



Rampion Offshore Wind Farm



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**MARINE MAMMAL VISUAL OBSERVATION DATA
ANALYSIS AND IMPACT ASSESSMENT FOR THE RAMPION
OFFSHORE WIND FARM DEVELOPMENT IN ZONE 6
(ENGLISH CHANNEL)**



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LIST OF ACRONYMS

BACI	Before-After Control-Impact
C-POD	Porpoise Detector
dB	Decibels
FM	Frequency Modulated
GAMs	Generalised Additive Models
GIS	Geographic Information System
Hz	Hertz
JNCC	Joint Nature Conservation Committee
kHz	Kilohertz
Km	Kilometre
M	Metre
MMO	Marine Mammal Observer
µPa	Micropascal
PAM	Passive Acoustic Monitoring
PTS	Permanent Threshold Shift
Q-Q plot	Quantile-Quantile plot
Rms	Root Mean Squared
SCANS	Small Cetaceans in the European Atlantic and North Sea
SST	Sea Surface Temperature
TCE	The Crown Estate
T-POD	Porpoise Echolocation-Click Detector
TTS	Temporary Threshold Shift

SUMMARY

Marine mammal surveys were carried out during a baseline study for the Rampion offshore wind farm development. Thirty surveys were conducted from March 2010 to February 2012, with between one-to-two surveys carried out each month. There were 93 survey days, amounting to a total effort time of *ca.* 788 hours. Sightings were summarised by different factors such as species, group, month, area and/or season, to elucidate possible trends or outliers. Sightings were summarised per survey and season in each year (spring: March – May, summer: June – August, autumn: September – November, and winter: December – February) for statistical analysis.

There were 113 marine mammal sightings in the survey area, comprising *ca.* 212+ animals. Six species were identified as definite: harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), white-beaked dolphin (*Lagenorhynchus albirostris*), minke whale (*Balaenoptera acutorostrata*), grey seal (*Halichoerus grypus*) and harbour (or common) seal (*Phoca vitulina*). The minke whale was sighted incidentally (i.e. not during survey effort). No marine mammals were observed in August 2010, December 2011, and during the second survey in November 2011. Cetacean calves/juveniles were seen on four occasions. Most marine mammals were sighted within the site and buffer zone. The minimum number of marine mammals observed per hour among the surveys was not considered to be different. There appears to be low level of marine mammal activity in the English Channel during the winter months (Dec – Feb). When survey effort was taken into account, spring had the highest marine mammal sightings rate. An initial investigation into the effect of sea state on sightings showed that sightings decreased when sea state increased.

The harbour porpoise was the most frequently observed marine mammal species in most areas (site, buffer, and control). The difference in harbour porpoise



sightings per hour and individuals seen per hour among the different surveys was not significant. There was a significant difference in harbour porpoise sighting rates and individuals seen per hour among seasons.

Sightings were too few to carry out distance sampling techniques, so other population estimate techniques were employed to calculate approximate relative density of harbour porpoises in the survey area. Population analysis could not be carried out on other marine mammals (dolphins, whales and seals), due to lower number of sightings. Sightings and planned transect lengths were pooled per survey and grouped per season. Corrected relative density was derived by dividing the number of animals observed on transect by the area observed along the transect lines, multiplied by a correction factor. Harbour porpoise relative density ranged from approximately zero to 0.29/km² along the survey transects. The maximum relative density was in March 2011. The difference in estimated porpoise density among the seasons was not significant, with highest estimated median density of 0.07/km² in spring 2011.

Large numbers of harbour porpoise coincided with an early spring bloom in the western part of the Channel. An increase in chlorophyll-*a* concentration and higher Sea Surface Temperature (SST) resulted in enhanced primary productivity and food availability, potentially making the adjacent region an energetically efficient place to forage.

An increase in the number of bottlenose dolphins coincided with lower numbers of harbour porpoises in the survey area. Elsewhere, bottlenose dolphins are known to show interspecific aggression towards harbour porpoises. There are various hypotheses for these interactions, including prey competition and infanticidal-related behaviour. While the data are too few to make behavioural assumptions for this study to try and establish whether interspecific aggression occurs in this area, future research in the English Channel should place greater emphasis on bottlenose dolphin and harbour porpoise sightings in addition to local strandings. Bottlenose dolphins (along with unidentified dolphins) were the second most frequently sighted animals at various points throughout the year, with highest number of animals observed in July 2010. On occasion, bottlenose dolphins were observed in association with feeding seabirds.

On one occasion, a single unidentified whale (probable minke) was observed on-effort in the site. On another occasion a single white-beaked dolphin was observed on-effort in the site. Sightings of seals (grey, common and unidentified) occurred in all areas (site, buffer, control and cable route), comprising single animals only.

1.0. MARINE MAMMALS

- E-ON Climate and Renewables successfully won the Crown Estates Round 3 wind farm development to construct and operate the Rampion offshore wind farm (formerly TCE's Hastings zone).
- The main objective of this report is to present information on the baseline marine mammal sightings data in and around the proposed wind farm site.
- Current literature has been reviewed on the impacts of wind farm construction, primarily impacts from piling on marine mammals.



1.1. Marine mammal species in the survey area

Table 1 below lists the marine mammal species that have been observed previously in the English Channel.

