. 2012); and

ix. ***The Irish Sea Leatherback Turtle Project***: The research project was established in April 2003 as a joint venture between the University of Wales Swansea and the University College Cork. Funded by the European Regional Development Fund's (ERDF) INTERREG IIIA initiative, key elements of the project included aerial jellyfish surveys of the Irish Sea, satellite tracking of leatherback turtles and shoreline jellyfish surveys (Houghton *et al*. 2006a; Houghton *et al*. 2006b; University of Wales Swansea & University College Cork. 2006).

10.3.2.2 Of particular relevance are a number of recent monitoring and survey projects which have been undertaken specifically in the Bristol Channel and Swansea Bay. These data sources include the following:

I. ***Atlantic Array Offshore Wind Farm baseline monitoring:*** Marine mammal monitoring undertaken as part of the then proposed application for the Atlantic Array Offshore Wind Farm development from 2009-2010 (Channel Energy Limited, 2012);

II. ***Gower Marine Mammal Project (GMMP) surveys***: Monitoring of harbour porpoise in the Bristol Channel (including Carmarthen Bay, the Gower, Swansea Bay and Scarweather Sands) was undertaken from December 2002 until January 2004 (Watkins and Colley, 2004; ABPmer, 2004). In 2007, the GMMP project extended its surveys offshore into the outer Bristol Channel. These surveys are ongoing but GMMP provided a summary of results as part of the Atlantic Array Offshore Wind Farm EIA (Channel Energy Limited, 2012);

III. ***Scarweather Sands Offshore Wind Farm baseline monitoring:*** A two-year pre-construction baseline of harbour porpoise activity within and adjacent to Scarweather Sands (Pierpoint, 2008a cited in Channel Energy Limited, 2012).

IV. ***Low Carbon Research Institute (LCRI) survey data*** - Vantage and boat-based survey data undertaken by Swansea Metropolitan University between February 2011 and May 2013 (Jenkins and Oakley, 2013).

10.3.2.3 Further details of each of these surveys are summarised in Table 10.1 with Figure 10.2 showing the spatial coverage of the surveys.

Table 10.1 Summary of recent monitoring in the Bristol Channel and Swansea Bay

Data Source	Survey Techniques	Survey Location	Timing of survey effort
Atlantic Array Offshore Wind Farm baseline monitoring (Channel Energy Limited, 2012).	The sighting survey and the towed hydrophone survey were carried out concurrently from the same vessel and followed a series of set transect lines eleven parallel, North South transects (a total line length of 149 km). C-POD's* were also deployed at four locations.	Bristol Channel-Vicinity of Atlantic Array Offshore Wind Farm.	Boat –based surveys deployed between April 2009 and March 2011. C-POD surveys between April and November 2010.
Scarweather Sands Offshore Wind Farm baseline monitoring (Pierpoint, 2008a).	Eighteen boat-based line transect surveys were completed over a 24 month period. T-POD* data were also collected at nine locations over this period (Figure 10.2).	Swansea Bay.	Surveys undertaken over a 24 month period between 2005 and 2007. No vessel based surveys were undertaken in January and November with low effort in March.
Gower Marine Mammal Project (GMMP)- Harbour porpoise occurrence Carmarthen Bay - Gower Peninsula - Swansea Bay (Watkins and Colley, 2004 ABPmer, 2004).	Fixed T-POD deployment, boat-based survey transects (with towed hydrophone array) and constant effort shore watches (Figure 10.2).	Fixed T-POD deployment at locations in Carmarthen Bay, off South Gower, Swansea Bay, Scarweather Sands and off the Porthcawl-Kenfig coast. Boat-based survey transects (with towed hydrophone array) in Carmarthen Bay, South of the Gower, Swansea Bay and the vicinity of Scarweather Sands.	December 2002 until January 2004.
Gower Marine Mammal Project (GMMP)- Offshore surveys in the outer Bristol Channel (summarised in Channel Energy Limited, 2012).	Thirteen systematic surveys with a total, transect effort total of 1,009 km.	Offshore in the outer Bristol Channel.	Surveys ongoing with data between 2007 and 2010 used in the baseline. Highest survey effort between April and September.
Low Carbon Research Institute (LCRI) survey data (Jenkins and Oakley, 2013; Jenkins, 2007).	Vantage and boat based survey data. In total 164 shore watches (totalling 474 hours of constant shore based effort watching) were undertaken along with 15 vessel surveys.	Vantage surveys undertaken at the Mumbles (Tutt Head) and Port Talbot. Dedicated vessel surveys focused on the Mumbles, North Gower Coast and Port Talbot along with passing observations of mammals within Swansea Bay recoded en route to these areas.	Forty-seven shore watches were conducted at Mumbles between 2003 and 2005 and a further 83 between 2011 and 2013. In addition, a further 34 were carried out at Port Talbot between 2011 and 2013. Vessel-based surveys were undertaken between March 2011 and May 2013.

* T-POD and C-POD are acoustic cetacean detectors. The passive acoustic monitoring instruments detect toothed whales, dolphins and porpoises by identifying the trains of echo-location sounds they produce. T-PODs ceased production in 2008 and have been superseded by C-PODs.

10.3.2.4 A number of other surveys and scientific studies on marine mammals have also been included where appropriate.

10.3.3 Impact assessment methodology

10.3.3.1 To facilitate the impact assessment process, a standard analysis methodology is applied. This framework has been developed from a range of sources, statutory guidance, consultations and ABPmer's extensive previous EIA project experience. The key guidance and regulations that are drawn upon include:

i. The criteria listed in Annex III of the EC Environmental Assessment Directive (85/337 EEC as amended by 97/11/EC);

ii. The assessment process developed by statutory conservation agencies to provide advice on operations within European Marine Sites (English Nature, 1998);

iii. An Environmental Risk Assessment approach developed by ABP Research (ABP Research, 1997); and

iv. Institute of Ecology and Environmental Management's (IEEM) Guidelines for Ecological Impact Assessment in the UK (IEEM, 2006) and Guidance on Impact Assessment in Marine and Coastal Environments (IEEM, 2010).

10.3.3.2 The environmental issues have been divided into distinct 'receiving environments', also referred to as 'receptors'. The effect of the proposed activities on each of these will be assessed by describing in turn: the baseline environmental conditions of each receiving environment; the 'impact pathways' by which the receptors could be affected; the significance of the impacts occurring and the measures to mitigate significant adverse impacts where these have been predicted.

10.3.3.3 This ES proceeds on the basis of the outline construction programme detailed in Chapter 4, Section 4.5.2, which anticipates construction starting in 2015 and with the main construction lasting for about three years. The assessments contained in this chapter are not materially sensitive to works commencing within the anticipated validity of the DCO, which is five years, or to an extension of (say) a further year-or-so.

10.3.3.4 This Impact Assessment Framework, which is presented in the following sections, is designed to incorporate the key criteria and considerations without being overly prescriptive.

Stage 1 - Identify features and changes

10.3.3.5 The first stage is identifying the potential environmental changes resulting from the proposed activities comprised in the Project (pressures) and the features of interest (receptors) that are likely to be affected. The combination of the pressure and receptor exposure to that pressure is referred to as the impact pathway. This aspect of the assessment has been developed in consultation with key statutory and non-statutory authorities.

10.3.3.6 The proposed activities and the potential impact pathways which are considered relevant to the EIA for the Project are as follows:

10.3.3.7 **Construction:** the process involved in constructing the Offshore Works and the impounding of the Lagoon, leading to the direct loss of intertidal and subtidal habitats under the footprint of the Offshore Works themselves, and that part of the Lagoon and foreshore no longer readily accessible to receptors, as well as potential indirect effects through settlement of suspended solids. Potential impacts could also occur through collision risk, visual disturbance and noise disturbance, toxic contamination and non-toxic contamination.

10.3.3.8 **Operation:** the process involved in operating and maintaining the Project over its lifetime. Potential impacts include changes to foraging habitat, access to foraging habitat, collision risk, and barrier effects upon movement, noise disturbance, electromagnetic fields and toxic contamination.

10.3.3.9 **Decommissioning:** the process of putting the Project into a non-operational state at the end of its operational lifetime. Potential impacts include collision risk, visual disturbance and noise disturbance, toxic contamination, electromagnetic fields and non-toxic contamination.

Stage 2 - Understand change and sensitivity

10.3.3.10 The second stage of the impact assessment has involved understanding the nature of the environmental changes to provide a benchmark against which the changes and levels of exposure can be compared. The scale of the impacts via the impact pathways depend upon a range of factors, including the following:

i. Magnitude;

   Spatial extent (small/large scale);

   Duration (temporary/short/intermediate/long-term);

   Frequency (routine/intermittent/occasional/rare);

ii. Reversibility;

iii. Probability of occurrence;

iv. The margins by which set values are exceeded (e.g. water quality standards);

v. The baseline conditions of the system (including existing long-term trends and natural variability); and

vi. The sensitivity of the receptor (resistance/adaptability and recoverability).

Stage 3 - Impact assessment

10.3.3.11 The likelihood of a feature/receptor being vulnerable to an impact pathway will then be evaluated as a basis for assessing the level of the impact and its significance.

The key significance levels for either beneficial or adverse impacts are described as follows:

I. **Insignificant**: Insignificant change not having a discernible effect;

II. **Minor**: Effects tending to be discernable but tolerable;

III. **Moderate**: Where these changes are adverse they may require mitigation; and

IV. **Major**: Effects are highest in magnitude and reflect the high vulnerability and importance of a receptor (e.g. to nature conservation). Where these changes are adverse they will require mitigation

Impact assessment guidance tables

10.3.3.12 The matrices in Tables 10.2 to 10.3 have been used to assess significance.

10.3.3.13 Table 10.2 has been used as a means of generating an estimate of exposure. Magnitude of change has been considered in spatial and temporal terms (including duration, frequency and seasonality), and against the background environmental conditions in the Study Area. Once a magnitude has been assessed, this has been combined with the probability of occurrence to arrive at an exposure score which has been used for the next step of the assessment, which is detailed in Table 10.3. For example, an impact pathway with a medium magnitude of change and a high probability of occurrence will result in a medium exposure to change.

Table 10.2 Exposure to change, combining magnitude and probability of change

Probability of Occurrence	Magnitude of Change			
	Large	Medium	Small	Negligible
High	High	Medium	Low	Negligible
Medium	Medium	Medium/Low	Low /Negligible	Negligible
Low	Low	Low /Negligible	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

10.3.3.14 Table 10.3 has been used to score the vulnerability of the features of interest based on the sensitivity of those features and their exposure to a given change. Where the exposure and sensitivity characteristics overlap, then vulnerability exists and an adverse effect may occur. For example, if the impact pathway previously assessed with a medium exposure to change acts on a receptor which has a high sensitivity, this will result in an assessment of high vulnerability. Sensitivity can be described as the intolerance of a habitat, community or individual of a species to an environmental change and essentially considers the response characteristics of the feature. Thus, if a single or combination of environmental changes is likely to elicit a response, then the feature under assessment will be considered to be sensitive. Where an exposure or change occurs for which the receptor is not sensitive, then no vulnerability will occur. Similarly, where a negligible exposure is identified during an impact assessment, vulnerability will always be 'none' no matter how sensitive the feature is, if the exposure to change has been assessed as 'negligible'.

Table 10.3 Estimation of vulnerability based on sensitivity and exposure to change

Sensitivity of Feature	Exposure to Change			
	High	Medium	Low	Negligible
High	High	High	Moderate	None
Moderate	High	Moderate	Low	None
Low	Moderate	Low	Low	None
None	None	None	None	None

10.3.3.15 The vulnerability is then combined with the importance of the feature of interest using Table 10.4 to generate an initial level of significance. The importance of a feature is based on its value and rarity such as the levels of protection. For example if a high vulnerability has previously been given to a feature of low importance the initial level of significance will be assessed as minor.

Table 10.4 Estimation of significance based on vulnerability and importance

Importance of Feature	Vulnerability of Feature to Impact			
	High	**Moderate**	**Low**	**None**
High	Major	Moderate	Minor	Insignificant
Moderate	Moderate	Moderate/Minor	Minor/Insignificant	Insignificant
Low	Minor	Minor/Insignificant	Insignificant	Insignificant
None	Insignificant	Insignificant	Insignificant	Insignificant

Stage 4 - Impact management

10.3.3.16 The final stage of the assessment process has identified any impacts that have been found to be moderate and/or major adverse significant and require mitigation measures to reduce residual impacts, as far as possible, to environmentally acceptable levels. Within the assessment procedure the use of mitigation measures will alter the risk of exposure and hence will require significance to be re-assessed and thus the residual impact (i.e. with mitigation) will be identified.

Stage 5 - Confidence assessment

10.3.3.17 Following the significance assessment, a confidence assessment has been undertaken which recognises the degree of interpretation and expert judgement applied.

Cumulative impact and in-combination assessment

10.3.3.18 It is necessary to assess the potential cumulative impacts of a proposed activity on all environmental receptors, together with other known developments in the area. The EIA cumulative and in-combination assessments are presented in Section 10.6.

10.4 Baseline conditions

10.4.1 Overview

10.4.1.1 Eighteen species of cetacean have been recorded in Welsh waters since 1990 (Baines and Evans, 2012). Of these, only five species (harbour porpoise *Phocoena phocoena*, Risso's dolphin *Grampus griseus*, common dolphin *Delphinus delphis*, bottlenose dolphin *Tursiops truncatus* and minke whale *Balaenoptera acutorostrata*) are either present at any time of the year or recorded annually as seasonal visitors within the Bristol Channel (Baines and Evans, 2012; Reid *et al*. 2003). Occasional sightings and strandings of other cetaceans such as long-finned pilot whale (*Globicephala melas*)**,** fin whale (*Balaenoptera physalus*) and killer whale (*Orcinus orca*) have been recorded, although these remain scarce (Reid *et al*. 2003; Solandt, 2007; Baines & Evans, 2012).

10.4.1.2 With regard to pinnipeds, grey seals are regularly recorded in the inner Bristol Channel with records of common (harbour) seal (*Phoca vitulina)* being rare (DECC, 2009; Baines and Evans, 2012).

10.4.1.3 Leatherback turtle *Dermochelys coriacea* is the only cheloniid species that is believed to undertake deliberate, seasonal migratory movement to UK waters to feed on gelatinous zooplankton prey (such as the jellyfish *Rhizostoma octopus).* While the species has been recorded in Wales (particularly off Carmarthen Bay and Tremadoc Bay), sightings are generally rare (with an average of 33 leatherback turtle records each year around the UK). All other turtle species are believed to reach UK waters only when displaced from their normal range by adverse currents and consequently UK waters are not considered part of their functional range (Marubini, 2010; Witt *et al.* 2007a, Witt *et al.* 2007b; University of Wales Swansea & University College Cork, 2006).

10.4.1.4 The baseline review has, therefore, focused on leatherback turtle and grey seal along with the five most commonly occurring cetaceans in the Bristol Channel (harbour porpoise, common dolphin, bottlenose dolphin, Risso's dolphin and minke whale). Some populations of marine mammal undertake large seasonal movements across wide ranges while others occur in relatively discrete areas or habitats.

10.4.2 Harbour Porpoise (*Phocoena phocoena*)

Introduction

10.4.2.1 Harbour porpoise distribution is restricted to temperate and sub-arctic (primarily 5-14^{o}C) seas of the Northern Hemisphere. The harbour porpoise is the most commonly recorded cetacean in UK waters, primarily occurring on the continental shelf (DECC, 2009; Reid *et al*. 2003). In coastal waters, they are often encountered close to islands and headlands with strong tidal currents (Evans *et al*. 2003; and DECC, 2009). Porpoise mating occurs around October with births (usually a single calf) from March to August. Harbour porpoise have a varied diet, exploiting seasonally abundant prey from both pelagic and demersal habitats. Small schooling fish including herring and sprat (Clupeidae), sandeel (Ammodytidae) and members of the cod family (Gadidae) are important food sources in UK and Irish waters (Pierpoint, 2008b).

10.4.2.2 Research has shown that harbour porpoises can range over large areas but generally concentrate their movements in small focal regions often proximate to islands, headlands, or restricted channels (Johnston *et al*. 2005). For example, recent satellite-tracking data in northern Denmark has shown that harbour porpoise typically remained within several hundred kilometres of the area they were first tagged. However, six animals (approximately 10% of the total number tagged) undertook long distance travel into western parts of the North Sea. These animals were recorded approximately 800-1000km away from the point they were first tagged, travelling to various locations offshore from the East Coast of the UK and the Shetland Isles (Teilmann *et al*. 2008; Sveegaard *et al*. 2011). It should be noted that, although this study provides interesting data, harbour porpoise have not been tagged in the UK and therefore limited information is known on their ranges.

10.4.2.3 The identification of different stocks or subpopulations for harbour porpoise was undertaken by ASCOBANS Population Structure Workshop based on genetic studies and the combining of information from other approaches (e.g. telemetry). The Workshop identified 14 distinct stocks for the North Atlantic (Figure 10.3). The stocks relevant to UK waters are the North Eastern North Sea & Skagerrak (NENS), South Western North Sea & Eastern Channel (SWNS), Celtic Sea (plus South West Ireland, Irish Sea & Western Channel) (CES) and North West Ireland & West Scotland (NWIS) (Evans and Teilmann, 2009). More recently the IAMMWG identified three MUs appropriate for harbour porpoise in UK waters (Figure 10.3, Volume 2) (IAMMWG, 2013):

1. North Sea (NS) (comprising ICES area IV, VIId and Division IIIa [Skagerrak and northern Kattegat]). Noting that the northern and western boundary with Division VIa is arbitrary and that there will be an interchange of animals here with the West Scotland MU;
2. West Scotland (WS) (comprising ICES area VIa and b). Noting that the boundary with the North Sea MU is arbitrary and that there will be an interchange of animals here and also with the Irish Sea and Celtic Sea MUs; and
3. Celtic and Irish Seas (CIS) (comprising ICES area VI and VII, except VIId).

Distribution and abundance in the Celtic and Irish Sea

10.4.2.4 Within Wales, harbour porpoise are the most numerous and commonly recorded species (Baines and Evans, 2012). The distribution of harbour porpoise sighting rates (1990-2009) compiled as part of the Atlas of the Marine Mammals of Wales (Baines and Evans, 2012) is summarised in Figure 10.4 (Volume 2). Harbour porpoise are widespread across much of the Celtic Sea, with the majority of individuals sighted off the South West coast of Wales, South coast of Ireland and West of the Isles of Scilly (DECC, 2012; Baines and Evans, 2012). The estimated abundance of harbour porpoise in the Celtic Shelf and Irish Sea areas in the SCANS II surveys was 95,843 (SCANS-II, 2008).The abundance estimate of the CIS MU that the Project falls within is 104,695 (CV 0.32; 95% CI 56,774-193,065) (Hammond et al. 2013 and Macleod et al. 2009 cited in IAMMWG, 2013).