Common name	Scientific name
Atlantic white-sided dolphin	<i>Lagenorhynchus acutus</i>
Bottlenose dolphin	<i>Tursiops truncatus</i>
Common dolphin	<i>Delphinus delphis</i>
Striped dolphin	<i>Stenella coeruleoalba</i>
White-beaked dolphin	<i>Lagenorhynchus albirostris</i>
Harbour porpoise	<i>Phocoena phocoena</i>
Killer whale	<i>Orcinus orca</i>
Long-finned pilot whale	<i>Globicephala melas</i>
Fin whale	<i>Balaenoptera physalus</i>
Humpback whale	<i>Megaptera novaeangliae</i>
Minke whale	<i>Balaenoptera acutorostrata</i>
Sei whale	<i>Balaenoptera borealis</i>
Grey seal	<i>Halichoerus grypus</i>
Common seal	<i>Phoca vitulina</i>

Table 1. Marine mammal species recorded in the English Channel (including strandings). Sources: Jones et al. (2004); Evans (2006).

The diversity of marine mammals recorded in the English Channel is relatively poor, with only bottlenose dolphins and common dolphins being observed regularly (Evans, 2006). Harbour porpoises are observed occasionally near-shore, long-finned pilot whales are observed more often offshore, and there is some evidence that minke whales are now seen more regularly in the western region of the English Channel (Evans, 2006). Grey and common seals are seen occasionally in the area but there are no known significant breeding/haul-out areas for either species in this region (Evans, 2006).

Bottlenose dolphins are observed most commonly during summer (July – September), the majority of sightings being around the Solent and also the West and East Sussex coast in late summer (August-September) (Jones et al., 2004). Harbour porpoises are seen in near-shore areas during April, and between the months of August and October (Jones et al., 2004). Common dolphins are observed mostly offshore; however, small numbers have been observed around Durlston Head and Poole Bay between October and January (Jones et al., 2004). Sightings of long-finned pilot whales are more frequent in the western channel, although there is an easterly movement around October, with whales remaining in the area until December or January and a secondary peak during April (Jones et al., 2004).

Other cetacean species that have been recorded within the English Channel and are not considered regular visitors include; white-beaked, Atlantic white-sided, and striped dolphins, and minke, fin, sei, humpback and killer whales (Evans, 2006).

2.0. METHODS

2.1. Data collection

At this time, specific survey methods used to collect marine mammal sightings data are inferred, i.e. it is assumed that, in some cases, similar methodologies were used for marine mammals as they were for seabirds (ex. size of distance bands used from March to August 2010). In the absence of information from Marine Mammal Observers (MMOs) onboard during the different surveys, the following variables are unclear:

- Guidelines used to survey marine mammals;
- Range estimation techniques;
- Whether scans for marine mammals were conducted on one or both sides of the vessel;
- What determined how often and when environmental data were collected; and,
- If each survey covered each transect line once or if in some cases parts of a transect may have been surveyed twice in one survey.

In order to assess marine mammal presence in the survey area, a total of 30 boat-based marine mammal surveys were carried out between 9 March 2010 and 7 February 2012 at an interval of one-to-two surveys per month covering the proposed wind farm site, the 5 km buffer zone, the adjacent control areas and the proposed cable route. Three survey vessels were used to carry out the line transect surveys; *Smit Spey*, *Smit Dee* and the *Mabel Alice*. Figure 1 shows the proposed area for the Rampion offshore wind farm in the English Channel, and the 24 line transects.

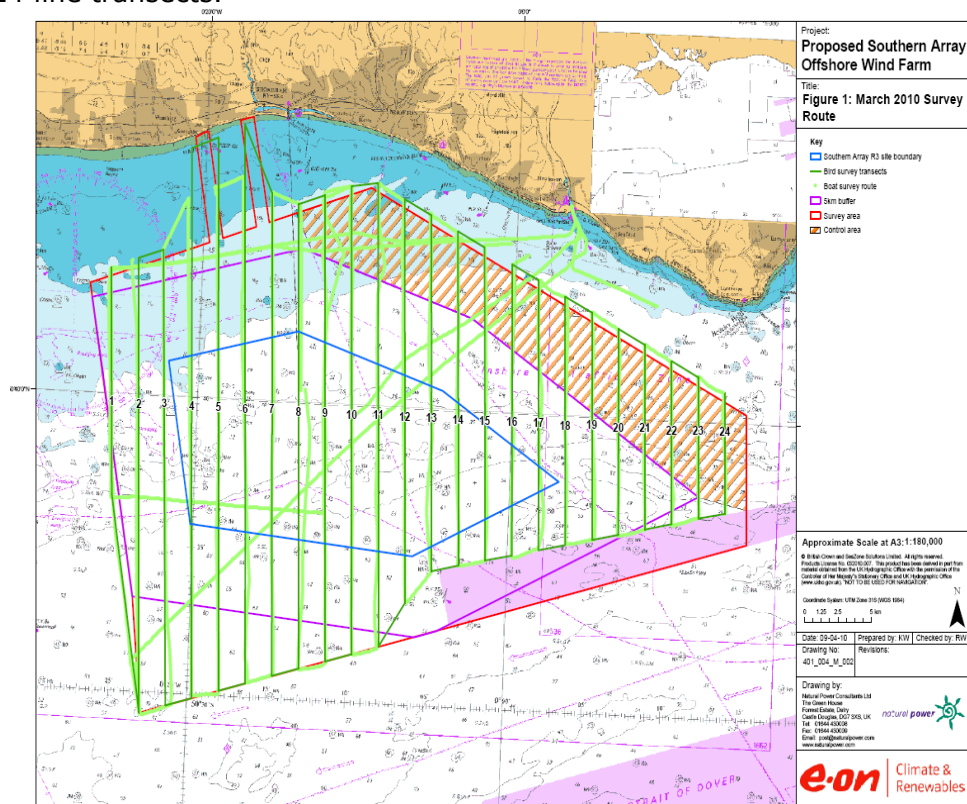


Figure 1. Proposed Rampion offshore wind farm (blue outline) and line transect survey area (red outline). Source: Pendlebury and Shreeve, (2010).