Distribution and abundance in the Bristol Channel

10.4.2.5 The *Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012) showed harbour porpoise occurring in moderate to high densities throughout much of the Bristol Channel area in both vessel and aerial based surveys (Figure 10.4, Volume 2). The importance of the Bristol Channel area for harbour porpoise was highlighted in a report commissioned by the World Wide Fund for Nature (WWF) which recommended that the Outer Bristol Channel should be for considered as a draft Special Area of Conservation (SAC) for harbour porpoise (Evans and Prior, 2012).

10.4.2.6 In order to understand the distribution and abundance of harbour porpoise in the Bristol Channel better, recent monitoring undertaken as part of the Atlantic Array Offshore Windfarm application (2009-2011) has been reviewed (Channel Energy Limited, 2012). Further details of the methods used in this survey can be seen in Table 10.1 with a summary of the results provided in Table 10.5 and Figure 10.5. Harbour porpoise were regularly encountered during the monitoring (189 sightings).

Table 10.5 Summary of the results of the Atlantic Array Offshore Windfarm monitoring (2009-2011) for harbour porpoise

Boat-based Survey Results	C-POD Results
Boat-based surveys recorded 587 sightings of marine mammals of which 32% (189 sightings) were harbour porpoise groups. However, there was considered to be too few double-platform sightings of harbour porpoise from which to estimate species density*. This was probably due to the effects of poor sea conditions on the ability of the observers to spot this inconspicuous species (Channel Energy Limited, 2012). A more robust index of relative abundance was obtained acoustically using towed hydrophones. Encounter rate peaked in August 2010 at 0.28 detections / km (CV = 0.22).	The C-POD data showed a high occurrence of harbour porpoise which were detected on at least one of the C-POD's every day of the 398 day deployment. There was an initial increase in porpoise activity throughout the region in May. From July to September the focus of porpoise activity appeared to shift eastwards further into the Bristol Channel. A shift in activity in the opposite direction was then observed in September to November. From December to February there was an intensification of porpoise activity throughout the survey area. Particularly high detection rates were found at Western sites, but this winter peak in activity was evident throughout the survey area.
* A double-platform survey consists of a pair of observers traversing a set of transects searching independently of each other for animals and recording the position at which each animal is detected, as well as other covariates associated with the detection.	

10.4.2.7 The Atlantic Array Offshore Windfarm Draft Environmental Statement suggests that acoustic encounter rates recorded during towed hydrophone surveys undertaken for the application for the windfarm indicate that the outer Bristol Channel supports aggregations of harbour porpoises (Channel Energy Limited, 2012). Peaks in activity were recorded during the late summer and also during the winter. A similarly important winter time peak is reported for nearby Swansea Bay in November 2005 and December 2006 by Pierpoint (2008a, but referenced from Channel Energy Limited, 2012). The study concluded that harbour porpoise in the area occur at comparable levels to similar habitat elsewhere in South West Wales and North Devon (Channel Energy Limited, 2012). Harbour porpoise have also been regularly sighted in the outer Bristol Channel during other surveys. For example, a total of 49 encounters with harbour porpoise were recorded in the GMMP offshore surveys which broadly overlapped with the Atlantic Array study area (Channel Energy Limited, 2012).

Distribution and abundance in Swansea Bay

10.4.2.8 *The Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012) showed a relatively high density of sightings of harbour porpoise in Swansea Bay and off the Gower Peninsula (Figure 10.4, Volume 2). In order to describe in more detail the distribution of harbour porpoise in Swansea Bay, survey work undertaken by the LCRI, GMMP and as part of the pre-construction baseline of monitoring data for the Scarweather Sands Offshore Wind Farm has been reviewed (Jenkins and Oakley, 2013; Watkins and Colley, 2004; Pierpoint, 2008a). A summary of the methods used in these surveys can be seen in Table 10.1 with a summary of the results provided in Tables 10.6 and 10.7.

10.4.2.9 The surveys have shown that harbour porpoise regularly occur around the Gower Peninsula, Swansea Bay, Scarweather Sands and the Port Talbot harbour approaches. T-POD data showed that the highest frequency of encounters occur at sites in the west of the survey area (Tables 10.6 and 10.7). Similar results were also found during boat-based surveys which found higher abundance rates further west, particularly near headlands on the Gower Peninsula as well as further offshore (Watkins and Colley, 2004; Pierpoint, 2008a). GMMP identified a number of 'hot spots' suggested as being of particular importance to harbour porpoise, namely Mumbles Head, Carmarthen Bay, Port Eynon Head, the west end of Shord channel, Burry Holms, Worm's Head and Helwick Bank (Watkins and Colley, 2004). High porpoise encounter rates were also found by Jenkins and Oakley (2013) around Port Talbot.

10.4.2.10 Pierpoint (2008a) recorded higher harbour porpoise activity during the summer and autumn and also early winter, suggesting some seasonality in harbour porpoise movement in this Swansea Bay. This survey also found that a relatively high proportion of harbour porpoise pods in Swansea Bay included young calves (19% overall), which were most common between June and September (Pierpoint, 2008a). Jenkins and Oakley (2013) also recorded seasonal patterns in abundance with the largest aggregations identified in the Spring and Autumn months (principally March – May and September – November). Calves/juveniles were observed during February, March, July, August, September and October with peak observations of mother and calves being in September (31%) and March (25%). Jenkins and Oakley (2013) concluded that locations around Port Talbot Dock and Swansea Bay/Mumbles must be considered important habitats for harbour porpoise, as survey and stranding data suggests these areas are regularly used by mothers and their young as well as being reliable foraging and feeding grounds for this species. However, it is important to note no data are provided within the study to support this statement. As such to validate the findings of this study, the supporting data would need to be reviewed. This Chapter, has assumed, in the absence of dedicated effort based survey data for the inner part of Swansea Bay and using a precautionary approach, that harbour porpoise occur at similar frequencies to other parts of Swansea Bay such as Port Talbot (see Section 10.5.1).

Table 10.6 Summary of the results of the LCRI survey data, GMMP surveys and Scarweather Sands Offshore Wind Farm baseline monitoring for harbour porpoise

Survey	Boat and Shore-Based Survey Results	TPOD Results
Low Carbon Research Institute (LCRI) survey data (Jenkins and Oakley, 2013)	Of the more recent survey effort employed at Mumbles (2011-13), 11% resulted in porpoise encounters while at Port Talbot, that figure increased slightly to 14%. Vessel-based surveys conducted at Mumbles and Port Talbot recorded 22 encounters with harbour porpoise between 2011 and 2013 with a combined encounter rate of $0.70hr^{-1.}$ When this data is disaggregated, encounter rates of 0.77 hr^{-1} were observed at Mumbles and 0.56 hr^{-1} at Port Talbot. This compares with an encounter rate of 0.48 hr^{-1} at Mumbles between 2003 and 2005 (Jenkins, 2007). Based on 2011-2013 vessel surveys alone, porpoise density in the study area is calculated as 0.6 $km\text{-}^{1}$. When all land and vessel survey sightings are combined in the whole study area, the density of porpoise is calculated as $0.84/km^2$. However, this information should be treated with caution given that land and boat based surveys have very different inherent biases and detection probabilities. Pierpoint (2008a) recorded 0.44 (June 2005) and 0.33 (July 2006) harbour porpoise schools per km in Swansea Bay. Highest numbers of harbour porpoise were recorded in Spring (37%) and Autumn (31%).This correlates with data from Jenkins (2007), where the highest peak was in Spring followed by Autumn. Observations show that, spatially, most sightings at Port Talbot are seen off the docks area coinciding with the 5 to 10m depth contours. At Mumbles, the 10m contour is located 1.05km offshore, with the 20m contour at 1.12 km and most sightings at this site occur between these two contours. Again this would seem to concur with Jenkins (2007).	N/A
Gower Marine Mammal Project (GMMP)-Harbour porpoise occurrence Carmarthen Bay - Gower Peninsula - Swansea Bay (Watkins and Colley, 2004).	Transects recorded far more animals in the southern and western blocks of the survey (offshore from the Gower) than transects further east (see Figure 10.2 and 10.6, Volume 2). The western block recorded 17 animals in 74nm (12.4 porpoise / 100km), the south block recorded 34 animals in 79nm (23.3 porpoise/100km) and the eastern block recorded 1 animal in 89nm (0.6 porpoise/100km).. Clear concentrations of recordings are visible at an area of complex bottom topography (c. centred at 51.27.50 x 4.25.00) south and west of the Helwick Bank, with an apparent association with low water (Watkins and Colley, 2004). Based on the shore-watch data, Burry Holms, Worm's Head and Mumbles Head were identified as important sites.	Port Talbot had an average mean encounter rate of 3 / day compared to 15 / day at Carmarthen Bay and 18 / day at the Mumbles (Table 10.7).

Scarweather Sands Offshore Wind Farm baseline monitoring (Pierpoint, 2008a).	The boat-based line transects completed in Swansea Bay recorded 205 groups of harbour porpoise. The distributions of harbour porpoise were widespread, but were encountered most regularly near headlands on the Gower Peninsula as well as further offshore in the Bristol Channel. Porpoise activity levels were found to be strongly correlated with seawater temperature with higher activity during summer than in the spring. The density of animals in Swansea Bay was estimated to be 0.44 km^{-1} in June 2005 ad 0.33 km^{-1} in July 2006 (1.8 porpoise / km^2 and 1.3 animals / km^2 respectively).	Porpoises were detected on at least 95% of 730 days of monitoring at six of the nine T-POD sites with lower rates of occurrence close to the sandbanks of Scarweather Sands. In Swansea Bay and off the Gower coast, detection rates were lowest from early January to April. Porpoise activity generally increased through the course of the spring and summer. Highest activity was recorded in autumn and early winter with highest annual detection rates recorded in November and December.

* These estimates were uncorrected for incomplete detection of animals close to the transect line and therefore probably underestimated true density.

Table 10.7 Summary of porpoise encounters at each T-POD during the GMMP surveys (ABPmer, 2004)

Location	Mean Encounter* Rate per Day^	Minimum Encounter Rate per Day	Maximum Encounter Rate per Day
Burry Holms	10 (10)	0	37
Carmarthen Bay	15 (11)	0	51
Mumbles	18 (8)	4	37
Port Eynon	12 (8)	1	35
Port Talbot	3 (3)	0	14
Kenfig Patches	3 (2)	0	6
Scarweather	1 (2)	0	9
Scarweather West	8 (9)	0	53
Scarweather Central	1 (1)	0	5
Scarweather East	2 (2)	0	9

An encounter is defined as a sequence of porpoise detections with a separation (or a period of time with no clicks) of less than 10 minutes. Days have been excluded from the data if a T-POD did not record or missed over 1 hour of recording during the day (which can be due to environmental conditions, T-POD errors or deployment timing). The data also excludes false-negative porpoise detection, something considered to be an artefact of T-POD malfunction.
^Standard deviation is provided in brackets.

10.4.3 Short-beaked Common Dolphin (*Delphinus delphis*)

Introduction

10.4.3.1 The common dolphin is widely distributed in tropical, subtropical and temperate seas of the Atlantic and Pacific Oceans both in oceanic and shelf waters. Within the Northeast Atlantic most sightings have been reported in waters south of 60°N. Analysis of summer sightings on shelf waters around the UK from 1983-1998 showed the vast majority of common dolphin sightings to occur in waters above 14°C in temperature. The mating period occurs from May to September, with a high density of sightings recorded along and off the continental shelf slope to the south west of the UK during this period (DECC, 2009; Reid *et al.* 2003). The IAMMWG (2013) suggested a single MU is appropriate for this species comprising all UK waters and extending to the seaward boundary used by the European Commission for Habitats Directive reporting (Figure 10.3, Volume 2).

Distribution and abundance in the Celtic and Irish Sea

10.4.3.2 The distribution of common dolphin sighting rates (1990-2009) compiled as part of the *Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012) is summarised in Figure 10.7 (Volume 2). Short-beaked common dolphin distribution is largely centred upon the Celtic Deep at the southern end of the Irish Sea. This high-density area extends eastwards towards the coast and islands of West Pembrokeshire. Elsewhere in the Irish Sea, the species occurs at low densities mainly offshore, in a central band that extends Northwards towards the Isle of Man (Baines and Evans, 2012). An estimated abundance of 242,817 common dolphin were recorded for the Celtic Shelf and Irish Sea areas in 2005 (SCANS-II, 2008).

10.4.3.3 Although this species is thought to be present in the southern Irish Sea throughout the year, sightings and numbers recorded tend to peak between July and October. There is also evidence of a movement further south into the Celtic Sea and the Bay of Biscay in the winter months (Earl *et al.* 2005).

Distribution and abundance in the Bristol Channel

10.4.3.4 The *Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012) shows common dolphin occurring mainly in the outer part of the Bristol Channel, typically in moderate or high sighting densities (Figure 10.7, Volume 2).

10.4.3.5 The baseline surveys undertaken as part of the proposed Atlantic Array Offshore Wind Farm development in the outer Bristol Channel also recorded a high abundance of common dolphin in this area with more sightings than for any of the other species observed (Channel Energy Limited, 2012). Further details of the methods used in this survey are summarised in Table 10.1, with a summary of the results provided in Table 10.8.

10.4.3.6 Sighting rates were found to be comparable and amongst the highest sighting rates recorded elsewhere in the Celtic Sea (Baines and Evans, 2012). The data suggests that the outer Bristol Channel supports substantial aggregations of common dolphin from the wider Celtic Sea population during the summer and early autumn, and, at times, during the winter. During the GMMP offshore surveys (which broadly overlaps with the Atlantic Array area), 55 encounters with common dolphin schools, numbering one to 150 animals, were recorded (Channel Energy Limited, 2012). A cetacean survey along the coasts of Wales and South West England by WDCS / Greenpeace in 2002 also found common dolphin to be particularly abundant in the outer Bristol Channel (de Boer and Simmonds, 2003). Pods of common dolphin were also recorded in the outer Bristol Channel in mega fauna survey undertaken by the Marine Conservation Society (MCS) in 2007 (Solandt, 2007).

Table 10.8 Summary of the results of the Atlantic Array Offshore Windfarm (2009-2011) for common dolphin

Boat-based Survey Results	C-POD Results
Common dolphin accounted for 54% of the sightings recorded in the boat-based surveys over the 2009 to 2011 monitoring period (314 sightings) (Figure 10.5, Volume 2). However, this was thought to be accounted in part, by their tendency to approach the survey vessel and their gregarious and often energetic behaviour, which made common dolphin schools relatively conspicuous compared to other species. Common dolphin density varied between 0.307 and 0.427 animals / km^2 during late spring and summer (May to August). The highest density of animals occurred in January however: 0.499 animals / km^2 (CV = 0.56*), when common dolphin was encountered in larger schools (mean 10.0 animals per sighting, compared to an overall mean of 5.1 animals). Point estimates of common dolphin abundance ranged from 177 to 246 animals during the summer and 287 (CV = 0.56) in January. This represented 1.5 to 2.5% of the combined SCANS II abundance estimate for the Celtic Sea and Irish Seas.	C-POD data indicated that common dolphins visited the area throughout the year (they were detected acoustically on 81% of days between April 2010 and May 2011). Lowest levels were recorded during February to March, with a marked increase during the spring apparent from the data.
*Coefficient Of Variation (CV) is a statistical measure of the dispersion of data points in a data series around the mean.	

Distribution and abundance in Swansea Bay

10.4.3.7 While common dolphin has sometimes been recorded in Swansea Bay, the species has a largely offshore distribution, typically where water depths range from 50-150 metres (Seawatch Foundation, 2007a; Baines and Evans, 2012). As an example, only a single sighting of common dolphin was recorded in Swansea Bay (of three adults and two juveniles in the entrance to Swansea Docks) during the GMMP monitoring between December 2002 and November 2004 (Watkins and Colley, 2004). Three groups of common dolphin were recorded during the pre-construction baseline monitoring for the Scarweather Sands Offshore Wind Farm between 2005 to 2007 (Pierpoint, 2008a).

10.4.4 Bottlenose Dolphin (*Tursiops truncatus*)

Introduction

10.4.4.1 The bottlenose dolphin in the North Atlantic appears to consist of two forms, coastal and offshore. The better known coastal form is locally common in the Irish Sea (particularly Cardigan Bay) and off North East Scotland (particularly the inner Moray Firth), and in smaller numbers in the Hebrides (West Scotland), and off South West England. Little is known about the offshore form of bottlenose dolphin, including the relationship between the offshore and coastal forms (Clark *et al*. 2010). More detailed studies in the North West Atlantic suggest that inshore and offshore populations are ecologically and genetically discrete (Hoelzel *et al*. 1998).

10.4.4.2 Based on the understanding of near-shore bottlenose dolphin population and community structure, the ASCOBANS / HELCOM small cetacean population structure workshop advised that the following populations are each proposed as separate management units (although it is quite possible that some areas have overlapping communities with different movement patterns) (Evans and Teilmann, 2009):

i. NS-North Sea (Eastern Scotland from Caithness to the borders with England);

ii. OH-Outer Hebrides (Island of Barra);

iii. IH-Inner Hebrides;

iv. IS-Irish Sea;

v. SHE-Shannon Estuary;

vi. WEI-Western Ireland;

vii. SE-Southern England;

viii. NF- North France (Channel Islands and Normandy coast);

ix. BR-Brittany coast and islands (West France);

x. SGA-Southern Galicia; and

xi. SAE-Sado Estuary (Portugal).

10.4.4.3 More recently the IAMMWG (2013) identified six MUs in UK waters (Figure 10.3, Volume 2):

I. Coastal west Scotland and the Hebrides (CWSH, to 12nm);

II. Coastal East Scotland (CES, to 12nm);

III. North Sea (NS, represented by ICES Area IV, excluding coastal east Scotland) It should be noted that very few bottlenose dolphin are seen in this area and, although there is no conclusive evidence, those seen are thought to belong to the Coastal Scottish group;

IV. The Channel and SW England (CSW) (ICES Divisions VIId to h);

V. Irish Sea (IS) (ICES Division VIIa); and

VI. Oceanic waters (OW) (ICES Divisions VIa-b, VIIb, c, k and j, excluding coastal west Scotland).

Distribution and abundance in the Celtic and Irish Sea

10.4.4.4 *The Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012) recorded the highest densities of bottlenose dolphin sightings in southern Cardigan Bay but with moderately high sighting rates also extending north into Tremadog Bay. The species also occurs off the north coast of Wales, particularly north and east of Anglesey (Figure 10.8, Volume 2).

10.4.4.5 The Cardigan Bay SAC is the nearest designated site to the Project that has bottlenose dolphin as a qualifying feature. The bottlenose dolphin population of the Cardigan Bay SAC has been estimated using photo-identification methods. The abundance estimates over the period 2001-2007 indicate that between 121 and 210 bottlenose dolphin have used the Cardigan Bay SAC in any one year, and 379 over the whole period. If an open population model is used, and the entire Cardigan Bay is considered, the estimates in a particular year vary between 154 and 248 (Pesante *et al*. 2008).