When marine mammals were sighted the following information was always recorded: date, time, transect, observer, species, number of animals, latitude, longitude and survey area. Most often, direction of travel, sighting cue and behaviour were also recorded. During surveys 1 – 6 (March – August 2010) observers recorded perpendicular distances to animals into the same distance bands used for seabird surveys (A = 0-50 m, B = 50-100 m, C = 100-200 m, D = 200-300 m, E = 300+ m). For every sighting from survey 7 – 30 (September 2010 – February 2012), angles and radial distances were measured to the animal or group of animals.

Environmental data collected during the survey included: wind direction, wind force, sea state, swell, visibility, cloud cover, rain and glare. Additional notes about the weather were sometimes recorded. Vessel bearing, speed and position were also recorded regularly. On occasion, observer position (port, starboard) was recorded.

2.2. Data analysis

Sightings from surveys 1 – 28 were plotted on a single route covered during one survey using MapInfo Professional 11, to look for any possible trends in the distribution of marine mammals in the survey area.

Sightings were summarised by different factors such as species, group, survey, area and/or season to look for possible trends or outliers. Statistical analysis was carried out using R-2.15.0 for Windows (32/64 bit).

Animal abundance, and therefore sighting success, is affected by a number of factors. It is important to quantify effort and incorporate correction factors that influence detectability, such as sea state (Evans and Hammond, 2004), visibility, observer effort, season etc., known as “multipliers” in distance sampling techniques (Buckland et al., 2001).

To account for differences in effort, the number of sightings and the number of observed individuals per day were divided by the amount of time spent surveying on that day to give sightings and individuals per hour. Sightings rates were summarised per survey and season in each year (spring: March – May, summer: June – August, autumn: September – November, and winter: December – February) for statistical analysis. Data were tested for normality using the Shapiro-Wilk test and Q-Q plots, and the appropriate statistical test undertaken. Rates were compared using the Kruskal-Wallis test to determine whether there was a difference in the number of sightings and individuals between surveys or seasons.

Effort was also taken into account by considering the amount of area surveyed during each season. Using planned transect length information, data gathered were used to calculate approximate density of the principle marine mammal species in the survey area, the harbour porpoise. It was assumed that each survey covered each transect line once per survey.

Estimated density analysis was based on sightings data that were pooled per survey and grouped per season. Only dedicated sightings within 300 m of either side of the vessel in distance bands A-D were considered to be on transect. Uncorrected density estimates were calculated by dividing the number of sightings during each survey by the surveyed area. The surveyed area equalled



the planned length of the survey transect multiplied by 600 m (2 x 300 m). A higher survey effort would therefore equate to a larger actual surveyed area. The number of harbour porpoises seen during each survey was then divided by the respective actual surveyed areas to estimate relative uncorrected densities.

A correction factor was calculated to account for the harbour porpoises missed at increasing distances from the transect line, and those missed on the transect line. The correction factor was calculated following similar methods used by Brasseur *et al.* (2004); however, all factors could not be applied fully due to the assumptions that are made, and how data were collected and recorded during this survey. Firstly, it is assumed that there were just as many porpoises observed in distance bands C and D, as there were in distance band AB. In a baseline study undertaken by Brasseur *et al.* (2004), 117 animals were observed in distance band AB on the starboard side. Applying this number to the other distance bands and to the port side, 702 (6 x 117) animals were estimated. To create a correction factor, the estimated number (702) was divided by the actual number of animals sighted (268), $702/268 = 2.62$. This factor only corrects for the effects of increasing perpendicular distance and assumes that all animals in the nearest distance band AB are actually seen. This is unlikely to be the case. Estimating a more accurate proportion of porpoises missed in distance band AB would have required the use of two observer teams watching the same strip at different distances ahead of the ship. This method was used in the Small Cetaceans in the European Atlantic and North Sea (SCANS) survey (Hammond *et al.*, 1995; 2002). During the SCANS porpoise surveys, about 1/3 of the porpoises at zero perpendicular distance were detected. Dividing the correction factor for increasing perpendicular distance by the proportion missed along the transect line, the overall correction factor for porpoise observations can be estimated, $2.62/0.33 = 7.91$. Therefore, in the study by Brasseur *et al.* (2004) any density estimations (or total numbers of harbour porpoises in the survey area) were multiplied by 7.91 to get the real densities or total numbers. As this is a survey specific correction factor, a separate one will be calculated from the data gathered during the Rampion offshore wind farm surveys.