10.4.4.6 A population of inshore bottlenose dolphin has also been documented to be wide-ranging but resident to the coast of South West England since the early 1990s (Clark *et al*. 2010). However, the average group size of coastal bottlenose dolphin has declined from approximately 15 animals per sighting in 1991 to approximately six animals per sighting in 2007 (Doyle at al. 2007). Substantial numbers of bottlenose dolphin also inhabit offshore areas of the Celtic Sea which could occasionally visit the inshore waters of South West England and South West Wales.

Distribution and abundance in the Bristol Channel

10.4.4.7 The bottlenose dolphin is occasionally sighted in the inner Bristol Channel although can be considered as an infrequent visitor (Baines and Evans, 2012) (Figure 10.8, Volume 2). For example, during the GMMP offshore surveys only two encounters with bottlenose dolphin were recorded with no other sightings from any of the other recent surveys undertaken in the Bristol Channel and Swansea Bay (Channel Energy Limited, 2012; Pierpoint, 2008a; Watkins and Colley, 2004).

Distribution and abundance in the in Swansea Bay

10.4.4.8 No bottlenose dolphin sightings have been recorded in any of the recent monitoring surveys in Swansea Bay or from the data compiled in the Atlas of the Marine Mammals of Wales (Baines and Evans, 2012). The species is therefore only likely to occur very rarely within Swansea Bay.

10.4.5 Risso's Dolphin (*Grampus griseus)*

Introduction

10.4.5.1 The Risso's dolphin is widely distributed in tropical and temperate seas of both hemispheres, occurring in small numbers along the Atlantic European seaboard from the Northern Isles, South to North West France, the southern Bay of Biscay, around the Iberian Peninsula and east into the Mediterranean Sea. Risso's dolphins generally prefer continental slope regions. However, in North West Europe Risso's dolphin appear to be a continental shelf species (Reid *et al*. 2003). The IAMMWG (2013) suggested a single MU is appropriate for this species comprising all UK waters (Figure 10.3, Volume 2).

Distribution and abundance in the Celtic and Irish Sea

10.4.5.2 The *Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012) showed that, around Wales, Risso's dolphin have a relatively localised distribution, forming a wide band running south west to north east that encompasses West Pembrokeshire, the western end of the Lleyn Peninsula and Anglesey in Wales. The species is also commonly recorded along the south east coast of Ireland and waters around the Isle of Man (Clarke *et al*. 2010; Reid *et al.* 2003) (Figure 10.9 Volume 2).

Distribution and abundance in the Bristol Channel

10.4.5.3 No Risso's dolphin sightings were recorded in the Bristol Channel in data compiled in the *Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012). During the GMMP offshore surveys only one encounter with Risso's dolphin was recorded (Channel Energy Limited, 2012). Sightings of Risso's dolphin have also been occasionally recorded in other surveys in the Bristol Channel (Reid *et al*. 2003). Risso's dolphin can therefore be considered as an infrequent visitor to the Bristol Channel with only sporadic sightings recorded (Baines and Evans, 2012).

Distribution and abundance in Swansea Bay

10.4.5.4 No Risso's dolphin sightings were recorded in any of the recent monitoring surveys in Swansea Bay or from the data compiled in the *Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012). The species is therefore only likely to occur very rarely in Swansea Bay**.**

10.4.6 Minke Whale (*Balaenoptera acutorostrata*)

Introduction

10.4.6.1 Minke whales are the smallest and most abundant of the baleen whales encountered around the UK coast. They appear to favour areas of upwelling or strong tidal currents and are usually seen singly or in pairs, but sometimes aggregate in greater numbers in areas of rich feeding (Reid *et al.* 2003). Within UK waters, minke whales are most frequently sighted in the North Sea and west of Scotland around the Hebrides. The IAMMWG (2013) suggested a single MU is appropriate for this species comprising all UK waters (Figure 10.3, Volume 2).

Distribution and abundance in the Celtic and Irish Sea

10.4.6.2 Minke whales are present in low numbers in the Irish and Celtic Seas (DECC, 2009). An estimated abundance of 2,792 minke whales was recorded in the Celtic Shelf and Irish Sea areas in the SCANS II surveys (SCANS-II, 2008). The distribution of minke whale sighting rates (1990-2009) compiled as part of the *Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012) is summarised in Figure 10.10, Volume 2). This species has a predominantly offshore distribution, with the highest densities of sighting rates over the Celtic Shelf, around the Isle of Man, and east of Co. Dublin. Within the 12 nm territorial limit of Wales, minke whales have been recorded predominantly to the west of Pembrokeshire, although land watches have recorded minke whales in North Wales off Anglesey and Bardsey Island (Baines and Evans, 2012).

Distribution and abundance in the Bristol Channel

10.4.6.3 The *Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012) showed minke whale occurring in low or moderate sighting densities in several parts of the outer Bristol Channel. The baseline surveys undertaken as part of the proposed Atlantic Array Offshore Wind Farm development also found that minke whale sightings were not uncommon during summer in the outer Bristol Channel, with a total of eight sightings (sightings were of single animals only) (Figure 10.5, Volume 2). Surveys carried out by GMMP in the outer Bristol Channel also recorded a total of eight sightings, recorded in groups of up to four whales (Channel Energy Limited, 2012).

Distribution and abundance in Swansea Bay

10.4.6.4 No minke whale sightings were recorded in any of the recent monitoring surveys in Swansea Bay or from the data compiled in the *Atlas of the Marine Mammals of Wales* (Baines and Evans, 2012). The species is therefore only likely to occur very rarely within Swansea Bay.

10.4.7 Grey Seal (*Halichoerus grypus*)

10.4.7.1 The grey seal is the larger of the two seal species found in British waters, with males reaching a length of 2.45m and a weight over 300kg (SCOS, 2013).

10.4.7.2 In Wales, grey seals are widely distributed[1] (Figure 10.11, Volume 2). Grey seals predominantly inhabit remote islands and coastlines in Wales, breeding on undisturbed beaches of cobble and boulders or within sea-caves along the coast. Pupping time occurs primarily from August through to December with September generally being the busiest month.

10.4.7.3 About 38% of the world's population of grey seal is found in Britain with over 88% of the British Grey seals breeding in Scotland (SCOS, 2013). At the start of the 2000 breeding season the UK population was estimated at 124,300 (CCW, 2009). During the 2010 breeding season UK grey seal production was estimated at 50,174 (SCOS, 2011). The most recent survey carried out at the beginning of the 2010 breeding season estimated the total UK population to have been 111,300 and is considered to be the

[1] The map of grey seal sightings (Figure 10.10, Volume 2) should be interpreted with some caution, because the recording of seals during sightings surveys has been erratic with many observers simply not recording seals when their main target species have been cetaceans (Baines and Evans, 2012).

current best estimate available (SCOS, 2011). The IAMMWG identified eleven MUs appropriate for grey seal in UK waters (Figure 10.3, Volume 2) (IAMMWG, 2013):

i. Shetland;

ii. Orkney and North Coast;

iii. Moray Firth;

iv. East Coast;

v. South-west Scotland;

vi. West Scotland;

vii. Western Isles;

viii. North-east England (Scottish border to Flamborough Head);

ix. South-east England (Flamborough Head to Newhaven);

x. West England and Wales (from Newhaven, through the SW Approaches, the Irish Sea to the Scottish border); and

xi. Northern Ireland.

10.4.7.4 Grey seal diet in West Wales was found to be composed mainly of gadoids (mainly whiting and *Trisopterus* species) and flatfish (mainly sole species) along with smaller amounts of herring (Strong, 1996).

Distribution and abundance in the Celtic and Irish Seas

10.4.7.5 Grey seal pup production at sites in South West England and Wales is not regularly monitored, although pup production amongst these sites was estimated at 1,900 in 2012. This represents approximately 4% of total UK pup production in 2010 (50,174) (SCOS, 2013). The largest grey seal breeding population in Wales is located along the West Wales coast. The West Wales population size, as determined by pup production estimates at sites between Carmarthen Bay and Aberystwyth, is approximately 5,000 individuals (Baines *et al*. 1995). Within the West Wales breeding population, the majority of pup production occurs on Ramsey Island, Skomer Island and along the North Pembrokeshire mainland coast, between St David's Head and the Teifi Estuary (Strong *et al*. 2006; Boyle *et al*. 2012). The Pembrokeshire Marine SAC is the nearest designated site to the Project which includes grey seal as a qualifying feature (representing over 2% of annual UK pup production). Grey seal is also a qualifying feature of the Cardigan Bay SAC.

10.4.7.6 In North Wales, grey seal distribution at haul-out sites is almost entirely confined to three areas: Ynys Enlli/Bardsey Island and Penrhyn Llyn/Lleyn Peninsula; the West Hoyle Sandbank at the mouth of the Dee Estuary, adjacent to Hilbre Island; and a cluster of localities on Anglesey. The total population size in North Wales was estimated at between 242 and 307 grey seals (Westcott and Stringell, 2003; Westcott and Stringell, 2004; Stringell *et al*. 2013).

10.4.7.7 Grey seals can undertake large ranging seasonal movements. Recent seal tagging studies have recorded seals making excursions from major haul-out sites in Wales into the Celtic Sea and outer Bristol Channel (Matthiopoulos and Aarts, 2005; Gordon *et al*. 2011; Thompson, 2012). Further details of these studies can be seen in Figure 10.12 and

10.13 (Volume 2). Research using photo identification methods has also found evidence of interchange between seals found at Skomer Island, Pembrokeshire and sites in West Cornwall, a distance of over 170km (Boyle *et al.* 2012). Kiely *et al.* (2000) recorded grey seals travelling freely across the Irish Sea, with animals being recorded at sites on the East and South East coasts of Ireland and in South West Wales. Grey seals tagged in south west Ireland were also recorded undertaking large ranging movements along the west coast of Ireland, some travelling at far as 700 km (Cronin*,* 2011). While grey seals may range widely between haul out sites, tracking has also shown that most foraging probably occurs within 100km of a haul-out site (SCOS, 2013). For example, Cronin *et al* (2013) found that foraging trips of tagged seals were present on average approximately 50 km from haul-out sites in southwest Ireland. McConnell *et al.* (1999) found that most tagged grey seals stayed relatively close to haul-out sites (mean distance of 39.8km travelled on a foraging trip) with an average of 43% of the grey seals time spent within 10km of a haul-out site.

Distribution and abundance in the Bristol Channel

10.4.7.8 Grey seal are regularly observed in the Bristol Channel, although usually in small numbers. During the Atlantic Array Offshore Wind Farm development baseline surveys, grey seal accounted for 7% of all marine mammal sightings (42 sightings). Grey seal sightings were widespread, with no evidence of clustering at any particular location. Higher numbers of seal sightings in May 2009 and 2010 may indicate an increase in the number of animals visiting the region at that time, to forage in the period between their spring moult and the beginning of the breeding season in late summer (Channel Energy Limited, 2012).

10.4.7.9 The main grey seal breeding population in the Bristol Channel is located at Lundy Island (North Devon). Grey seal is a qualifying feature of the Lundy Island SAC. Westcott (2010) estimated that typically 125 grey seals were present at Lundy Island with the number of animals varying little throughout the year. Annual pup production, currently, appears to be 40 – 45 (26-32% of the population), probably varying from year to year according to sea conditions (Westcott, 2010).

10.4.7.10 It is suggested that small numbers of individuals also regularly haul out on the rocks at Worms Head on the Gower Peninsula (between 10-35 seals) some 30km to the west of Swansea Bay (Judith Oakley *pers. comm*).

Distribution and abundance in Swansea Bay

10.4.7.11 Very few, if any sightings are reported of grey seals in or around Swansea Bay (Barnes & Evans, 2012), while this may reflect the relatively restricted survey effort spent observing these sites, it may also indicate the very infrequent visits of seals to this region.

10.4.7.12 Grey seal are occasionally reported at Tutt Head (Mumbles), on the Mumbles foreshore and off Rotherslade Bay. These individuals include adults, pups and juveniles (Judith Oakley *pers. comm*). During the land-based surveys undertaken by the Low Carbon Research Institute at Tutt Head on the Mumbles and at Port Talbot docks, a total of 21 seal sightings were observed (16 from the Tutt Head and five from Port Talbot). Three seals were also observed during vessel surveys and, of these, two were hauled out near Limeslade Bay and a third was seen travelling across Swansea Bay. Twenty three per cent of all seal sightings were observed in September, with 18% in October and 14% in both March and May (Jenkins and Oakley, 2013).

10.4.7.13 In the absence of dedicated survey data of grey seal abundance and distribution in Swansea Bay area, brief interviews were conducted with local sea "users", such as fishermen and commercial skippers, but also coastal wildlife enthusiasts, bird observers and other marine mammal watchers. Most frequent "users" of the area report having seen grey seals within the Bay area sometime within the last 36 months. However, these sightings are not common and typically consist of a single seal sighted, bottling (positioned upright) in the water. No known haul-out sites are reported anywhere within the Bay area, the nearest being the Worm's Head at Gower Peninsula, where a very small number of seals have been sighted, but not on a regular basis. None of the seven people interviewed report having ever seen juvenile seals within the Bay. There were no records found of evidence of grey seal pupping sites anywhere within Swansea Bay, or the wider area studied, within the last ten years. The only reports of pups were from the mid 1990's from the Worm's Head on the Gower peninsula. An adult grey seal was however noted within the Kings Dock during a breeding bird survey on 26 April 2013.

10.4.7.14 The results of these (albeit non quantitative) interviews indicate that the Swansea Bay may be utilised only very occasionally by few individual seals, who probably travel there from haul-out sites in Pembrokeshire or North Devon.

10.4.7.15 The pre-construction baseline monitoring for the Scarweather Sands Offshore Wind Farm recorded a total of nine sightings of grey seal (Pierpoint, 2008a). Appendix 10.1 presents anecdotal reports of grey seal sightings within Swansea resulting from interviews carried out in November 2013 with local users of the Bay which indicated low grey seal usage of the bay. Therefore, based on these observations, incidental sightings and their known distribution within the Bristol Channel, grey seal are assumed to occur relatively frequently in Swansea Bay but usually only in small numbers.

10.4.8 Leatherback Turtle (*Dermochelys coriacea*)

10.4.8.1 The leatherback turtle is the only cheloniid species which undertakes deliberate migration into UK waters. This species exhibits physiological adaptations which allow it to function in temperate waters, and is the only species of marine reptile to be considered a regular member of the UK marine fauna (Marubini, 2010).

10.4.8.2 Foraging migrations in this species are extremely wide-ranging. Leatherback turtle breed in the tropics where females come to nest every two to three years; for the rest of their lives they are mainly pelagic. They feed exclusively on jellyfish and other gelatinous zooplankton throughout their life cycle and northern latitude waters offer a rich foraging habitat. In the North Atlantic, leatherback turtles migrate north from the Caribbean and South America at the onset of summer along the North American coast following the main surface currents; they either continue northward reaching Nova Scotia in large numbers or they utilise the North Atlantic gyre and move north-eastward across the Atlantic reaching the European shelf (including UK waters) (DECC, 2009). Food availability is also understood to be an important influence on distribution. Houghton *et al.* (2006a) linked leatherback sightings to the distribution of jellyfish species such as *Rhizostoma.*

Distribution and abundance in the Celtic and Irish Sea

10.4.8.3 The 'TURTLE' database recorded an average of 33 leatherback turtle records each year (minimum 15, maximum 62) from different locations around the UK between 1998 and 2008 (Marubini, 2010). These sighting and strandings show a non-random spatial distribution with a much higher occurrence in south-west facing aspects with 70% of records in the Western Channel and Celtic Sea and Irish Sea. A seasonal pattern of occurrence is also apparent in the record with a clear peak in relative abundance in the late summer months. For the rest of the year, occurrences are only occasional (Marubini, 2010).

10.4.8.4 The INTERREG IIIA Project surveyed a combined total area of 7700 km^2 between 2003 and 2005 in the Irish Sea (University of Wales Swansea & University College Cork, 2006). The study found that consistent aggregations of *Rhizostoma octopus* extending over tens of square kilometres were identified in distinct coastal ''hotspots'' over the survey period: Carmarthen Bay in South Wales, Tremadoc Bay in North Wales and Rosslare on the southeast coast of Ireland. Examination of retrospective sightings data (>50 yr) suggested that 22.5% of leatherback turtle distribution could be explained by these hotspots, with the inference that these coastal features may be sufficiently consistent in space and time to drive long-term foraging associations.

Distribution and abundance in the Bristol Channel

10.4.8.5 Sightings of leatherback turtles are low throughout the Bristol Channel, with the exception of Carmarthen Bay which is known to be a foraging hotspot for opportunistic leatherback turtles (Houghton *et al.* 2006c; University of Wales Swansea & University College Cork. 2006). Aerial surveys have shown that Carmarthen Bay is an area of high *Rhizostoma octopus* density, with this species appearing to drive the broad–scale distribution of leatherback turtle in the southern Irish Sea. Elevated nutrient supply increasing planktonic productivity in the coastal waters and estuarine systems found in Carmarthen Bay is thought to drive the prey resource for the aggregations of *Rhizostoma* recorded in this area (Houghton *et al.* 2006c; University of Wales Swansea & University College Cork. 2006).

Distribution and abundance in Swansea Bay

10.4.8.6 Very occasional, sporadic sightings of leatherback turtle have been recorded in Swansea Bay (Marubini, 2010). The species is therefore considered to be a rare seasonal visitor to Swansea Bay.

10.4.9 Conclusion

10.4.9.1 A summary of the distribution and relative abundance of each of the marine mammal species and leatherback turtle based on the information reviewed above is provided in Table 10.9. Harbour porpoise can be considered a commonly occurring species in Swansea Bay and the surrounding area. The species is widely distributed throughout this area but have been most regularly encountered near headlands on the Gower Peninsula and Port Talbot Dock, as well as further offshore, such as around the Helwick Bank (Channel Energy Limited, 2012; Pierpoint, 2008a; Watkins and Colley, 2004; Jenkins and Oakley; 2013). Jenkins and Oakley (2013) suggests that locations around Port Talbot Dock and the Mumbles must be considered important habitats for harbour porpoise, as survey and stranding data indicates that these areas are regularly used by mothers and their young as well as being reliable foraging and feeding grounds for this species. However, as noted previously, no supporting data are provided in the study and this would need to be analysed to confirm these findings. While short-beaked common dolphin are sometimes recorded in Swansea Bay, the species has a largely offshore distribution, typically where water depths range from 50-150 metres (Seawatch Foundation, 2007a; Baines and Evans, 2012). Other species of cetacean are rarely recorded in Swansea Bay.

10.4.9.2 Grey seal are regularly recorded in Swansea Bay and along the Gower Peninsula although usually only in small numbers. Records of common (harbour) seal are rare (DECC, 2009; Pierpoint, 2008a).

10.4.9.3 Leatherback turtle are occasionally recorded in Swansea Bay but are more commonly encountered further west in Carmarthen Bay (Houghton *et al.* 2006c; University of Wales Swansea & University College Cork. 2006). The species is therefore considered to be a rare seasonal visitor to Swansea Bay.