To provide a correction factor that will give a reasonable density estimate for harbour porpoises that takes into account increasing perpendicular distance from the transect line and the proportion of sightings likely to have been missed, sightings numbers were multiplied by 3.78 to get estimated corrected densities. Estimated densities were then compared between seasons. These densities are not intended to be accurate population estimates, as they do not fully model the proportion of animals that may have been missed.

The line transect methods used during this survey are well suited for the estimation of marine mammal density and abundance in the survey area with distance sampling analyses (Buckland *et al.*, 2001; Thomas *et al.*, 2006). Distance sampling analysis involves fitting a detection function to the observed distances, which is then used to estimate the proportion of animals or groups missed. To do this, perpendicular distances were used, either from the observers recording radial angle and distance to each sighting, or recording perpendicular distances directly. As with the estimated densities above, a cut-off distance of 300 m was used. As sea state can affect the ability for observers to detect marine mammals, only sightings in Beaufort sea states of two or less are considered analysable (Hammond, 2007). With these restrictions it is possible that there will not be enough data to fit a detection function. A minimum sample size of at least 60 – 80 observations per species is required to estimate a reliable detection function (Buckland *et al.*, 2001). Various models were run in the software



package Distance 6.0 release 2 to investigate the feasibility of estimating a detection function with the limited data available.

There is not considered to be sufficient data to determine accurately the effects of sea state on the number of sightings; however, a preliminary investigation into this relationship was also undertaken to try and ascertain any further potential sources of error in the data. The number of harbour porpoise sightings from March 2010 – June 2011 at each sea state were divided by the amount of time spent surveying at that sea state to give a sightings rate per sea state. This took into account the differences in time spent surveying at each sea state. The correlation between sea state and sighting rates was then compared using Spearman's rank correlation.

2.3. Uncertainty and technical difficulties encountered

Data were collected by two different groups and then analysed by another. This has led to inconsistencies in data collection and difficulties in communication.

Between March and May, and September and November 2011, two surveys were carried out each month, but there was only one survey per month for the same period during 2010. Survey dates varied slightly between months, and on occasion was evidently due to poor weather. The timings in which surveys are carried out helps maximise the quality of scientific data collected while also highlighting any trends in seasonality and abundance.

Data collected during the March – August 2010 surveys recorded the distance to the animals as a category in the perpendicular distance bands used for surveying seabirds. During the September 2011 – February 2012 surveys distance to the animals was recorded as a radial distance in metres along with the angle to calculate perpendicular distance afterwards. Weather data were collected continuously throughout the surveys but not specifically recorded at the time of sightings, therefore increasing the time needed for analysis.

The calculation of harbour porpoise density also assumed that the MMOs were observing both sides of the vessel for marine mammals; this may not be the case. Information on exact survey methods were never received from the MMOs.

Some sightings information was interpreted differently in the monthly reports, for example in April 2010 there were nine harbour porpoise sightings in the buffer zone, yet the monthly report only mentioned seven in the buffer zone, so these two sightings have been interpreted as buffer incidental sightings for analyses purposes. This report only used raw data for analysis and not summaries from monthly reports.

3.0. RESULTS

3.1. Marine mammal sightings

Six species of marine mammals were positively identified ('definite') during 113 encounters with ca. 212+ individuals during line transect surveys (see Appendix). These species were harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, common seal and grey seal. Three harbour porpoises and one bottlenose dolphin were identified as a calf or juvenile. From March 2010 through

to February 2012, 30 surveys were completed. There were 93 survey days, equating to ca. 788 hours of total effort time.

Figure 2 shows the minimum number of marine mammals recorded within each survey area during dedicated sightings and also the number of individuals recorded as incidental sightings (outside the survey area or while not actually surveying a transect line). Marine mammals were seen most often within the site development area, followed in decreasing order by the 5 km buffer zone, adjacent control areas and the cable route corridor. Locations of marine mammal sightings during the surveys from March 2010 to early January 2012 are plotted in Figure 3. From this plot the pattern emerges that it appears that fewer marine mammals are observed in the far eastern side of the survey area.

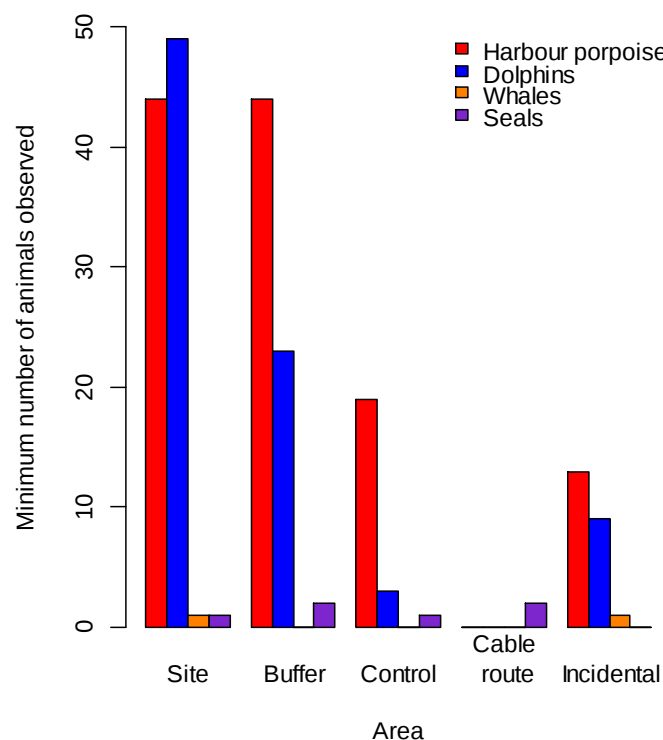


Figure 2. Minimum number of marine mammals recorded during dedicated and incidental sightings per area from the Rampion offshore wind farm site between March 2010 & February 2012. Source: OSC, 2012.

Figure 4 indicates that sightings of harbour porpoises were highest during spring/early summer, with maximum numbers of individuals recorded in March 2011. Bottlenose dolphin encounters occurred at various points throughout the year, with highest numbers of animals observed in July 2010. Sightings of seals (grey, common and unidentified) occurred in all areas within the surveyed area (site, buffer, control and cable route corridor), all with sightings of single animals. On one occasion, a single unidentified whale (probable minke) was observed in the site. A single white-beaked dolphin was seen on one occasion in the site in November 2011. There appears to be a low level of marine mammal activity in the English Channel during the winter months (Dec – Feb).

Harbour porpoises were recorded most frequently throughout all surveys. **Figure 5** shows harbour porpoise numbers between seasons, with spring showing highest number of sightings in both 2010 and 2011. There were no harbour



porpoise sightings during the 2010/2011 winter season and only two sightings, each of two individuals, during the 2011/2012 winter season.



RSK Marine mammal observation data analysis, Rampion

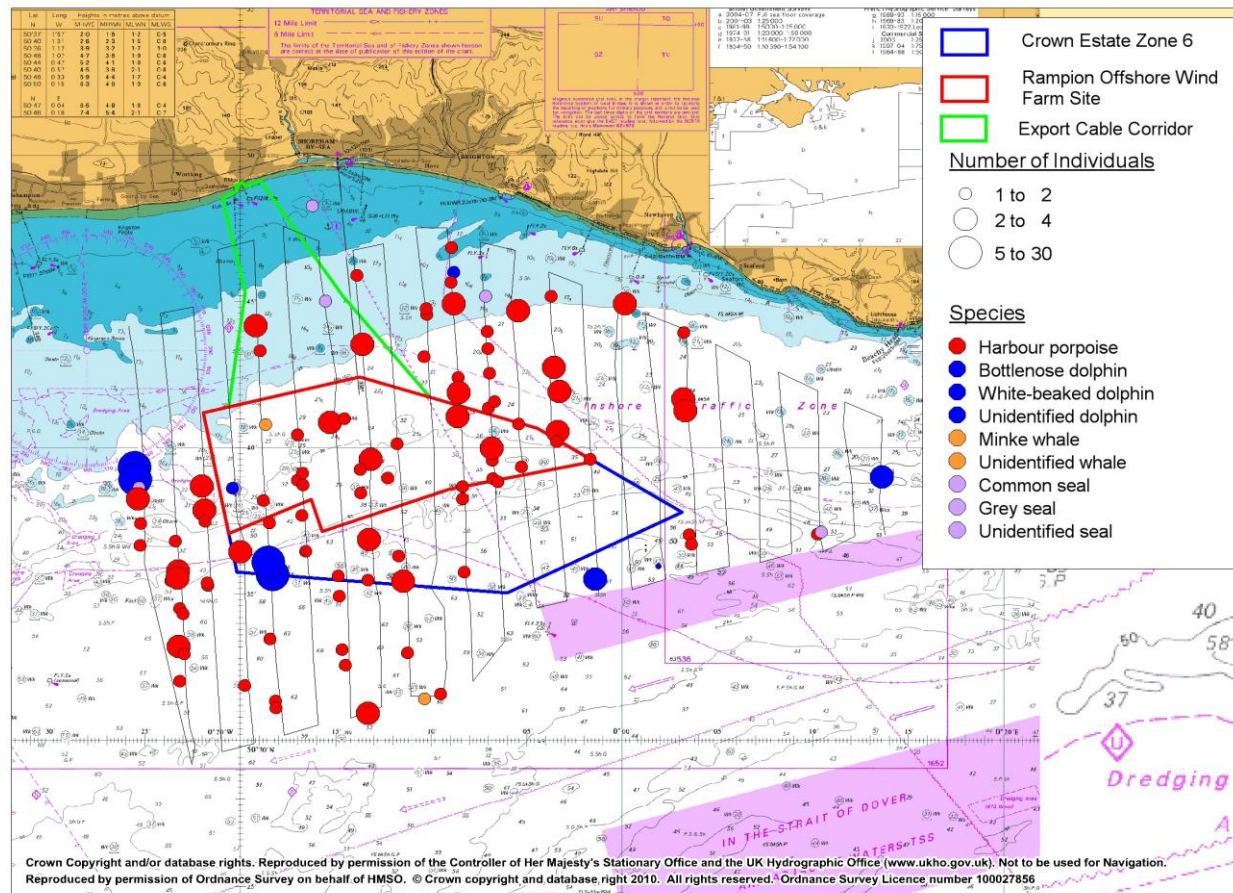


Figure 3. Marine mammal sightings at the Rampion offshore wind farm site between March 2010 and February 2012. Colours indicate the different types of marine mammal species observed. The size of the points indicates the number of marine mammals seen during that sighting. The line transect shown is from the July 2011 survey. The latest proposed consultation boundary is shown in green. The numbers in brackets next to each category show the number of sightings in that category. Source: OSC, 2012.