Table 10.9 Summary of the distribution and relative abundance of the most common marine mammals and leatherback turtle within the different study areas

Species	Celtic/Irish Sea			Bristol Channel			Swansea Bay		
	Distribution	**Temporal occurrence**	**Density estimate (km^2)[1]**	**Distribution**	**Temporal occurrence**	**Density estimate(km^2)[2]**	**Distribution**	**Temporal occurrence**	**Density estimate (km^2)[3]**
Harbour Porpoise	Widespread distribution with the highest density of sightings off the South West coast of Wales, Anglesey, Lleyn Peninsula and the South coast of Ireland	Resident year round with seasonal shifts in distribution within area.	Celtic Shelf= 0.41 animals/km^2(CV=0.50) Irish Sea = 0.34 animals/km^2(CV=0.35)	Widespread distribution.	Resident year round with seasonal shifts in distribution within area.	0.5 animals /km^2 (CV=0.23)	Widespread distribution with the highest density of sightings offshore as well as around the headlands of the Gower Peninsula. Area of functional importance for mothers with calves (particularly from March to September)	Resident year round	0.84 animals /km^2
Common Dolphin	Widespread distribution with the highest density of sightings around the Celtic Deep and off West Pembrokeshire	Resident year round with seasonal shifts in distribution within area.	Celtic Shelf= 0.56 animals /km^2(CV=0.61) Irish Sea = 0.0081 animals /km^2(CV=0.73)	Widespread distribution with the highest density of sightings in the Outer part of the Bristol Channel.	Resident year round with seasonal shifts in distribution within area.	0.50 /km^2 (CV=0.56)	Infrequent visitor		N/A
Bottlenose Dolphin	Relatively localised inshore distribution with the highest density of sightings in Cardigan Bay, off the North and East of Anglesey and off South-West England	Resident year round	Celtic Shelf= 0.027 animals /km^2(CV=0.49) Irish Sea = 0.0052 animals /km^2(CV=0.75)	Infrequent visitor		N/A	Rare		N/A
Minke Whale	Widespread distribution with the highest density of sightings over the Celtic Shelf, around the Isle of Man and West of Pembrokeshire	Mainly a seasonal visitor in warmer months	Celtic Shelf= 0.0087 animals /km^2(CV=0.43) Irish Sea = 0.023 animals/km^2(CV=0.89)	Widespread distribution	Mainly a seasonal visitor in warmer months	Unknown but is recorded seasonally in low densities	Rare		N/A

Species	Celtic/Irish Sea			Bristol Channel			Swansea Bay		
	Distribution	Temporal occurrence	Density estimate (km^2)[1]	Distribution	Temporal occurrence	Density estimate(km^2)[2]	Distribution	Temporal occurrence	Density estimate (km^2)[3]
Risso Dolphin	Relatively localised distribution with the highest density of sightings off West Pembrokeshire, the Western end of the Lleyn Peninsula and Anglesey	Resident year round	Unknown	Infrequent visitor		N/A	Rare		N/A
Grey Seal	Widespread distribution with the largest breeding colonies recorded in West Wales at sites such as Ramsey Island and Skomer Island	Resident year round	Unknown	Widespread distribution with the largest breeding colony recorded on Lundy Island	Resident year round	Unknown	Frequent visitor expected to occur in low numbers. Small numbers haul out on the Mumbles	Year round visitor	Unknown
Leatherback turtle	Widespread distribution with the highest density of sightings of Carmarthen Bay in South Wales, Tremadoc Bay in North Wales and Rosslare. Ireland	Mainly a seasonal visitor in warmer months	Unknown	Highest density of sightings in area off Carmarthen Bay	Mainly a seasonal visitor in warmer months	Sightings of leatherback turtles are low throughout the Bristol Channel with the exception of Carmarthen Bay which is known to be a foraging hotspot for opportunistic leatherback turtles	Rare		N/A

1. SCANS-II (2008).
2. Channel Energy Limited (2012)
3. Jenkins and Oakley (2013).

10.5 Likely significant effects

10.5.1 Introduction

10.5.1.1 This section considers the potential changes to the baseline conditions which may be brought about by the Project. The marine mammal which occurs most frequently and in the highest abundances within Swansea Bay area is the harbour porpoise. Grey seal are also recorded relatively frequently. Although a number of other species, such as common dolphin, are recorded in the Bristol Channel, these are rarely sighted inshore around Swansea Bay. Given that only leatherback turtles are recorded in Swansea Bay and that these records are rare, turtles are not specifically focused on as part of this assessment. The following assessment has, therefore, focused primarily on harbour porpoise and grey seal. Reference has been made to other species where appropriate.

10.5.1.2 Cetacean monitoring in Swansea Bay has recorded high densities of harbour porpoise in areas around the Gower Peninsula (including the Mumbles) and Port Talbot (Channel Energy Limited, 2012; Pierpoint, 2008a; Watkins and Colley, 2004; Jenkins and Oakley; 2013). Dedicated survey data for the inner part of Swansea Bay which overlaps with the footprint of the Project is limited. However, anecdotal observations of mammals within Swansea Bay recorded en route to dedicated survey areas or transects, as well as casual sightings, indicate that harbour porpoise are regularly recorded within the inner part of Swansea Bay. Therefore, in the absence of dedicated effort based survey data for the inner part of Swansea Bay and using a precautionary approach, the assumption has been made that harbour porpoise occur at similar frequencies to other parts of Swansea Bay such as Port Talbot. Similarly it is assumed that Grey seal occur relatively frequently in Swansea Bay but usually only in small numbers.

10.5.1.3 Throughout the impact assessment all marine mammal species are considered to be of high importance given the high level of protection they are afforded under a range of UK and European Legislation.

10.5.1.4 A number of potential pathways exist by which the proposed Project could affect the behaviour or use of the area by marine mammals or turtles during construction, operation and decommissioning. Individual key impact pathways have been identified and allocated into the short-term ‘Construction Phase’ and ‘Decommissioning Phase’ effects, along with the longer-term ‘Operational Phase effects’. The full list of 13 relevant pathways is as follows:

10.5.1.5 Construction Phase:

- Impact Pathway 1: Collision risk during construction (construction vessels and machinery);
- Impact Pathway 2: Visual disturbance during construction;
- Impact Pathway 3: Noise disturbance during construction;
- Impact Pathway 4: Release of contaminants associated with the dispersion of Suspended sediments during construction; and
- Impact Pathway 5: Changes in suspended sediment concentrations during construction.

10.5.1.6 Operational Phase:

- Impact Pathway 6: Changes to foraging habitat during operation;
- Impact Pathway 7: Collision risk during operation (turbines);
- Impact Pathway 8: Barrier to movement during operation;
- Impact Pathway 9: Noise disturbance during operation; and
- Impact Pathway 10: Electromagnetic fields during operation.

10.5.1.7 Options for decommissioning have been considered and the potential 'Decommissioning Phase' effects are discussed in more detail below in 10.5.12.

10.5.2 Impact Pathway 1: Collision risk during construction (construction vessels and machinery)

General scientific context

10.5.2.1 Seals and cetaceans can potentially collide with vessel propellers and machinery, possibly leading to physical injury (such as propeller wounds) and, in the worst cases, fatalities (ASCOBANS, 2003; Pace *et al.* 2006).

10.5.2.2 Marine mammals have quick reflexes, good sensory capabilities and fast swimming speeds (over 6m/s for harbour porpoise). These species can also be very agile (Carter, 2007; Hoelzel, 2002.). These are all attributes which increase the chance of close range evasion with an object that could cause a collision risk. However, there have been a number of reported incidents of mortality or injury of cetaceans caused by vessels in UK waters, particularly with inquisitive bottlenose dolphins (WDCS, 2009). In addition, several cases of seal injury, thought to be caused by ducted propellers and azimuth thrusters (used for the dynamic positioning of vessels) have also been reported in recent years (Thompson et al. 2010; Bexton *et al*. 2012). Despite this, in general, incidents of mortality or injury of marine mammals caused by vessels remain a very rare occurrence in UK waters (ABP Research 1999; CSIP, 2011). For example, out of 478 post mortem examinations carried out on harbour porpoises in the UK from 2005-2010 only four (0.8%) were attributed to boat collision with the biggest causes of mortality including starvation and by-catch, although some incidents are likely to remain unreported (CSIP, 2011).

10.5.2.3 Reduced perception levels of a collision threat through distraction, whilst undertaking other activities such as foraging and social interactions, are possible reasons why collisions are recorded in marine mammals (Wilson *et al.* 2007). Juvenile grey seal pups, which are inexperienced in the water, are likely to be particularly vulnerable to collision risk. Marine mammals can also be very curious of new foreign objects placed in their environment and so curiosity around an object could also increase the risk of collision. Marine mammals are relatively robust to potential strikes as they have a thick sub-dermal layer of blubber which would defend their vital organs from the worst of any blows (Wilson *et al.* 2007). Nevertheless, a direct collision with a sharp object such as a moving blade still has the potential to cause injury to marine mammals.

10.5.2.4 Although all types of vessels may collide with marine mammals, the most lethal and serious injuries are caused by large ships (e.g. 80 m or longer) and vessels travelling at speeds faster than 14 knots (Laist *et al*. 2001).

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10.5.2.5 Construction of the seawalls and turbine/sluice gate structure will be undertaken from approximately March/April 2015 to August 2017 and will require a number of offshore plant vessels including:

i. Cutter Dredger;

ii. Backhoe Dredger;

iii. Split Barge;

iv. Rock barge;

v. Tug;

vi. Side Stone Dumping Vessel; and

vii. MultiCat.

10.5.2.6 Vessels involved in the construction phase of the Project are either likely to be stationary or travelling at relatively slow speeds (typically around 3-5 knots). Boat speeds could be higher during steaming to the site although maximum speeds of these vessel types are typically less than 14 knots (the speed above which most lethal or serious injury is considered to be caused). However, the construction vessels could be using ducted propellers which have been linked to several cases of seal mortality in recent years (Thompson *et al*. 2010; Bexton *et al*. 2012).

10.5.2.7 Swansea Bay is a busy area for vessel traffic including recreational boats, dredgers and fishing boats. Harbour porpoise and grey seal in the Swansea Bay area are therefore regularly exposed to vessels and will routinely need to avoid collision. Nevertheless, local strandings data suggests that some porpoise mortality has been caused by vessel collision (Jenkins and Oakley, 2013).

10.5.2.8 Based on the information provided above in the scientific review, marine mammals (both adults and juveniles) are considered to have a moderate sensitivity to collision during construction given that vessels will be mainly stationary or travelling at low speeds (avoiding speeds more than 6 knots as advised in the Natural Resources Wales (NRW) Sea Wise Code (NRW, 2013)). In addition JNCC guidance on reducing the risk to marine mammals of corkscrew injuries (linked to vessels that used ducted propellers) will be followed. The probability of a collision occurring is considered to be low as, while collision incidents have been recorded in the UK (including Swansea Bay), they are generally considered to be a rare occurrence. The risk of collision will be restricted mainly to the Project footprint. In addition, construction activities are only short term and temporary. The magnitude of change is therefore assessed as medium, leading to a negligible to low exposure. The importance of the feature is scored as high given that all marine mammals are protected under UK law and European legislation (e.g. Wildlife and Countryside Act, EU Habitats Directive) leading to an **insignificant to minor adverse impact.**

10.5.2.9 Confidence in this assessment is considered to be medium, as scientific understanding of vessel collision impacts is generally good although some uncertainty still surrounds the sensitivity of seals to vessels with ducted propellers.

10.5.3 Impact Pathway 2: Visual disturbance during construction

General scientific context

10.5.3.1 Disturbance caused by an external visual influence can cause marine mammals to stop feeding, resting, travelling and/or socialising, with possible long term effects of repeated disturbance including loss of weight, condition and a reduction in reproductive success (JNCC, 2008).

10.5.3.2 Unlike some other cetacean species, harbour porpoise rarely approach boats, usually actively moving away from vessels (Dunn *et al.* 2012; Seawatch Foundation, 2007b). Porpoise vision is poor in air (the spherical lens makes the eye short-sighted in air and they are not likely to be able to see objects sharply beyond a few metres). Underwater vision is considered good in harbour porpoise. However, given the shy nature of this species, it is more likely that harbour porpoise will respond to noise stimuli and show avoidance response before visual cues can be detected (NERI, 2006). Noise disturbance is discussed in more detail below in Section 10.5.4.

10.5.3.3 Seals which are hauled out on land, either resting or breeding, are considered particularly sensitive to visual disturbance (Hoover-Miller *et al.* 2013). In general, ships more than 1,500m away from grey and common seal haul out areas are unlikely to evoke any reaction. Between 900m and 1,500m, seals could be expected to detect the presence of vessels and at closer than 900m a flight reaction could be expected (Scottish Executive, 2007). However, the level of response is dependent on a range of factors, such as the species at risk, age, weather conditions and the degree of habituation to the disturbance source. Jansen *et al* (2010) found that harbour seals at haul-out sites in Disenchantment Bay, Alaska approached by a ship as close as 100m were 25 times more likely to enter the water than seals 500m from a ship. Seals were also 4 times more prone to enter the water when ships were approaching directly rather than passing abeam. In a study undertaken at one of the major seal reserves in Denmark, harbour seals were alerted by boats at significantly greater distances compared to pedestrians (560–850m and 200–425m, respectively). Similar differences in the flight initiation distances were also observed (510–830m for boats and 165–260m for pedestrians) (Anderson *et al*. 2012). A study focusing on the impacts of tourism on a colony of grey seals on the South Devon coast found that vessels approaching at distances between 5 and 25m resulted in over 64% of seals entering the water, but at distances of between 50m and 100m only 1% entered the water (Curtin *et al.* 2009).

10.5.3.4 The NRW Sea Wise Code (NRW, 2013) recommends that vessels do not approach within 100m of seals and cetaceans to avoid disturbance. Other schemes, such as the *Whale and Dolphin Conservation Shorewatch Code of Conduct,* also recommends a maximum approach distance of 100m.

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10.5.3.5 Construction of the seawalls and turbine/sluice gate structure will be undertaken between approximately March/April 2015 and August 2017 and will require a number of offshore plant vessels including dredger boats, barges and tugs during the different stages of construction (see Section 10.5.2).

10.5.3.6 The Project is several kilometres away from the several minor seal haul out sites located on Mumbles Head and the Gower Peninsula and consequently no visual disturbance of these sites is anticipated. It is suggested that Grey seal have been regularly recorded in areas with frequent vessel movements such as Port Talbot and the Mumbles (including recreational craft and fishing boats, cargo ships and dredging boats) (Jenkins and Oakley (2013). Any Grey seal in the area are therefore expected to be reasonably habituated to visual disturbance.

10.5.3.7 Overall, with regard to visual disturbance during construction, the probability of some disturbance occurring is considered to be high. With regard to magnitude, as noted above, construction activities will only be relatively short-term and temporary. Activities will be located at a distance that will not cause visual disturbance to hauled out seals and some habituation of Grey seal to visual disturbance from vessels is anticipated. Furthermore, harbour porpoise vision is poor in air and underwater it is more likely that harbour porpoise will respond to noise stimuli and show avoidance response before visual cues can be detected given the shy nature of this species (NERI, 2006). To further minimise the potential effect, guidance documents including the NRW Sea Wise Code (NRW, 2013) and the Whale and Dolphin Conservation Shorewatch Code of Conduct, will be adhered to where possible. Based on these considerations the magnitude of impact is assessed as negligible, and thus exposure to change is also assessed as negligible. Based on the evidence presented above in the scientific review, sensitivity to construction disturbance is assessed as low to moderate (with variations depending upon the levels of habituation, vessel speed and the regularity of vessel movements) and vulnerability is consequently assessed as none. The feature importance is scored as high because of the protection afforded to marine mammals. Overall, therefore the visual disturbance during construction will result in an **insignificant impact**.

10.5.3.8 Confidence in this assessment is considered to be medium to high as the impacts from visual disturbance to marine mammals are well understood through a large number of research studies on this subject.

10.5.4 Impact Pathway 3: Noise disturbance during construction

General scientific context

10.5.4.1 During the construction phase of the Project, and especially during piling activity, the potential exists for noise generated to disturb/affect marine mammals. Marine mammals (particularly whales and dolphins) are considered to be the most sensitive to acoustic disturbance of any marine species in the marine environment, due to their use of echolocation and vocal communication (DECC, 2009). To evaluate the potential effects on marine mammals it is necessary to understand the character of noise propagation underwater and the potential response of marine mammal species to that noise. These are described further below.

10.5.4.2 The level of sound at any particular point underwater is a function of several factors including: ground geology; ambient background noise; the proximity to anthropogenic noise sources; the level of sound generated by the source (Source Level, SL); and the attenuation of sound as it propagates away from the source (Transmission Loss, TL). SLs are generally expressed in terms of decibels for a reference pressure of 1µPa and a reference range of 1m (dB re 1µPa-1m). The EU Marine Strategy Framework Directive (MSFD) Technical Subgroup (TSG) on underwater noise and other forms of energy (TSG Noise) has published a report providing guidance on the terminology and metrics which should be used to assess the effects of underwater noise (TSG Noise, 2013). In summary, the report recommends that, for both single and repeated transient sounds (e.g. impulsive sounds from pile-driving activities), zero-to-peak sound pressure (0-p, in Pa) as well as Sound Exposure Level (SEL, in dB re 1µPa^2 s) should be used.

10.5.4.3 The propagation of underwater noise in shallow water environments can be represented by the following logarithmic model: L(r) = SL – N log10 (r). Where L(r) is the sound pressure level at distance r from a source, SL is the Source Level and N is a factor for attenuation due to geometric spreading. An N coefficient of 20 has been assumed, which corresponds to spherical spreading, to take account of the shallow nature of the study area and potential absorption of sound in water and boundaries[2].

10.5.4.4 The impacts of noise on marine mammals can broadly be split into lethal and physical injury, auditory injury and behavioural response. The possibility exists that lethality and physical damage can occur at very high exposure levels, such as those typically close to underwater explosive operations or offshore impact piling operations. A permanent threshold shift (PTS) is permanent hearing damage caused by very intensive noise or by prolonged exposure to noise. A temporary threshold shift (TTS) involves a temporary reduction of hearing capability caused by exposure to noise. An intense short exposure can produce the same scale of TTS as a long-term, repeated exposure to lower sound levels. The significance of the TTS varies among species depending on their dependence on sound as a sensory cue for ecologically relevant functions. Both PTS and TTS are considered to be auditory/physiological injuries. At lower Sound Pressure Levels it is more likely that behavioural responses to underwater sound will be observed. These reactions may include the animals leaving the area for a period of time, or a brief startle reaction. While a range of potential responses is recognised, the received noise levels around which lethality, physical damage or disturbance can occur are not well understood (Parvin *et al*. 2007).

10.5.4.5 Southall et al. (2007) proposed a set of criteria for preventing auditory/physiological injuries to marine mammals. These criteria are based on both peak sound levels and SEL. The SEL criteria can be applied either to a single transient pulse or the cumulative energy from multiple pulses. The study by Southall et al. (2007) recommended a peak noise criterion of 230dB re.1µPa for cetaceans (whales, porpoises and dolphins) and 218dB re.1µPa for pinnipeds (seals), to prevent physiological auditory injury and the onset of PTS. This corresponds to a Sound Exposure Level of 198dB re.1µPa2s M-Weighted for whales and dolphins and 186dB re.1µPa2s M-Weighted for pinnipeds. Behavioural response criteria and the onset of TTS are defined at a peak noise criterion of 224dB re.1µPa for cetaceans and 212dB re.1µPa for seals; and a corresponding

[2] Measurements undertaken in the field at various shallow water locations indicate that the N coefficient can range from 20 to 25 and therefore we have assumed an N coefficient of 20 as a conservative parameter of the propagation of noise in these environments. This is considered representative for Swansea Bay.

Sound Exposure Level of 183dB re.1µPa2s M-Weighted for cetaceans and 171dB re.1µPa2s M-Weighted for pinnipeds.

10.5.4.6 Another way to evaluate the responses of marine mammals and the likelihood of behavioural responses is by comparing the received sound level against species specific hearing threshold levels[3]. The hearing sensitivity and frequency range of marine mammals varies between different species and is dependent on their physiology. For example, odontocete cetaceans (toothed whales, porpoises and dolphins) are particularly sensitive to high frequencies. Impact piling is predominantly a low frequency noise, typically ranging from around 200Hz to 1kHz. By plotting both the levels of noise associated with impact piling and species specific threshold levels from published audiograms against frequency, it is possible to identify the frequencies at which the greatest difference between noise levels and species specific thresholds occur.

10.5.4.7 Nedwell and Edwards (2004) developed a generic dB scale to enable better estimates of the effects of sound on marine species. Although this approach is not internationally recognised and has not been validated by experimental study, it has been recommended by other UK government agencies, particularly in relation to fish, and is the only method available that provides an indication of the behavioural reaction of marine mammals to underwater noise**.**

10.5.4.8 In their dB_{ht} (Species) scale, a frequency dependent filter is used to weight the sound. The suffix 'ht' relates to the fact that the sound is weighted by the hearing threshold of the species. The effects of sound that may prospectively be addressed by the dB_{ht} metric include behavioural effects such as an avoidance reaction, the limit of tolerance, the onset of hearing damage presenting as a temporary threshold shift, and traumatic hearing loss. A set of criteria based on the use of the dB_{ht} (Species) was proposed by Nedwell *et al*. (2007) that allow the likelihood of behavioural effects and damage to hearing to be assessed for a wide range of species. These criteria are shown in Table 10.10. Although these threshold ranges provide a useful summary, it is important to note that the relationship between noise and effect is a continuous sliding scale.

Table 10.10 Criteria for the effects of underwater noise on marine mammals and fish

Level in dB_{ht} (species)	Effect
Less than 50	Mild reaction by minority of individuals
50 to 75	Mild reaction by majority of individuals
75 to 90	Stronger reaction by majority of individuals
90 to 130	Strong avoidance reaction by all individuals and increasing risk of physiological injury
Above 130	Possibility of traumatic hearing damage from single event
Above 140	Risk of lethal injury

[3] The minimum level of sound at which a species can detect noise.

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10.5.4.9 For the Project, piling activities will generate the greatest levels of underwater noise. For the construction of the turbine/sluice gate structure a temporary cofferdam will need to be constructed such that the turbine/sluice gate structure can be built in the dry. Approximately 5000 sheet piles are estimated to be required for the temporary twin wall sheet pile cofferdam. These are anticipated to be in region of 24m long, 700mm wide and driven in pairs. Sheet piling will also be used for the base of the perimeter of the turbine and sluice gate structures. The formation of the offshore cofferdam is anticipated to take up to six months. In order to make the most of good weather and sea conditions construction will be 24/7 so far as possible.

10.5.4.10 The ground investigation results (Chapter 6) suggest that the most appropriate piling method would be vibratory, but there may be times when harder material is encountered and in these circumstances percussive methods may need to be adopted. Percussive piling (which is also referred to as impact/hammer piling), will generate the highest noise Source Levels (SLs) and, therefore, the assessment has focussed on the potential noise effects of this type of approach in the first instance.

10.5.4.11 Based on these requirements, an underwater noise assessment of the construction components of the Project was carried out to assess the impacts on grey seal and harbour porpoise. The mean unweighted peak SL spectra from percussive and vibro piling measurements of 600mm sheet piles, which is the approximate width of the sheet piles proposed, was derived from a review undertaken by The California Department of Transport (Illinworth and Rodkin, 2007). The derived zero-to-peak sound pressure of the percussive piling of these sheet piles is 10,000 Pa and SEL is 174 dB re 1µPa^2 s.

10.5.4.12 In order to predict the potential distances at which a significant behavioural response will occur, the peak SLs derived from Illinworth and Rodkin (2007) were plotted with species specific hearing threshold levels from published audiogram data available in Nedwell *et al*. (2004) against frequency on the x-axis and the levels at which the greatest differences between the two threshold levels occur were determined (see Paragraph 10.5.4.6). These levels were then applied as input values to the logarithmic underwater sound propagation model (see Paragraph 10.5.4.3). In the case of grey seal, for example, the greatest difference occurred at 2kHz, corresponding to a percussive piling SL of 202dB re 1µm -1m, (a vibro-piling SL of 177dB re 1µm -1m) and a hearing threshold level of 84dB re 1µm.

10.5.4.13 By comparing the received sound levels derived from the logarithmic noise propagation model with the criteria proposed by Southall *et al*. (2007), neither PTS nor TTS will occur in harbour porpoise, even at the source of percussive piling noise (or vibro-piling noise). In grey seal, no physiological effects will occur even at the source of percussive piling noise (or vibro-piling noise) and TTS will only occur within a couple of metres of percussive piling noise (but not vibro-piling).

10.5.4.14 In terms of the dB_{ht} (Species) scale, the model predicts that harbour porpoise will exhibit a strong behavioural response at $90dB_{ht}$ within a maximum range of around 445m from the source of percussive piling, and within around 22m if a vibratory hammer is used. Any grey seal that may be passing or feeding in the area during the piling works is predicted to show a strong behavioural response at $90dBht_{ht}$ within a maximum of around 25m from the source during percussive piling and within a couple of metres from the source during vibro-piling.

10.5.4.15 The effects of piling noise on marine mammals also needs to be considered in relation to the duration of exposure. It is proposed that the piling work will take six months to complete, working up to 24 hours each day (somewhere in the region of 25-50% of working time would involve piling). In this way, the actual proportion of percussive piling is estimated to be at worst 50% over any given construction week. In other words, any marine mammals in Swansea Bay at the time of piling will be exposed, at worst, 50% of the time.

10.5.4.16 It is also important to consider that the area in which the construction will take place already experiences shipping, as well as maintenance dredging and, therefore, marine mammals are likely to be habituated to a certain level of anthropogenic background noise.

10.5.4.17 Applying the standard impact assessment criteria, the sensitivity of harbour porpoise and grey seal is considered to be moderate to underwater noise generally. The probability of occurrence is high as is the importance of harbour porpoise and grey seal, given their level of protection. Given that any effects during vibro-piling, which is the preferred construction method, are limited to behavioural responses within close proximity to the construction site (<22m), the magnitude of the effects is considered to be small. With respect to percussive piling which will be used during construction on an 'as required basis only' (see above), although no significant physiological effects (PTS or TTS) are predicted to occur, a strong behavioural response will occur over a relatively small area in the context of the 10380ha of subtidal habitat comprising Swansea Bay[4] (approximately 0.4% and 0.001% for harbour porpoise and grey seal respectively) and therefore the magnitude of the effects is considered at worst to be medium. The overall exposure and vulnerability of marine mammals to adverse noise during vibro-piling and percussive piling are therefore considered to be low and moderate respectively. Overall, therefore, the temporary noise during construction has been assessed as having a **minor adverse impact** during vibro-piling and a **moderate adverse impact** during percussive piling.

10.5.4.18 In order to reduce the significance of the impact during percussive piling, several mitigation measures are proposed which are discussed in greater detail in Section 10.7. These include following JNCC "Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals during piling" (JNCC, 2010) and also using soft-start procedures for percussive piling. With these measures in place, residual impacts on marine mammals from construction noise are assessed as being of **minor adverse significance**.

10.5.4.19 Confidence in this assessment is considered to be medium, given that the underwater noise model is based on theoretical parameters and there is limited empirical evidence of the behavioural effects of noise on marine mammals.

[4] The subtidal and intertidal habitat extents within the Bay are taken as those within the Swansea Bay coastal water body as identified by the River Basin Management Plan (EA, 2009)

10.5.5 Impact Pathway 4: Release of contaminants associated with the dispersion of suspended sediments during construction

General scientific context

10.5.5.1 Marine mammals are exposed to a variety of anthropogenic contaminants, through the consumption of prey. As top predators, they are particularly at risk from contaminants which biomagnify through the food chain (i.e. those found at increasing concentrations at higher trophic levels). Most research has focused on the persistent organic pollutants (POPs) such as polyaromatic hydrocarbons (PAHs), heavy metals, butyl tins and perfluorinated chemicals (Gunderson *et al.* 2013; DECC, 2009; Tanabe, 1999). Although high levels of potentially damaging pollutants have frequently been detected in marine mammals, particularly seals and cetaceans inhabiting nearshore environments, direct causal links with health status and population changes have rarely been demonstrated.

10.5.5.2 POP's accumulate in fatty tissues and are often found in high concentrations in marine mammal blubber. They are persistent and commonly resistant to metabolic degradation. They may affect the reproductive, immune and hormonal systems which can eventually lead to mortality (Weijs *et al.* 2009). For example, Jepson *et al* (2009) suggested a possible link between high levels of PCB (polychlorinated biphenyls) recorded in the blubber of stranded dead bottlenose dolphins in the UK with the decline in bottlenose dolphins observed in this region between 1960s and 1990s. A strong association has also been found between poor health status (mortality due to infectious disease) and PCB chemical contamination for a large sample of UK-stranded harbour porpoises collected since 1990 (Jepson *et al*. 2009). Grey seals during the 1970s had lesions of the reproductive system attributed to high PCB and DDT levels in their tissues. By the late 1980s and through the 1990s, as levels in those pollutants declined, the proportion of individuals with lesions declined substantially, along with an increase in their pregnancy rate. In an experimental study where harbour seal females were fed fish from the heavily polluted Dutch Wadden Sea, seals had poorer reproductive success than those fed less contaminated fish from the North Atlantic (Evans, 2002).

10.5.5.3 Cadmium, lead, zinc and mercury are the heavy metals of greatest concern to marine mammals. They are frequently present in the highest concentrations in the liver, kidney and bone, with levels varying considerably with the geographic location of the species (Das *et al.* 2002). Marine mammals are able to produce certain proteins (metallothioneins) which can sequester certain metal ions into less toxic complexes; this enables many species to cope with relatively high dietary exposures to certain metals. Whilst there are few studies that show major impacts of heavy metals, it is possible that they may have combined effects as they often co-occur with persistent organic contaminants (DECC, 2009; Das *et al.* 2002).

Project impact assessment

10.5.5.4 During the construction phase of the Project, the potential exists for contamination to be released into the water column. This could occur in one or more of the following ways:

i. The release of contaminated sediments during dredging and disposal activities; and

ii. The release of contaminant within sediment that is present in-situ in areas where works will be carried out.

10.5.5.5 The impacts from these pathways are reviewed within Chapter 6 (Coastal Processes, Sediment Transport and Contamination). The conclusion from this work is that the risk of contamination through these proposed works to other areas of Swansea Bay (or the Bristol Channel) is insignificant. This is based, in summary, on the following considerations:

I. The low levels of contamination observed in samples taken in the area which were within acceptable levels of disposal as determined by CEFAS;
II. The use of geotubes® which are designed to contain the sediment for use in the seawall; and
III. The fact that any releases would become rapidly well mixed/diluted once entering the water column.

10.5.5.6 In view of these considerations, the overall probability of contamination occurring is therefore considered to be <u>low</u> while the magnitude of any change, should it occur, would vary from <u>negligible</u> to <u>small</u> depending upon the scale of the pollution event that occurs. This translates to an overall exposure level that is negligible. The sensitivity of marine mammals to contaminants is assessed as <u>low</u> to <u>moderate</u> because while contaminants can cause toxicity in marine mammals, the concentrations required to produce both lethal and sub-lethal effects are generally high (typically through chronic exposure to prey species in which contaminants have bioacummulated). Vulnerability is therefore assessed as <u>none</u> at worst. Therefore, while marine mammals are of <u>high</u> importance, the overall significance of the impact on marine mammals is assessed as **insignificant**.

10.5.5.7 Confidence in this assessment is considered to be medium to high as scientific understanding of the subject is considered to be good and the methodology used for the baseline contamination survey robust.

10.5.6 Impact Pathway 5: Changes in suspended sediment concentrations during construction

General scientific context

10.5.6.1 Increased turbidity could affect foraging, social and predator/prey interactions of marine mammals. However, marine mammals are known to have acute hearing capabilities which allow them to function as predators in low visibility, turbid conditions. Seals only use passive listening while odontocetes (toothed whales) are known to use both passive and active listening when navigating and foraging (echolocation). For example, harbour porpoise produce short ultrasonic clicks (130 kHz peak frequency, 50-100 µs duration (Teilmann *et al.* 2002) and are able to orientate and find prey even in complete darkness. Porpoises tagged with acoustic data loggers indicate that they use their echolocation almost continuously (Akamatsu *et al.* 2006; Akamatsu *et al.* 2005).

10.5.6.2 Marine mammals have well developed underwater vision which allows them to operate in low light levels (Scottish Executive, 2007). Seals hunting in poor visibility waters also use fish-generated water movements for locating prey, which they can detect using their highly sensitive mystacial vibrissae (Hanke and Dehnhardt, 2013**;** Schulte-Pelkum *et al.* 2007).

10.5.6.3 Marine mammals are therefore considered to be well adapted to living in areas with a high suspended sediment load and are regularly recorded in such environments in the UK e.g. estuaries and tidal steams.

Project impact assessment

10.5.6.4 During dredging operations and placement of the Geotubes® there will be localised and temporary increases in suspended sediment concentration (SSC) as described in Chapter 6 (Coastal Process, Sediment Transport and Contamination). The modelling results predict that these temporary elevations in SSC will dissipate to background concentrations within a spring-neap tidal cycle on cessation of the works. Changes outside Swansea Bay are unlikely to be distinguished from the natural variability. Therefore, in physical terms, the plumes resulting from any dredging are expected to have a minimal and local effect on SSC in the vicinity of the Project. SSC during dredge disposal is predicted to be within the level of variability found during existing disposal operations at the disposal ground. The magnitude of the dredging and disposal activities is considered to be medium, with the probability of occurrence as high. The exposure to change is therefore considered to be medium. Because of the naturally high suspended sediment loads in Swansea Bay and the physiological traits of the receptors highlighted above, marine mammals living in Swansea Bay are considered to be well adapted to turbid conditions and therefore not sensitive to the scale of changes in SSC predicted during construction. It is also considered that marine mammals can avoid these areas and return after the plume has settled. Therefore, even though marine mammals are of high importance, the overall significance is assessed as **insignificant**.

10.5.6.5 Confidence in this assessment is considered medium as, while numerical modelling uses conservative assumptions, there is always a degree of uncertainty associated with modelling approaches. However, scientific understanding of the tolerance of marine mammal to suspended sediments is good.

10.5.7 Impact Pathway 6: Changes to foraging habitat during operation

General scientific context

10.5.7.1 Large infrastructure and coastal development projects can result in the direct loss of foraging habitat for marine mammals through land reclamation and barrier effects (Jefferson *et al*. 2009). Changes in the quality of foraging habitat through degradation and indirect changes to prey resource can also impact on marine mammals.

10.5.7.2 Foraging areas are considered a critical habitat for marine mammals; with a critical habitat understood to be ‘a place or area regularly used by a cetacean group, population or species to perform tasks essential for survival and equilibrium maintenance’ (WDCS, 2010). While marine mammals typically utilise very large ranges they can often be aggregated in patches where prey resources are found in the highest densities (Anderwald *et al*. 2012; Hazen *et al* 2009; Mikkelsen *et al.* 2013). For example, strong tidal currents and the steep walls of the trench are suggested to concentrate prey in an area of Ramsey Sound, Pembrokeshire, which are then funnelled towards waiting harbour porpoises (Pierpoint, 2008b). Minke whale distribution around the Isle of Mull was found to be distributed seasonally in localised areas of prey habitat (sandeel and herring) (Macleod *et al*. 2004).

10.5.7.3 Marine mammals can therefore be particularity susceptible to changes or loss of habitat in key foraging areas. For example, in August 1988, southern Hervey Bay contained an estimated 1753 dugongs which feed on the seagrass beds within the bay. Following two floods and a cyclone in early 1992, more than 1000 km^2 of seagrass was lost from the area. Approximately eight months later, southern Hervey Bay contained only 71 dugongs with full recovery expected to take more than 25 years (Preen and March, 1995). Another study undertaken by Capps and Mann (2005) found evidence that foraging bottlenose dolphin decreased their use of an area in Shark Bay, Western Australia after several oyster farms were installed.

10.5.7.4 Marine mammals can also be attracted to coastal developments through beneficial changes to habitat and prey resource. Scheidat *et al* (2011) investigated whether harbour porpoise occurrence has been affected by the presence of a Dutch offshore wind farm. Acoustic activity associated with porpoises was found to be significantly higher inside the wind farm than in the reference areas, indicating that the occurrence of porpoises in this area increased as well. The reasons for this apparent preference for the wind farm area was not clear with increased food availability inside the wind farm (reef effect) considered a possible cause (Marine Scotland, 2007). Marine mammals (particularly pinniped species) have also been observed aggregating around aquaculture facilities. This is because the high density of fish stocked inside the salmon pens constitutes a strong attraction for these predators. Examples of interactions between pinniped and salmon farms have been recorded in Norway, Scotland, Canada, Australia, the United States, New Zealand, and Chile (Vilata *et al.* 2010). Increased bottlenose dolphin encounters in the Gulf of Aranci have also coincided with the presence of a marine fin fish farm (Díaz López *et al.* 2005). Evidence from the Tees indicates that grey seals may preferentially feed downstream of the Tees Barrage on migratory salmonids, although in this instance the structure is relatively close to an existing haul-out site (Woods, 2011).

Project impact assessment

10.5.7.5 The lagoon will cover a total intertidal and subtidal area of approximately 11.5km^2. As discussed in Section 10.5.9, transient movement of marine mammals into the lagoon through the sluice gates is possible but considered likely to be a rare occurrence. If a marine mammal does pass into the lagoon it could become trapped and might need to be released. The assumption has therefore been made that the lagoon constitutes an area of potential displacement (and consequently habitat loss) for marine mammals. However, Jenkins and Oakley (2013) observed that harbour porpoise typically forage between the 10m and 20m depth contours off Mumbles, reducing to 5-10m at Port Talbot. Much of the lagoon is within the intertidal zone or shallow infralittoral zone. Marine habitat within the lagoon deeper than 5m (below Chart Datum) covers approximately 2.4 km^2 (which represents 21% of the total lagoon area). This is a very small area in the context of the wider Bristol Channel or Celtic and Irish Seas MMU (<0.1% and <0.001 respectively).