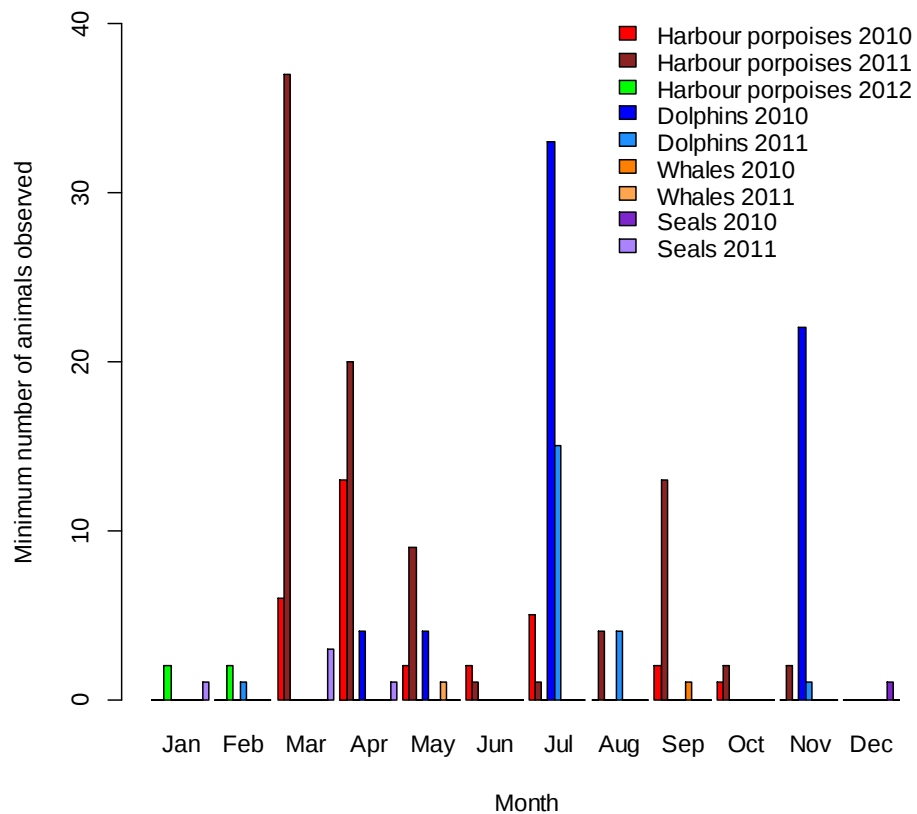


Figure 4. Monthly comparison of marine mammal sightings at the Rampion offshore wind farm site between March 2010 & February 2012. Two surveys were carried out during the months March, April, May, September, October and November 2011. Source: OSC, 2012.

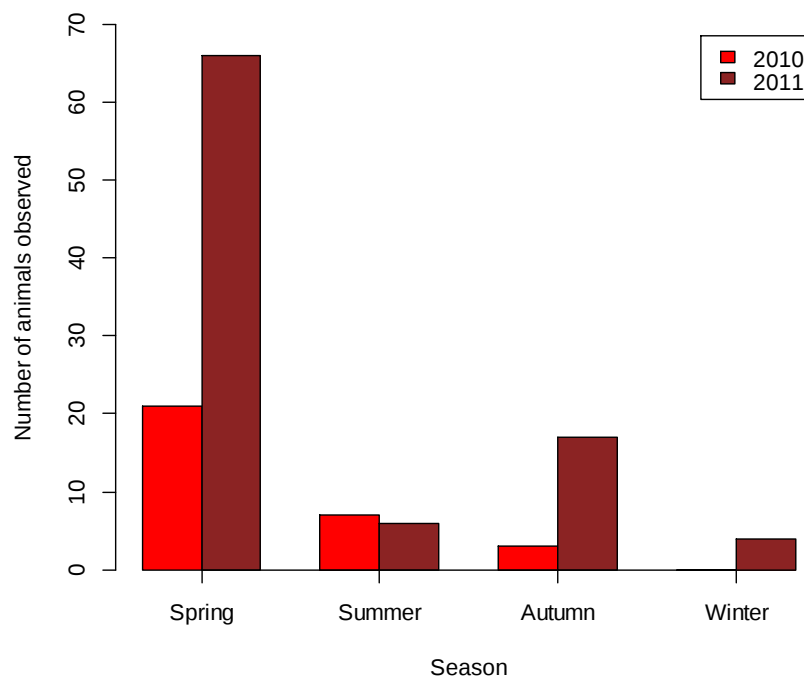


Figure 5. Comparison of harbour porpoise counts between seasons during baseline study at the planned Rampion offshore wind farm. January and February 2011 are classed as winter 2010 and January and February 2012 are classed as winter 2011. Source: OSC, 2012.

3.2. Sighting rates

The Shapiro-Wilk test and Q-Q plots showed that data were non-normally distributed ($p < 0.05$). Data transformations did not normalise the data, so non-parametric statistical analysis was used. The convention for reporting non-normally distributed data is through medians and interquartile ranges.