10.5.7.6 The lagoon will cause a direct loss of habitat (<u>high</u> probability of occurrence). Both harbour porpoise and grey seal have been recorded foraging in the general area of the lagoon, with seals regularly being observed at the Tawe Barrage fish ladder. However, there is no evidence to suggest that populations of harbour porpoise and grey seal in Swansea Bay are discrete or isolated from the wider Irish and Celtic Sea populations and both are wide ranging species (Evans and Prior, 2012; Gordon *et al*. 2011; Thompson, 2012; IAMMWG, 2013). In addition, there is no evidence to suggest any of the marine species present are reliant on a particular habitat or prey species within Swansea Bay. Given the high mobility and large foraging range of these species, loss of habitat because of the lagoon is likely to only constitute a very small fraction of the total area used by these species for foraging. Magnitude of change is therefore assessed as small leading to a low exposure to change. Marine mammals are considered to have a moderate sensitivity to changes in foraging habitat. This is based on the information provided in the scientific review (Section 10.5.7.1 to 10.5.7.4) which suggests that local distribution is often strongly related to prey habitat and mammals can therefore be particularly susceptible to changes or loss of key foraging habitat. The importance of the feature is scored as high because of the protection afforded to marine mammals. Therefore, the direct loss of foraging habitat is considered to result in a **minor adverse impact.**

10.5.7.7 The results from Chapter 9 (Fish, commercial and recreational fisheries), suggest that school bass will take advantage of the flow in and out of the tidal Lagoon to feed upon small pelagic fish such as sprat and herring; these smaller fish may in turn be feeding upon planktonic invertebrates arriving with the flow.

10.5.7.8 Based on the information provided above, the probability that the Project will cause some indirect changes to foraging habitat during operation (through changes in prey resource) is considered to be medium. It is possible that some grey seals and harbour porpoise could aggregate near the Project area to feed on the potentially higher concentrations of prey items. However, certain prey of these species such as flatfish (which are not piscivores, typically feeding on benthic invertebrates) are unlikely to increase in abundance in the area. Magnitude of change is therefore assessed as small leading to low exposure to change.

10.5.7.9 Marine mammals are considered have a moderate sensitivity to changes in foraging habitat. This is based on the information provided in the scientific review which suggested that local distribution is often strongly related to prey habitat and mammals can therefore be particularly susceptible to changes or loss of key foraging habitat. The importance of the feature is scored as high because of the protection afforded to marine mammals. Therefore, the indirect change to foraging habitat during operation is considered to result in an **insignificant** to **minor beneficial impact.** The impact of collision risk associated with any marine mammals that may be near the turbines is assessed in Section 10.5.8.

10.5.7.10 Confidence in this assessment is considered to be low as while the general effects of habitat loss on marine mammals are well understood and detailed monitoring data exists for some parts of Swansea Bay, survey data for the footprint area is more limited.

10.5.8 Impact Pathway 7: Collision risk during operation (with turbines)

General scientific context

10.5.8.1 Behavioural responses of marine mammals to perceived threats can be broadly categorised in two ways: avoidance and evasion. Hence, with respect to the presence of the hydro turbines, marine mammals may demonstrate two types of response: long range avoidance (i.e. avoiding the area within the vicinity of the turbine/sluice gate structure) or close range evasion (i.e. during a close encounter with a turbine blade), depending upon the distance at which the device is perceived and the subsequent behavioural response. Collision risk can be seen as a function of the extent of exposure, avoidance response (both long range avoidance and close range evasion) and the potential physiological damage caused by a hydro turbine. Further information on the general sensitivity of marine mammals to collision is presented in Section 10.5.2.

10.5.8.2 Inevitably, uncertainty currently exists with respect to the behaviour of marine mammals around hydro turbines during operation, given the relatively small number of tidal power projects which are in operation globally (Thompson et al. 2013) - indeed, there are no tidal lagoon generating stations currently in operation. Specifically, collision monitoring of marine mammals with bulb turbines (as used in barrages or lagoons) is very limited. The review has therefore been primarily based on research on open bladed tidal stream turbines to provide a general overview of current collision monitoring techniques. Since these types of turbines are not encased and are not grouped in a housing, like the bulb turbines proposed here, collision monitoring is harder to perform. As such, monitoring techniques for the Project are likely to be more straightforward. In terms of the unmitigated (i.e. without deterrent) effect, the enclosed nature of the bulb turbine means that there are fewer opportunities for entrained individuals to escape. Therefore, whilst outcomes for affected individuals are likely to be more severe, the certainty as to the prediction can be assessed with a relatively greater degree of certainty.

10.5.8.3 The most comprehensive field based monitoring of marine mammals with turbines currently available is from the SeaGen tidal turbine device located in the Narrows of Strangford Lough, Northern Ireland from 2005 to 2010 (Royal Haskoning, 2011). This work has concluded that no major impacts on marine mammals had occurred across the 3 years of post-installation monitoring. No long-term changes in abundance of either seals or porpoises were attributed to the presence or operation of the device. However, small scale changes in the behaviour and distribution of seals and harbour porpoises were observed during operation. Seals generally transited at a relatively higher rate during periods of slack water, indicating avoidance. The report suggested that this avoidance reduces the risk of any direct interactions with the moving rotors and that both seals and porpoises have the capacity to adjust their distributions at local scales in response to a potential hazard. Monitoring of harbour porpoise has also been undertaken around the NSPI (OpenHydro) tidal turbine device deployed in the Minas Passage, Bay of Fundy (Nova Scotia) from August to November 2010. The monitoring used passive acoustic techniques and found that harbour porpoise were detected regularly through late summer and autumn, but did not appear to spend significant time periods around either the turbine or the control site (suggesting transit through Minas Passage or local foraging in areas out of detectable range). The study found no statistical evidence of the presence of the turbine attracting or repulsing porpoises, but when porpoises were present, behaviour appeared to differ between the two sites (Tollit *et al.* 2011).

10.5.8.4 In order to help assess the extent to which a device might pose a collision risk to marine mammals a number of theoretical models have been created. For example, Marine Scotland (2011) developed a model to assess the risk presented by a proposed development in the Sound of Islay on common seal. The aim of the model was to estimate the number of animals colliding with the tidal turbine over a period of a year. The collision model factored in the size, foraging behaviour and also estimated number of dives made by seals in the survey area. The results showed that less than one common seal was expected to collide within the array of turbines at the site within a year. Using a similar approach ABPmer (2010) undertook collision risk modelling for a single prototype device in Ramsey Sound, Pembrokeshire. The research found that in the absence of any avoidance or evasion reaction, less than 1% of the grey seal population would be exposed to a collision risk that might result in serious injury. In addition, grey seal were expected to exhibit strong avoidance and evasion reactions such that the overall number of collisions resulting in significant injury would be expected to be very low. While predictive models provide a useful tool to try and quantify the level of risk prior to installation of a device, the models are based on a large number of assumptions and unknowns that need to be verified through project monitoring.

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10.5.8.5 In total, up to 16 bulb turbines each with a diameter of 7m and rotational speed of up to 67rpm are proposed as part of the Project. The turbines will be operational both during the day and at night.

10.5.8.6 Seals (particularly juveniles) are inquisitive and have been regularly observed finding their way into enclosed anthropogenic structures such as power station cooling water intake chambers as well as through sluices, locks and weirs[5] (EDF, 2012; Tethys, 2013a). Although harbour porpoise can be shy and often avoid being in close proximity to anthropogenic structures, they have been recorded passing through sluice gates and other similar structures (Jansen et al. 2013). Harbour porpoise and grey seal are fast swimmers with maximum recorded swimming speeds of 4.3 to 6.2 m/s for harbour porpoise and up to 3 m/s for grey seal (Thompson & Fedak, 1993; Gallon et al. 2007; Leatherwood et al. 1988; Culik et al. 2001; Otani et al. 2001). Swim speeds of harbour porpoise with calves are likely to be less than 4.3m/s and assessments for other developments have typically used a lower worst case speed of 1.5m/s (NRW, pers. comm). Peak flood flow rates outside the lagoon of approximately 1.5m/s have been predicted within a few metres of the turbines with lower rates recorded at greater distances away. Close range evasion is therefore considered possible for these species (as they could turn around and swim against the flows). The maximum tip speed of one of the Project turbine blades is approximately 25 m/s. There would therefore be no chance of evasion if a marine mammal entered the turbine and, as such, this would likely result in serious injury or fatality. This is compounded by the small spacing between the turbine blades and also the housing and the turbine blades.

10.5.8.7 Overall, the probability of a collision occurring is considered to be <u>low</u> as, while harbour porpoise and grey seals are recorded in Swansea Bay, and some individuals (particularly juvenile grey seal pups) could aggregate near the turbines due to minor changes in prey resource (Section 10.5.7), close range evasion of both species is considered possible. The risk of collision will be restricted to a relatively small area (i.e. the turbines) but will be present during the entire operational phase. The magnitude of change is therefore assessed to be <u>medium</u>, leading to a <u>low</u> exposure. Sensitivity of mammals to a collision with a turbine is considered to be <u>high</u>, given that any interaction with a turbine blade is expected to result in death or serious injury. Consequently, vulnerability is scored as

[5] http://www.worcesternews.co.uk/news/10056593.Seal_spotted_in_the_river_Severn; http://www.scotsman.com/news/scotland/top-stories/rescue-bid-for-trapped-seals-at-at-cockenzie-power-station-1-2704529

moderate. The importance of the feature is scored as high (all marine mammals are protected under UK law and European legislation e.g. Wildlife and Countryside Act, EU Habitats Directive) leading to a **moderate adverse impact** without mitigation.

10.5.8.8 An appropriate package of adaptive mitigation and monitoring measures to reduce significance levels is being developed as described in Chapter 23. These measures will be discussed and agreed with NRW as part of the European Protected Species (EPS) licensing conditions. Measures which could be applied are discussed in greater detail in Section 10.7. In addition, the acoustic deterrents that are being proposed to be used to mitigate the risk of collision for fish (see Section 10.5.10) will provide early acoustic warning for marine mammals and lead to minor behavioural avoidance reactions. With appropriate measures in place, residual collision impacts on marine mammals are assessed as **insignificant to minor adverse significant**.

10.5.8.9 Confidence in this assessment is considered to be low as, while confidence in the likelihood that mortality or serious injury will occur as a result of turbine interaction is considered to be high, understanding of the extent of potential behavioural avoidance around hydro turbines is limited due to a lack of empirical data.

10.5.9 Impact Pathway 8: Barrier to movement during operation

General scientific context

10.5.9.1 The potential for a structure to act as a barrier to movement will be dependent on the spatial confines and size of the development, e.g. whether it spans the entire mouth of an estuary or bay. Marine mammals can be particularly vulnerable to any structure which could act as a barrier, thereby preventing movement to key foraging or nursery grounds. For example, evidence suggests that the Three Gorges Dam in China stopped the baiji river dolphin from returning to its breeding ground in the upper Yangtze river (Flynn, 2012).

10.5.9.2 Barriers can also be caused through noise and visual stimuli deterring marine mammals even if access is not physically blocked by a structure. For example, Morton *et al*. (2002) found that high-amplitude, acoustic harassment devices used to deter predation on fish pens by harbour seals displaced killer whales from around the Broughton Archipelago in Canada (which formed part of the core range of orca in this area). Once acoustic harassment ended, whale occurrence re-established to baseline levels.

10.5.9.3 Cetaceans and marine turtles are highly mobile, pelagic species which can undergo large seasonal movements and migrations to undertake foraging and breeding (Witt *et al*. 2007b; Reid *et al* 2003; Learmonth *et al*. 2006). However, while many cetaceans have large ranges, localised discrete populations have been identified in many coastal species (Matkin *et al*. 2013; Robinson *et al*. 2012). Habitat and resource specialisation have been suggested as key factors in determining local differentiation among populations which can lead to parapatric or socially segregated communities to develop (Beck *et al*. 2012). Population sub-divisions can occur in species indicative of geographically-isolated or demographically-independent communities (Mirimin *et al.* 2011). For example, the Shannon Estuary bottlenose dolphin population appears to be genetically isolated from populations in adjacent coastal areas (Mirimin *et al.* 2011). Research has also indicated a level of population genetic structure among the resident populations of dolphins from East Scotland and West Scotland, and those in adjacent waters in Wales and Ireland. However, there appears to be insufficient genetic divergence to suggest that these are demographically isolated populations. At the same time, the analyses indicated that animals from these four areas do not form a single randomly mating population (Thompson *et al*. 2011). Discrete or endangered populations will therefore be particularly sensitive to barriers that cause further fragmentation of a population. Development of hydroelectric power and irrigation in both India and Pakistan has prevented dolphin migration and has led to the segregation of both the Indus River dolphin and Ganges river dolphin populations (Sinha, 2011; Reeves *et al.* 1991). The total population of Indus Dolphins, numbering perhaps 500 individuals, is subdivided by barrages and dams into five or six subpopulations. At least two of these are so small (fewer than 20 animals) (Reeves *et al.* 1991). This fragmentation of the metapopulation has reduced the dolphin gene pool, leading to a loss of genetic diversity (Sinha, 2011).

10.5.9.4 Some developments can act as partial barriers to movement in which marine mammals swim through a structure in one direction but mechanisms, water flow or disorientation prevent them from easily moving back across the barrier which can lead to an animal becoming trapped. A storm surge barrier with sluice gates was built between 1979 and 1986 at the entrance to the Eastern Scheldt to safeguard the tidal ecosystem while reducing the risk of flooding (Jansen *et al.* 2013). Since the building of a storm surge barrier, movement of harbour porpoise in and out of the Eastern Scheldt tidal bay (SW-Netherlands) has been limited. Anecdotal data shows that porpoises used to be common visitors in the Eastern Scheldt. However, for a few decades after the building of the storm surge barrier, no porpoises were observed in the area. Over the last ten years, small numbers of porpoises have been observed again in the Eastern Scheldt. Jansen *et al* (2013) analysed stranding data and used stable carbon (δ13C) analysis to get insight into the habitat use and residency of porpoises in the Eastern Scheldt. The study concluded that the barrier might act as an ecological trap for porpoises entering it (Jansen *et al*. 2013). Similarly, the body of an immature Humpback whale was discovered near the head of tide, upstream from the Annapolis Royal Generating Station (a 20 MW tidal power station). A post-mortem was inconclusive but suggested the whale had become trapped in the river after following fish through the sluice gates (Tethys, 2013b).

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10.5.9.5 As discussed in Section 10.5.8 it is unlikely that marine mammals will be able to swim through the turbines without it resulting in mortality or serious injury. The only other access for marine mammals into the lagoon is through the sluice gates. The Project will use ten sluice gates (each 13.5m wide and 14.5m high at the narrowest section). These sluices are wide and deep enough for both harbour porpoise and seals to pass through. However, the difficulty (and potential distress) for marine mammals associated with swimming through the sluice passages, could prevent any transient movements into the lagoon (particularly for harbour porpoise which often avoid anthropogenic structures). Nevertheless, both grey seals and harbour porpoises have been recorded passing through sluice gates and other similar structures (Jansen *et al*. 2013; Tethys, 2013a).

10.5.9.6 The sluice gates will only be open for a 30-40 minute period at the end of the flood and ebb tidal phases. Marine mammals are most likely to swim with the flow through the sluice into the lagoon at the end of the flood tide rather than swimming against the flow when the gates are open at the end of the ebb phase. The window of opportunity for marine mammals to swim into the lagoon is therefore relatively small. Transient movement of marine mammals into the lagoon through the sluice gates is therefore possible but considered a rare occurrence.

10.5.9.7 However, if a marine mammal were to enter the lagoon it could become trapped, given the small window of opportunity available to swim back through the sluice at the end of the ebb phase. It is also possible that a marine mammal could become disorientated and distressed once inside the lagoon, which could further compound the ability for a mammal to swim back to the open sea thus resulting in an increased potential for collision risk with the turbines. If the mammal is trapped for an extended period of time it is possible that the condition of the animal could deteriorate causing health problems.

10.5.9.8 Based on this information the probability of the lagoon acting as a barrier to movement is considered to be <u>high.</u> However, the lagoon will not block any migratory routes. In addition, given the large ranges of these species, direct loss of habitat due to displacement was assessed as being a minor impact (Section 10.5.7). Nevertheless, the Project is still considered to reduce the full extent of habitat currently available in Swansea Bay for both harbour porpoise and grey seal. In addition, through acting as a partial barrier there is also a risk of animals becoming trapped inside the lagoon which could cause health problems and potentially an increased collision risk with the turbines. However, very few individuals are expected to enter the lagoon. Barrier effects will also be reversible on decommissioning (see Section 10.5.12). Based on these factors, the magnitude is considered to be small and the exposure to change was assessed as <u>low</u>. Sensitivity of marine mammals to barriers is considered to be <u>high</u> given that marine mammals are susceptible to barriers. Vulnerability is consequently assessed as <u>low</u> to <u>moderate</u>. The importance of the feature is scored as high (all marine mammals are protected under UK law and European legislation leading to a **moderate adverse impact** without mitigation.

10.5.9.9 In order to reduce the significance of this impact further, a capture and release protocol will be developed as part of the EPS licensing conditions. This would be in consultation with the local Llys Nini Royal Society for the prevention of Cruelty to Animals (RSPCA) group, RSPCA Cymru, British Divers Marine Life Rescue (BDMLR) and NRW for any marine mammal entering the lagoon. This is discussed in greater detail in Section 10.7. With an appropriate protocol in place, residual barrier impacts on marine mammals are assessed as being of **minor adverse significance**.

10.5.9.10 Confidence in this assessment is considered to be medium as some uncertainty exists with regard to the type of behavioural response marine mammals will elicit around the development sluice gates.

10.5.10 Impact Pathway 9: Noise disturbance during operation

General scientific context

10.5.10.1 Noise during the operational phase of renewable developments is generally considered to be less intrusive than during the construction phase (Inger et al. 2009; Marine Scotland, 2012). There is, however, no published information on the operational noise from the specific hydropower turbines that will be used specifically for the Project. The limited evidence available on tidal stream turbine devices and their potential effects on marine mammals has been reviewed below. The subsequent assessment has been based on the only known underwater measurements available from similar turbines, which were used in hydroelectric power stations on the Colombia River in the United States (Anderson et al., 1989).