When survey effort was taken into consideration, the survey during the second half of March 2011 had the highest median number of marine mammals observed per hour, based on minimum group size estimates (Figure 6). No marine mammals were observed during the August 2010 survey, the second November 2011 survey and the January 2012 survey; though, two harbour porpoises were seen in January 2012 during the December 2011 survey. The difference in minimum marine mammals observed per hour among the surveys was not statistically significant (Kruskal-Wallis chi-squared = 31.7956, $df = 29$, $p = 0.3289$).

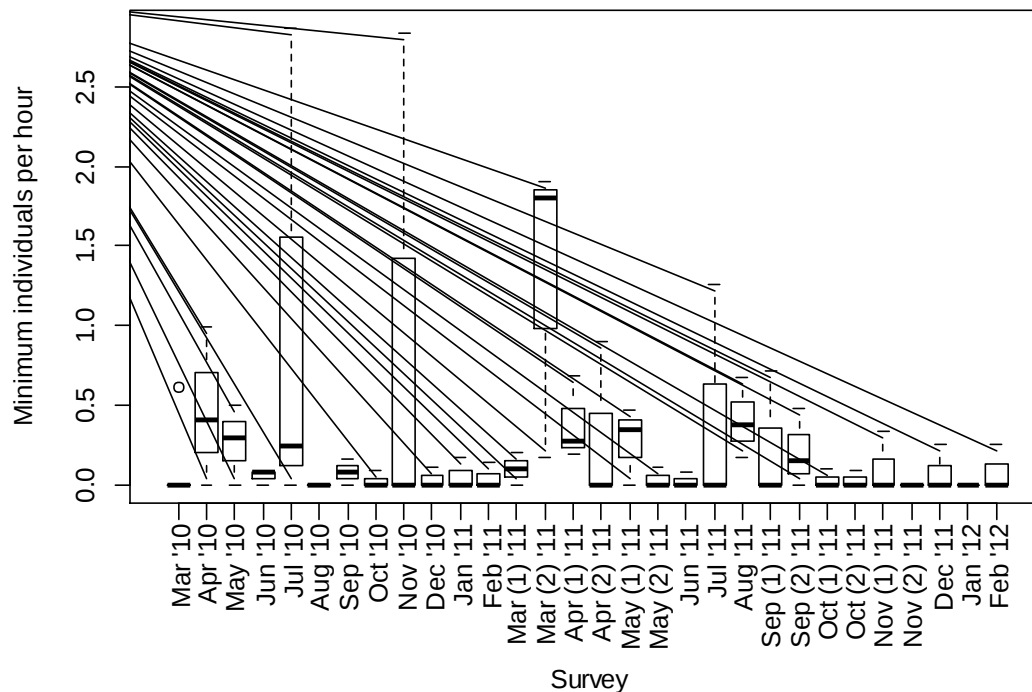


Figure 6. Median (thick line) minimum number of marine mammals observed per hour for each survey at the planned Rampion offshore wind farm. Months with two separate surveys are shown with (1) and (2). Whiskers show minimum and maximum data values, and boxes show interquartile range. Outliers are shown as dots. Source: OSC, 2012.

When surveys were grouped into season, spring 2011 had the highest median number of minimum marine mammals observed per hour (Figure 7). The difference in minimum marine mammals observed per hour among the seasons each year was not statistically significant (Kruskal-Wallis chi-squared = 9.8153, $df = 7$, $p = 0.1993$).

Harbour porpoises were the marine mammal observed most frequently. The survey in the second half of March 2011 had the highest harbour porpoise sightings rate (Figure 8). The difference in porpoise sightings per hour (Kruskal-Wallis chi-squared = 36.4451, $df = 29$, $p = 0.161$) and individuals per hour

(Kruskal-Wallis chi-squared = 35.1388, $df = 29$, $p = 0.2$) among the different surveys was not statistically significant.

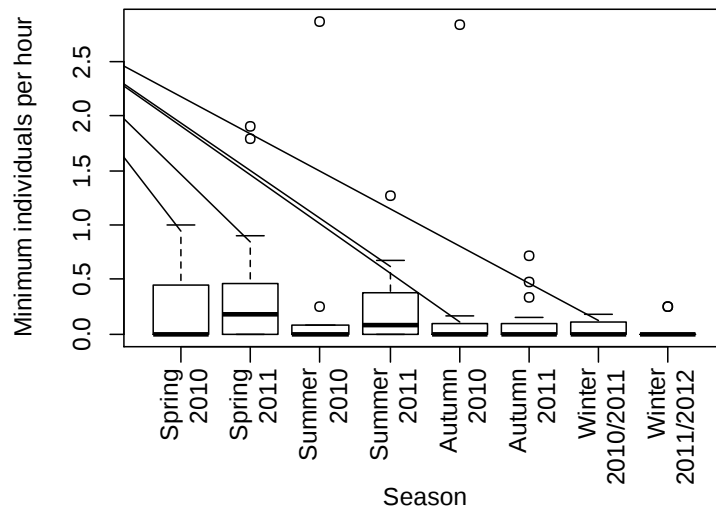


Figure 7. Median (thick line) minimum number of marine mammals observed per hour for each season at the planned Rampion offshore wind farm. Whiskers show minimum and maximum data values, and boxes show interquartile range. Outliers are shown as dots. Source: OSC, 2012.