10.5.10.2 Studies undertaken as part of the Scottish Marine Renewables SEA (Scottish Executive, 2007) included undertaking a quantitative analysis of the permanent threshold shift (PTS) and temporary threshold shift (TTS) ranges of marine mammals for the operation of the MCT tidal current turbine described previously above. PTS occurs when there is a persistent high intensity noise that causes lasting damage, and TTS occurs when exposure to elevated high noise levels is for a few hours only and is followed by rapid recovery. The PTS assessment revealed that if the most sensitive receptor were to spend 30 minutes within a distance of 16m of the device it might suffer permanent hearing damage. The 16m relates to a frequency of 19,953 Hz and source levels of 157.6 dB re 1µPa-1m and is estimated to be the maximum distance over which PTS could occur for the most sensitive species. Evidence suggests that it is unlikely that a mobile animal would choose to stay in close proximity to the source of a loud noise. The assessment of TTS revealed that if the most sensitive receptor were to spend 8 hours within 934m of the device it might suffer temporary, recoverable hearing damage. The 934m relates to a frequency of 15,849 Hz and source levels of 157.2 dB re 1µPa-1m and is estimated to be a maximum distance over which TTS could occur for the most sensitive species. The assessment was based on the assumption that the devices radiate omnidirectionally. A number of precautionary assumptions were also assumed to provide a worst-case scenario of potential effects to marine mammal species. For example, the seabed type that was applied to these calculations was a hard reflective seabed and the water depth was assumed to be relatively shallow. In deeper water with a less reflective seabed (e.g. a muddy seabed), the range of PTS and TTS impact would be reduced.

10.5.10.3 Monitoring of harbour porpoise distribution around the NSPI (OpenHydro) tidal turbine deployed in the Minas Passage, Bay of Fundy (Nova Scotia) from August to November 2010 found no statistical evidence of the presence of the turbine attracting or repulsing porpoises (Tollit et al. 2011). Similarly, the results of field based monitoring of marine mammals currently from the SeaGen tidal turbine device located in Strangford Lough, Northern Ireland from 2005 to 2010 concluded that no major impacts on marine mammals had occurred across the 3 years of post-installation monitoring. While porpoises were recorded less frequently during installation, no long-term changes in abundance of either seals or porpoises were attributed to the presence or operation of the device. Observations found that seals and porpoises regularly transit past the operating turbine, demonstrating a lack of any barrier effect from this turbine (Royal Haskoning, 2011).

10.5.10.4 As mentioned above, no specific data on the operational noise of the hydropower turbines that will be used for the Project currently exists and as a result the assessment has been based on underwater measurements from similar turbines used in hydroelectric power stations on the Colombia River in the United States (Anderson et al., 1989). These are considered to be more relevant to this Project than the tidal stream turbine devices reviewed above.

Project impact assessment

10.5.10.5 The turbines for the proposed Project will be installed in a concrete turbine housing structure which will be located along the south western extent of the seawall. The turbine housing will be set at a depth so that the turbines are permanently underwater. The turbine housing will contain 16 turbines each 7m in diameter.

10.5.10.6 In order to predict the potential distances at which a significant behavioural response will occur, the root mean squared (RMS) noise level measurements derived from Anderson *et al*. (1989) were plotted with species specific hearing threshold levels from published audiogram data available in Nedwell *et al*. (2004) against frequency on the x-axis and the levels at which the greatest differences between the two threshold levels occur were determined (see Paragraph 10.5.4.6). In the case of harbour porpoise, for example, the greatest difference occurred at 1kHz, corresponding to a turbine noise SL of 104dB re 1µm -1m and a hearing threshold level of 80dB re 1µm. These levels were then applied as input values to the logarithmic underwater sound propagation model (see Paragraph 10.5.4.3).

10.5.10.7 By comparing the received sound levels derived from the logarithmic noise propagation model with the criteria proposed by Southall *et al*. (2007), neither PTS nor TTS will occur in harbour porpoise or grey seal even at the source of turbine noise.

10.5.10.8 The model predicts that neither harbour porpoise nor grey seal will exhibit any behavioural response even at the source of noise. The noise generated by the turbines will only be audible within around 16 metres for harbour porpoise and 12m for grey seal.

10.5.10.9 Applying the standard impact assessment criteria, the sensitivity of harbour porpoise and grey seal is considered to be <u>moderate</u> to underwater noise generally. The probability of a change in underwater noise occurring during operation is considered to be <u>high</u> as is the importance of harbour porpoise and grey seal, given their level of protection. No behavioural or physiological responses are predicted to occur in either harbour porpoise or grey seal even at the source of the turbine noise and therefore the magnitude of the change in operational noise is considered to be <u>negligible</u>. Taking these factors into account, the overall exposure and vulnerability of marine mammals will be <u>negligible</u> and <u>none</u> respectively. Overall, therefore, the impacts of the operational noise generated by the turbines is considered to be **insignificant**.

10.5.10.10 Acoustic fish deterrents (AFDs) identifies the potential to mitigate the potential collision risk of fish as a result of the operation of the turbines (see Chapter 9, Fish including recreational and commercial fisheries). This will also provide early acoustic warning for marine mammals. Sound projector source levels are typically 160 dB re 1µPa@1m, with frequencies covering a maximum range of 20-3000 Hertz. Neither PTS nor TTS will occur in harbour porpoise or grey seal even at the source of the AFDs. Strong behavioural reactions are also not predicted to occur in either species. However, a minor behavioural reaction of 50dBht is anticipated to occur in the majority of individuals within a maximum range of approximately 180m in harbour porpoise and 20m in grey seal.

10.5.10.11 Fish that are resident within the vicinity of the turbines for long periods may become habituated to acoustic signals if subjected to them repeatedly. For this reason, AFD operation should ensure that signals can altered at intervals to prevent habituation (Turnpenny & O'Keeffe, 2005). This can be achieved through the use of signal generators with multi-signal capability. Marine mammals (seals in particular), can also become habituated to continuous acoustic signals and therefore, this approach of randomising the operation of the AFD will be of benefit to marine mammals.

10.5.10.12 Only minor behavioural responses are predicted to occur in harbour porpoise or grey seal within a short distance of AFDs and therefore the magnitude of the change in operational noise is considered to be <u>negligible</u> to <u>small</u>. Applying the standard impact assessment criteria as above, the overall exposure and vulnerability of marine mammals will be <u>none</u> to <u>low</u>. Overall, therefore, the impacts of the operational noise generated by the AFDs is considered to be **insignificant to minor adverse significant** but in terms of collision risk it could be considered to be a benefit as it will act as an early acoustic warning (see Section 10.5.8.6).

10.5.10.13 Confidence in this assessment is considered to be low given that the underwater noise model is based on theoretical parameters, noise measurements for hydropower turbines are limited and there is limited empirical evidence of the behavioural effects of noise on marine mammals.

10.5.11 Impact Pathway 10: Electromagnetic fields during operation

General scientific context

10.5.11.1 Electromagnetic fields (EMF) arise from power cables for transmitting electricity as a result of the current passing along the conductor and the voltage differential between the conductor and earth ground, which is nominally at zero volts. The nature and strength of the fields produced, depends on the system voltage and the current (Alternating Current (AC) or Direct Current (DC)) passing through the cables. The effects on the surrounding environment depend on the cable construction, configuration and orientation in space. The two constituent fields of EMF are defined as the E (Electric) field and the B (Magnetic) field, whilst the induced electric field should be labelled the iE field (Gill *et al*. 2005).

10.5.11.2 Magnetic Fields are produced from AC or DC current passing through the conductor and these emanate outwards from the cable in a circular plane, perpendicular to its longitudinal axis. The field strength produced as a result of the operation of electricity transmission (AC or DC) decreases rapidly with distance away from the source (the decay curve follows the inverse square law). The magnetic field around an AC cable is constantly changing at the same frequency as the alternating current that is producing it, which means that the modulation it produces in the Earth's field will also be constantly variable.

10.5.11.3 Marine mammals are not considered to be electrosensitive species (Hanke and Dehnhardt, 2013; Gill *et al*. 2005; Fisher, and Slater, 2010,). For magnetosensitive species, sensitivity to the geomagnetic field is associated with a direction finding ability e.g. migration. Gill *et al* (2005) lists cetaceans including the harbour porpoise as magnetosensitive. However, the underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains unproven and is based on circumstantial information. There is also no apparent evidence that existing cables have influenced migration of cetaceans. The migration of harbour porpoise in and out of the Baltic Sea involves several crossings over operating subsea High Voltage DC cables in the Skagerrak and western Baltic Sea without any apparent effect on their migration pattern (Scottish Executive, 2007). No evidence has been found to suggest that pinnipeds are magneto-sensitive (Gill *et al*. 2005; Murphy, 2012.).

Project impact assessment

10.5.11.4 The electric cables from the turbines will be buried within the western arm of the Lagoon seawall, above the water level and appropriately insulated. The cables will then be laid via land to the western bank of the River Neath. No cables will be buried directly within Swansea Bay. The cables will then cross the River Neath, either in existing ducts or by means of directional drilling.

10.5.11.5 Overall, B-fields (magnetic fields), whether anthropogenic or naturally occurring, rapidly diminish in strength in seawater with increasing distance from the source. For example, modelling of a typical offshore energy industry-standard cable conducting 132kV and an AC current of 350A found the size of the B field produced was present only directly adjacent to the cable and fell to background levels within 20m of the cable (CMACS, 2003).

10.5.11.6 Given that magnetic field strength quickly diminishes away from a cable, potential exposure to B-fields detectable above background levels is only likely to occur within a few metres of the lagoon wall or the River Neath crossing. Harbour porpoise are rarely recorded in the River Neath estuary with grey seal only occasionally recorded. Therefore, whilst there is a <u>high</u> probability of magnetic fields being generated, magnitude of change is considered to be <u>negligible.</u> No evidence linking magnetic fields from cables to impacts on the direction finding ability or movement of cetaceans has been found and seals are not considered magnetoreceptive. Sensitivity is therefore considered to be <u>low</u>. Therefore, whilst marine mammals are considered to be of <u>high</u> importance, the impact from electromagnetic fields during operation is considered to be **insignificant**.

10.5.11.7 Confidence in this assessment is considered to be medium to high as the assessment is based on a number of detailed scientific reviews on the subject.

10.5.12 Decommissioning

10.5.12.1 In terms of decommissioning, as identified in Chapter 4: Project Description, there are two potential options under consideration which vary in terms of physical intervention. The primary option to decommission is: At the end of the operational life of the facility (estimated to be some 120 years), the turbines and sluice gates could be removed, and the tide allowed to flow through the resultant gaps in the structure**.**

10.5.12.2 However, it is equally likely that at the nominal end of the working life of this facility, power generation by tidal lagoons will have further developed, and the Swansea Bay Tidal Lagoon will be progressively updated so that the facility can be kept in use as an energy source as well as its ongoing leisure use. This would not constitute decommissioning and it is to be expected that in such circumstances the operational phase effects would continue.

10.5.12.3 The effects of decommissioning will therefore be different for each of the options noted above. If the proposed use of the Project is maintained then the potential impacts will remain the same as those identified for the operational phase.

10.5.12.4 In terms of decommissioning the Project, it is anticipated that the works to remove the turbines and sluice gates would be undertaken from the turbine/sluice gate structure using the overhead gantry cranes. As such, the potential impacts will be negligible compared to those identified for the construction phase. Removing the sluice gates and turbines will result in similar potential impacts to those identified for the operational phase, except that the collision risk and noise disturbance pathways will no longer be applicable. Removal of these structures may enable marine mammals to pass into the lagoon, but, as the lagoon will be less spatially confined, egress is expected to be easier.

10.6 Cumulative and in combination

10.6.1 Introduction

10.6.1.1 The development of the Project will take place alongside other plans, projects and activities. These have the potential to result in additional or modified impacts on the same receptors as those identified from the Project resulting in a cumulative and/or in-combination impact.

10.6.1.2 Based on consultation, a number of plans and projects have been identified which are potentially relevant in terms of cumulative and in-combination effects as outlined in Chapter 2: EIA Process and Assessment of Significance. These are listed in Table 10.11 and an initial screening has been undertaken to identify those which have connectivity with the Project and have been considered further in the cumulative and in-combination assessment.

Table 10.11 Summary of plans and projects in the wider study area

Projects	Stage in Planning Process	Preliminary Screening
Swansea University Bay Campus, adjacent to Crymlyn Burrows.	Construction Feb 2013 – Sept 2015.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
St Modwens land development- east of Swansea Docks, to west of Neath estuary.	Remediation of land, and potential future developments – no details available.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Mumbles pier, foreshore and coastal strip redevelopment	Due to be completed by the end of 2013.	Construction is expected to be completed prior to the Lagoon construction. In addition, noise levels associated with general construction will be generated above sea level and will be unlikely to produce very high sound and pressure levels (Royal Haskoning, 2010). No impacts will occur during operation beyond that currently experienced from the pier. Overall, therefore, there will be **no cumulative/in-combination impacts** on marine mammal receptors.

Projects	Stage in Planning Process	Preliminary Screening
Construction of new RNLI Lifeboat Station, Mumbles	Expected completion 2014.	Piling works are required for the construction of the lifeboat house foundation and slipway which are anticipated to take up to 5 months. (Royal Haskoning, 2010). Mitigation is required to reduce the potential impact of piling activities which include the use of a Marine Mammal Observer during piling works. If the mitigation measures are put in place and adhered to, a negligible adverse impact was expected for marine mammals in the vicinity of Mumbles Pier (Royal Haskoning, 2010). Piling noise associated with the Project is not expected to overlap temporally with piling required for the new RNLI lifeboat station which is due to be completed in 2014. However, cumulative temporal disturbance effects could occur. The cumulative/in-combination impacts associated with noise risk on marine mammal receptors have been assessed further in Section 10.6.2. No impacts will occur during operation beyond that currently experienced from the pier (Royal Haskoning, 2010).
SA1 development, Swansea	Development currently taking place. Completion date unknown.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Construction of the southern access road to Coed Darcy Urban Village, crossing nearby Crymlyn Bog.	Yet to commence.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Swansea Boulevard project- work between Princess way and the Strand, and the River Tawe bridges and The Strand.	Phase to be complete in November 2013. Phase 2 to start 2014	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Wind turbine- on Welsh water site on Fabian Way.	Application – Unsuccessful 25/10/2013	Not considered since the project application was unsuccessful.
Five wind turbines- at Mynydd Marchywel between Rhos and Cilfrew Neath	Submitted Jan 2012. Consultation finished Jan 2013. Still in planning.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Sixteen wind turbines- at Mynydd Y Gwair, Swansea	Approved – unknown construction timetable.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Five wind turbines- on land at Mynydd Brombil Farm, Margam Port Talbot	Submitted June 2012, still in planning. Consultation finishes April 2013.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Atlantic Array Wind Farm – off North Devon Coast approx 35km distant.	DCO application submitted but withdrawn in November 2013.	Not considered since the project is not proceeding.
Seventy six turbine Pen y Cymoedd windfarm near Neath.	Planning approved – construction 2014.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Llynfi Afan Renewable Energy Park -fifteen turbine windfarm – on land 500m southwest of Cynnonville Port Talbot	Planning permission refused. Application was allowed on appeal 27/08/2013.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.

Projects	Stage in Planning Process	Preliminary Screening
Mynydd y Betws- Fifteen turbine windfarm located on land to the east of Ammanford in Camarthenshire	Granted planning consent 2009. Started operating April 2013.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Mynydd y Gwrhyd- windfarm in the Upper Amman and Swansea valleys	Approved on appeal 07/05/2009	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Swansea Port single wind turbine	Operational	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Newlands Farm, single wind turbine- Margam	Application submitted January 2013.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Kenfig Industrial Estate single wind turbine	Application submitted. Expected decision by Feb 2014.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Port Talbot Harbour redevelopment	Potential future activities/ development. Status unknown.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Upgrading of the existing coastal defence of Aberavon West Promenade, Sandfields, Port Talbot	Completed August 2013.	Project completed. **No cumulative/in-combination impacts** on marine mammal receptors.
Porthcawl regeneration scheme includes Porthcawl Marina project and 19th century lighthouse restoration	Approved by BCBC -timescale unknown.	Onshore/coastal works with no impact pathways identified for marine mammals., there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Underground coal gasification under Swansea Bay	License potentially to be extended.	During the construction phase there is potential for interaction between noise and vibration arising from the Project construction and noise and vibration from the underground coal project. However, no timescale is available for this project and there is a lack of information available to undertake a **cumulative/in-combination** impact assessment.
Underground coal gasification under Llanelli	Conditional licence issued.	Underground works outside of the marine environment and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Navigational dredging along the Swansea (Tawe), Neath and Port Talbot.	On-going.	During the construction phase there is potential for interaction between noise arising from the Project construction and noise created by maintenance dredging of the Swansea, Neath and Port Talbot approach channels. There is also potential for interaction between sediment plumes arising from the Project construction and sediment plumes created by maintenance dredging of the approach channels. The cumulative/in-combination impacts associated with noise and sediment plumes on marine mammal receptors have been assessed further in Section 10.6.2
Marina dredging - Monkston cruising and sailing club and Swansea Marina	On-going maintenance as required.	During the construction phase there is potential for interaction between noise arising from the Project construction and noise created by maintenance dredging of the Swansea, Neath and Port Talbot approach channels. There is also potential for interaction

Projects	Stage in Planning Process	Preliminary Screening
		between sediment plumes arising from the Project construction and sediment plumes created by maintenance dredging of the approach channels. The cumulative/in-combination impacts associated with noise and sediment plumes on marine mammal receptors have been assessed further in Section 10.6.2
Mumbles Oyster project: Plan to put 10,000 oysters on seabed off the village of Oystermouth.	Permission granted September 2013.	No impact pathways between the fishery order and the Project have been identified. Therefore, there will be **no cumulative/in-combination impacts** on marine mammal receptors
Severn Barrage	Not within foreseeable future	Not considered. See note in Chapter 2
Swansea Barrage	Operational	The Barrage is currently operational and there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Cardiff Barrage	Operational	The Barrage is currently operational and there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Baglan Power station	Operational.	Onshore with no cooling water discharge into the marine environment and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Prenergy Biomass Power Station, Port Talbot – 350MW wood chip fuelled thermal generating station.	Granted condition approval by BERR on the 20 November 2007. While large scale construction has not been begun, a lawful start of development has occurred and as such the planning permission remains extant.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Abernedd Power Station was granted conditional approval by DECC on the 23 Feb 2011 for construction of a 870MW gas fired combined cycle gas turbine power plant.	No lawful start has yet been made to this development.	Onshore works and therefore there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Nobel banks aggregate extraction site	Ongoing.	This development is located approximately 35km and beyond a tidal excursion[6] from the Project. No cumulative impacts associated with suspended sediments are therefore anticipated. However, noise during dredging activities could lead to potential behavioural reactions in marine mammals which could interact with noise during construction of the Project. The cumulative/in-combination impacts associated with noise on marine mammal receptors have been assessed further in Section 10.6.2

[6] The nature of the tide is such that its movement is typically described as an almost closed ellipse. These tidal ellipses can be viewed as a package of water that will move to and fro over one tidal cycle, typically along a dominant axis, returning to almost the same position. As such, they can also be used to identify the maximum likely distance that water, or any material suspensions or solutions it may contain, might be tidally transported from a given location or area.

Projects	Stage in Planning Process	Preliminary Screening
The Swansea Bay (Thomas Shellfish Limited) Mussel Fishery Order 2012	Ongoing.	No impact pathways between the fishery order and the Project have been identified. Therefore, there will be **no cumulative/in-combination impacts** on marine mammal receptors.
Ro-Ro Ferry- Swansea Port	Currently not operational	Not considered.
Rhiannon Offshore Windfarm	Pre-application stage.	This development is located approximately 300km from the Project and therefore beyond the distance of any significant movement of marine mammals from Swansea Bay. Therefore, there will be **no cumulative/in-combination impacts** on marine mammal receptors
Burbo Bank Offshore Windfarm extension	Existing and extension sought 2013.	This development is located approximately 350km from the Project and therefore beyond the distance of any significant movement of marine mammals. Therefore, there will be **no cumulative/in-combination impacts** on marine mammal receptors
Tidal Energy Ltd Deltastream Installation Ramsey Sound	Consent secured. Installation 2014.	The EIA for the Deltastream prototype on marine mammals found all potential impacts to be insignificant/minor with the exception of operational collision risk which was assessed as of moderate adverse impact. However, with the implementation of an adaptive monitoring and mitigation strategy, the risk of collision was assessed as minor (Tidal Energy Limited, 2009). This development is located approximately 100km from the Project and is therefore considered in the range of potential movement of grey seal and harbour porpoise. Therefore it is possible that there may be some overlap of the movement of marine mammals between the changes brought about by this development and those of the Project. In particular, during the operational phase there is potential for increased overall collision risk associated with this development and the changes brought about by the Project. These potential cumulative/in-combination impacts on marine mammal receptors is assessed further in Section 10.6.3.
SeaGen Skerries Tidal Stream Array	Consent secured. Installation 2014.	This development is located approximately 300km from the Project and therefore beyond the distance of any significant movement of marine mammals. Therefore, there will be **no cumulative/in-combination impacts** on marine mammal receptors.

Projects	Stage in Planning Process	Preliminary Screening
Tidal Stream Energy Demonstration Array St David's Head Pembrokeshire.	Consent is planned to commence in 2017.	This development is located approximately 100km from the Project and is therefore considered in the range of potential movement of grey seal and harbour porpoise. Therefore it is possible that there may be some overlap of the movement of marine mammals between the changes brought about by this development and those of the Project. In particular, during the operational phase there is potential for increased overall collision risk associated with this development and the changes brought about by the Project. These potential cumulative/in-combination impacts on marine mammal receptors is assessed further in Section 10.6.3.

10.6.1.3 Of the plans and projects listed in Table 10.11, only the following are considered likely to have potential cumulative and/or in-combination impacts on marine mammal receptors in respect of the Project:

i. Construction of new RNLI Lifeboat Station, Mumbles;

ii. Navigational dredging at Tawe, Neath, Port Talbot and Bristol Channel;

iii. Marina dredging at Monkston Cruising and Sailing club and Swansea Marina;

iv. Aggregate dredging at Nobel banks aggregate extraction site;

v. Tidal Energy Ltd Deltastream Demonstrator Installation Ramsey Sound, Pembrokeshire; and

vi. Tidal Stream Energy Demonstration Array, St David's Head, Pembrokeshire.

10.6.1.4 Other activities considered in the assessment are existing shipping and recreational boating.

10.6.2 Construction phase

10.6.2.1 The key cumulative and/or in-combination impacts as a result of the potential interaction between the Project and other plans, project and activities during the construction phase are cumulative changes in suspended sediments and noise.

Changes in suspended sediments

10.6.2.2 The Project will have only localised effects on SSC as a result of the dredging and filling of geotubes (see Section 10.5.6 and Chapter 6 Coastal Processes). The modelling results predict that these temporary elevations in SSC will dissipate to background concentrations within a spring-neap tidal cycle on cessation of the works. Changes outside Swansea Bay are unlikely to be distinguished from the natural variability. Therefore, in physical terms, the plumes resulting from any dredging are expected to have a minimal and local effect on SSC in the vicinity of the Project. SSC during dredge disposal are predicted to be within the level of variability found during existing disposal operations at the disposal ground. The probability of plumes associated with the Project overlapping with ongoing maintenance dredging and aggregate extraction activities in

Swansea Bay and the wider area together are considered to be low to medium. The magnitude associated with any potential overlap is considered to be small given the existing high natural variability in background levels of SSC. Exposure to change is consequently assessed as negligible to medium. Marine mammals living in Swansea Bay are considered to be well adapted to turbid conditions and are therefore not considered sensitive to the predicted scale of changes in SSC (Section 10.5.6). Based on the level of protection afforded to marine mammals, the importance of the feature is considered to be high. Therefore, overall, the cumulative and/or in-combination impacts associated with changes in SSC are considered to be **insignificant.**

Noise

10.6.2.3 Piling during construction of the Project is predicted to cause no significant physiological effects with behavioural responses calculated to occur only in very close proximity to the construction site during vibro-piling (the preferred construction method) and over a relatively small area of Swansea Bay during percussive piling (used on an as required basis only) (Section 10.5.4).

10.6.2.4 Piling noise associated with the Project is not expected to overlap temporally with piling required for the new RNLI lifeboat station which is due to be completed in 2014. The lack of temporal overlap between these projects will avoid any potential cumulative spatial barrier and displacement effects but cumulative temporal disturbance effects could still occur. However, all the projects will be required to follow JNCC piling protocol and soft start procedures during percussive piling which will help to reduce the risk of injury and disturbance.

10.6.2.5 Ongoing channel and aggregate dredging campaigns also have the potential to cause noise related impacts to marine mammals. However, recent research has indicated that it is very unlikely that underwater sound from either channel dredging or aggregate operations will cause injury to marine mammals (CEDA, 2011; Robinson *et al*., 2011; Parvin *et al*. 2008). The main reaction from cetaceans and pinnipeds to dredging is likely to be some limited, temporary avoidance during the works. In addition, harbour porpoise are regularly sighted in areas which are subject to regular maintenance dredging such as Port Talbot harbour approaches and are expected to be relatively habituated to dredging noise in Swansea Bay.

10.6.2.6 Therefore, whilst there is a high probability of some overlap between construction noise emitted as part of the Project and other development/activities, magnitude of the impacts is considered to be negligible to small resulting in a negligible to low exposure. Sensitivity of harbour porpoise and grey seal are considered to be moderate to underwater noise generally. Based on the level of protection afforded to marine mammals, the importance of the feature is considered to be high. Therefore, overall, the cumulative and/or in-combination impacts associated with noise are considered to be of **insignificant to minor adverse significance**.

10.6.3 Operational phase

Collision

10.6.3.1 There is a possibility of an overall increase in the collision risk of marine mammals from the operation of the Project turbines together with the Tidal Energy Ltd Deltastream Demonstrator Installation turbine (Ramsey Sound) and the Tidal Stream Energy Demonstration Array turbines (St Davids Head).

10.6.3.2 Magnitude of change is assessed as medium and probability low, leading to a low exposure. Based on the information provided above in Section 10.5.8, marine mammals are considered to have a high sensitivity to collision during operation. The importance of the feature is scored as high given that all marine mammals are protected under UK law and European legislation (e.g. Wildlife and Countryside Act, EU Habitats Directive), leading to an **moderate impact**. However, all projects will require an adaptive monitoring and mitigation strategy to be in place to ensure that collision risk remains low. The residual impact is therefore assessed as **minor**.

10.6.3.3 Confidence in the cumulative/in-combination assessment is considered to be low to medium given the large number of variables associated with a cumulative assessment and uncertainties surrounding noise levels and frequency of collisions associated with each of the projects.

10.7 Mitigation and monitoring

10.7.0.1 This section presents a review of measures that will be implemented to mitigate adverse effects. Mitigation measures are presented within this section and further detailed within Chapter 23 Mitigation and Monitoring. Mitigation measures will also be part of the Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP) that will be prepared for the Project for both the construction and operational phases of the Project (see Chapter 4, Project description). An Environmental Liaison Officer will be employed during the construction phase and a warden will be employed during the operational phase. These individuals, together with any specialist marine mammal personnel, will be responsible for the managing the environmental aspects of the Project, together with ongoing communication with statutory and non-statutory organisations. Mitigation measures will be secured and developed as part of the EPS Licence conditions applicable to the Project and through further discussion with NRW.

10.7.0.2 Chapter 23 also outlines the monitoring framework proposed for the Project which will be further `developed as the Project progresses. The Adaptive Environmental Monitoring Plan will review the available information from monitoring undertaken together with management processes in an iterative manner to improve future management. A carefully planned period for the management cycle will be defined within the AEMP to present a clear timeframe after which both management advice and the management process will be reviewed and updated (Lusseau *et al*. 2012).

10.7.0.3 In order to inform the Adaptive Environmental Monitoring Plan, such that the monitoring identified within this ES can be developed for the construction and operational phase of the Project, TLSB is working in conjunction with the SEACAMS

(Sustainable Expansion of the Applied Coastal and Marine Sectors in Wales) project at Swansea University.

10.7.0.4 As an initial step in this work, a long-term acoustic monitoring programme for harbour porpoises is being set up in the lagoon footprint and the wider Swansea Bay area. Surveys are being undertaken in 2014 to examine the use of Swansea Bay by harbour porpoises, and to determine if there are any seasonal patterns to usage. C-PODs will be deployed within the Lagoon footprint and outside the area as a control site. The survey will involve the use of four C-PODs, 2 at the lagoon site and 2 at a designated control site (off Mumbles), the exact locations will be dependent on mooring logistics and permit restrictions. Data will be collected on the presence and absence as well as foraging frequency and intensity for harbour porpoises. Monitoring will continue during construction and operation. Data will be analysed to determine daily and seasonal patterns. The results of the surveys will inform the subsequent monitoring strategies.

10.7.0.5 The following mitigation measures and monitoring will be implemented during the construction and operational phases of the Project:

Percussive (impact) piling

i. Vibropiling will be used where possible. However, if percussive piling works are needed, monitoring and mitigation would be undertaken following the guidelines highlighted in the JNCC “Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals during piling” (JNCC, 2010).

ii. CEMP to be developed to allow for transition between vibropiling and percussive piling during visibility conditions or night time work.

iii. For percussive piling only, establishment of a ‘mitigation zone’ of radius 500m around the piling site, prior to any piling.

iv. Within this mitigation zone, detection would be undertaken by a Marine Mammal Observer (MMO) and acoustically using appropriate Passive Acoustic Monitoring (PAM) equipment.

v. Both the observers and equipment will be deployed at least 20 minutes before percussive piling is due to commence.

vi. Percussive piling would not commence if marine mammals are detected within the mitigation zone or until 20 minutes after the last visual or acoustic detection.

vii. The MMO/ PAM operative should track any marine mammals detected and ensure that they are satisfied that the animals have left the mitigation zone before they advise the crew to commence percussive piling activities.

viii. Percussive piling will commence using an agreed soft start procedure for at least 20 minutes (the gradual increase of piling power, incrementally, until full operational power is achieved). The soft-start procedure will vary according to hammer and pile design and other factors.

ix. Procedures will incorporated into the CEMP to allow for transition from vibro-piling to percussive piling during hours of darkness or poor visibility. If possible percussive piling works will commence within 20mins of cessation of vibro-piling. If 20 minutes have elapsed data from PAM and sonar of mitigation zone will be used to determine potential presence of Harbour Porpoise. If mitigation zone is clear, soft start procedures will commence.

Collision risk

10.7.0.6 An appropriate package of adaptive mitigation and monitoring to reduce collision impacts will be developed as outlined in Chapter 23. As discussed above, the findings of further data collection will inform the AEMP for the operational phase of the project. In addition, methods employed at other marine energy sites will be reviewed in terms of their appropriateness for the Lagoon project and their effectiveness. Outline monitoring and mitigation measures for collision risk are presented below together with examples of where they have been used before:

I. **Turbine Collision Risk Monitoring**- Monitoring of marine mammals will be undertaken following construction of the Project. The results of the monitoring will be regularly reviewed as part of the AEMP process to ensure that the most appropriate collision risk mitigation package is in place. The content and duration of the monitoring programme will be agreed with NRW based on further discussion as part of the EPS licensing conditions. Monitoring may include detection of mammals using both surface detection (using a qualified Marine Mammal Observer) and an active sonar system. This combination was used successfully to monitor collision risk at Strangford Lough SAC (Royal Haskoning, 2011). For Strangford Lough active sonar relied on 24-hour a day manual monitoring. However, SMRU have recently been developing software for the detection and classification of marine mammals using active sonar which could be developed as part of an automated system (Hastie et al, 2012).

II. **Acoustic Deterrent -** The acoustic deterrents that are being proposed to be used to mitigate the risk of collision for fish (see Section 10.5.10) will provide early acoustic warning for marine mammals and lead to minor behavioural avoidance reactions. Carter and Wilson (2013) recently investigated the feasibility of acoustic devices to warn marine mammals of tidal devices. The study concluded that the use of acoustic warning equipment, if appropriately designed, could prove a valuable mitigation tool should a collision problem become apparent. However the report also highlighted that existing acoustic warning equipment developed to dissuade seals from approaching fish farms, warn marine mammals of fishing gear, steer fish away from power stations and other applications are likely to be inappropriate in a tidal energy context. Finally, the report highlighted seven attributes that should be considered when developing a system. These were that the signal must elicit an appropriate response; emission rates must suit approach velocities; emission frequencies must be audible for target species; amplitudes must be appropriate for detection ranges and sites; signals must be directionally resolvable; the warning should be co-ordinated with the threat; and the location of the sound sources at a turbine must facilitate appropriate spatial responses. The above will be further considered in when developing an appropriate system of acoustic deterrent for the Project. The deterrents will be developed in conjunction with fish requirements (Chapter 9 Fish, Commercial and Recreational Fisheries).

III. It is proposed that prior to the installation of acoustic deterrents, acoustic modelling of the proposed devices should be undertaken to ensure that the spread of noise is not excessive, which might **interfere** with the natural movements of marine mammals. Sound projector source levels are typically 160 dB re 1µPa@1m, with frequencies covering a maximum range of 20-3000 Hertz. Normally effective ranges are limited to a few tens of metres. The actual acoustic field should be measured during the commissioning phase to allow adjustment of sound levels to the desired values. In addition to this study, noise monitoring of the operational turbines prior to installation of the acoustic deterrents will also be undertaken.

IV. To assess the potential noise effects of the operational turbines and the effectiveness of acoustic deterrents to reduce the risk of turbine collision, it is proposed to examine marine mammal reaction to generated noise by using both acoustic dataloggers and visual observation from survey vessels in the vicinity of site using established guidelines. This data will be used together with research previously undertaken (e.g. See for example: Dawson et al (2013), To ping or not to ping: the use of active acoustic devices in mitigating interactions between small cetaceans and gillnet fisheries, Endangered Species research Vol. 19: 201–221, 2013) to determine the suitability for using acoustic deterrent devices.

V. **Carcass Surveillance –** It is understood that at present any carcasses which are washed ashore tend to be reported and assessed. Within the monitoring programme identified above, the need for regular additional monitoring for carcasses, post mortem evaluation of carcass stranding and assessment of cause of death will be ascertained and linked into any existing programmes. The Lagoon Warden will undertake routine surveillance for carcases. They will liase with the UK Cetacean Strandings Investigation Programme (CSIP) concerning existing shoreline surveillance which covers key areas which are predicted to be hotspots for strandings, based on local advice and hydrodynamic modelling. Integration of the Lagoon programme would be developed and run in coordination with the CSIP.

VI. **Reporting** - Collision events or near misses will be recorded and an appropriate reporting mechanism will be set up to report such events to the appropriate authorities and to inform the mitigation and monitoring protocols. A strategy will be developed to locate any collided (injured or dead) animals and appropriate measures will be taken to deal with carcasses.

VII. **Capture and Release of Trapped Marine Mammals** - Further details are provided below.

Barrier effects

I. **Capture and Release of Trapped Marine Mammals –** Measures will be put in place in the event of a marine mammal entering the lagoon and not successfully leaving via the sluice gates. A capture and release monitoring programme will be developed and further guidance will be sought from BDMLR, RSPCA Llys Nini, RSPCA Cymru and NRW. The team at RSPCA Llys Nini, run an Animal Centre in Penllergaer, North Swansea and they have the RSPCA's seal first aid station, where they currently handle injured and abandoned seal pups. Likewise RSPCA Cymru provides follow on support for these animals before being released back into the wild. As such, both their expertise would be valuable in developing such a programme. Once appointed the Lagoon Warden will undertake further discussion with all parties to ensure that appropriate support can be put in place. This would include communication routes and access arrangements.

10.8 Conclusion

10.8.0.1 This Chapter identifies a number of pathways in which potential impacts to marine mammals arising from the Project could occur. Table 10.12 summarises the impact significance, suggested mitigation and monitoring, residual impact and confidence for each of the pathways in construction and operation based on the findings presented in 10.5 to 10.7. The main impacts arising from the Project on marine mammals are percussive piling noise during construction (if used); collision risk with turbines during operation; and barrier effects. All these impacts have been assessed as worst case moderate adverse without mitigation. In order to reduce the significance of these impacts, several mitigation measures are proposed. With these measures in place, the residual impacts are assessed as being insignificant to minor adverse.

Table 10.12 Summary of potential impacts and outline mitigation and monitoring

Project Stage	Pathway	Impact Significance	Mitigation and monitoring	Residual Impact	Confidence
Construction Phase	Collision risk (construction vessels and machinery)	Insignificant to minor	Not required	Insignificant to minor	Medium
	Visual disturbance	Insignificant	Not required	Insignificant	Medium to high
	Noise disturbance	Minor (vibro-piling) Moderate (percussive/ impact piling)	Use of vibro-piling as far as possible Follow JNCC piling protocol when percussive piling Soft-start techniques during percussive piling	Insignificant to minor	Medium
	Release of contaminants associated with the dispersion of suspended sediments	Insignificant	Not required	Insignificant	Medium to high
	Changes in suspended sediment concentrations	Insignificant	Not required	Insignificant	Medium to high
	Cumulative/in-combination: Suspended Sediments	Insignificant	Not required	Insignificant	Low to medium
	Cumulative/in-combination: Noise	Insignificant to minor	No additional mitigation required	Insignificant to minor	Low to medium
	Cumulative/in-combination: Collision Risk	Insignificant	Not required	Insignificant	Low to medium
Operational Phase	Changes to foraging habitat	Direct loss of habitat – minor (adverse) Indirect changes to habitat-insignificant to minor (beneficial)	Not required	Direct loss of habitat –minor (adverse) Indirect changes to habitat-insignificant to minor (beneficial)	Low

Project Stage	Pathway	Impact Significance	Mitigation and monitoring	Residual Impact	Confidence
	Collision risk (turbines)	Moderate	Development of appropriate turbine collision monitoring programme with potential detection through MMO/ PAM and active sonar Activation of acoustic deterrent if a marine mammal is recorded within 50m. Potential additional Carcass surveillance	Insignificant to minor	Low
	Barrier to movement	Moderate	Development of capture and release protocol	Minor	Medium
	Noise disturbance	Insignificant to minor	Not required	Insignificant to minor	Low
	Electromagnetic fields	Insignificant	Not required	Insignificant	Medium to high
	Cumulative/ in-combination: Collision Risk	Insignificant	No additional mitigation required	Minor	Low to medium

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