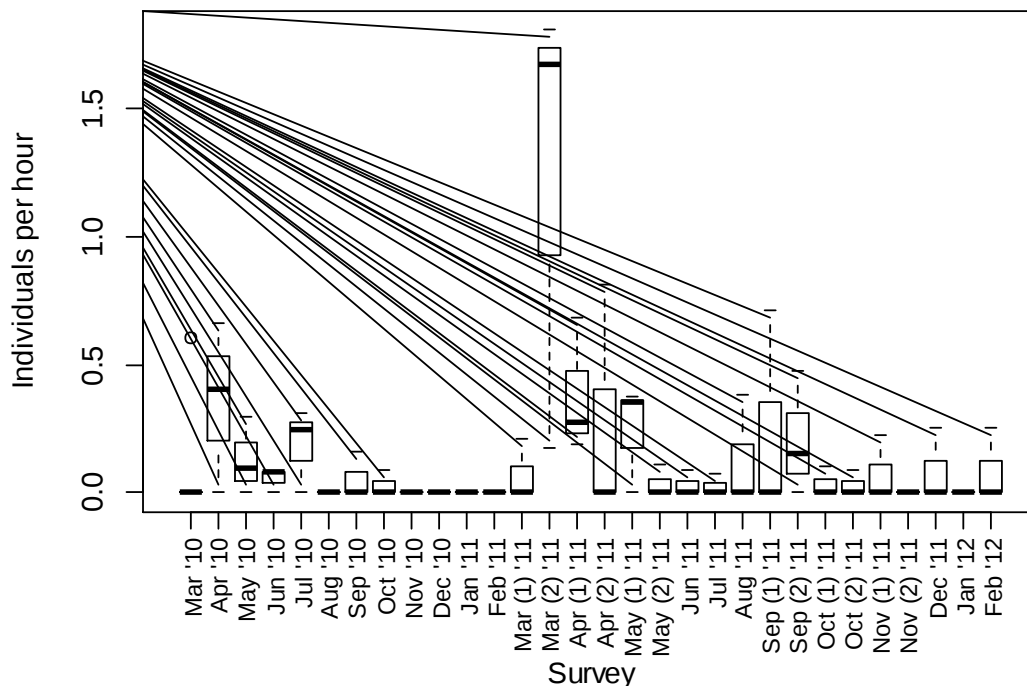


Figure 8. Median (thick line) number of harbour porpoise observed per hour during individual surveys at the planned Rampion offshore wind farm. Months with two separate surveys are shown with (1) and (2). Whiskers show minimum and maximum data values and boxes show interquartile range. Outliers are shown as dots. Source: OSC, 2012.

When compared by season, spring 2011 had the greatest number of harbour porpoise sighting per hour and individuals observed per hour (Figure 9). There were no harbour porpoise sightings during the winter of 2010/2011. The difference in porpoise sightings per hour (Kruskal-Wallis chi-squared = 16.394, $df = 7$, $p = 0.02175$) and individuals seen per hour (Kruskal-Wallis chi-squared = 15.3501, $df = 7$, $p = 0.03176$) among the seasons was statistically significant.

There were too few sightings of other marine mammal species (dolphins, whales and seals) to conduct statistical analysis for these species separately.

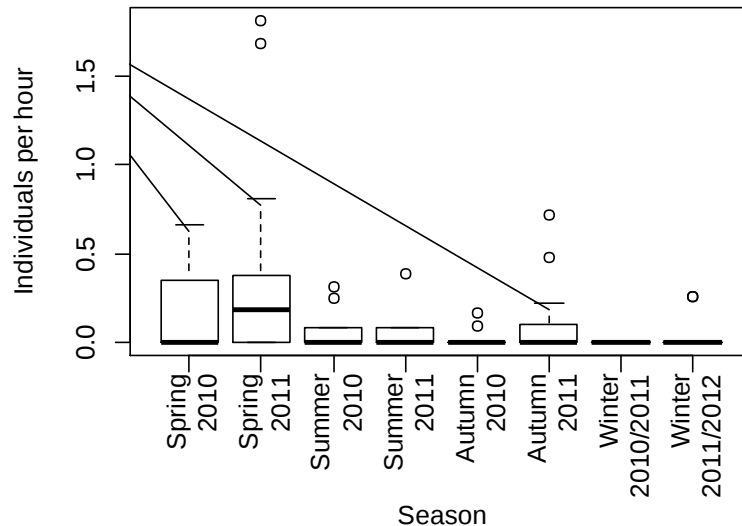


Figure 9. Median (thick line) number of harbour porpoises observed per hour for each season at the planned Rampion offshore wind farm. Whiskers show minimum and maximum data values, and boxes show interquartile range. Outliers are shown as dots. Source: OSC, 2012.

3.3. Relative density

The length of all survey transects totalled approximately 514.42 km for each survey. Harbour porpoise density ranged from approximately zero to 0.08/km² in the survey area, without the correction factor. Including the correction factor, there was a maximum porpoise density of approximately 0.29/km² during the second survey in March 2011.

There were 37 harbour porpoises seen in distance band AB. In total we would expect there to be 111 harbour porpoises in the transect area, assuming 37 porpoises are seen in each distance band. The correction factor for animals missed at increasing distances from the transect line equals the expected number (111) divided by the actual number of animals seen within 300 m (89), $111/89 = 1.257$. Dividing the correction factor for increasing perpendicular distance by the proportion missed along the transect line, the overall correction factor for porpoise observations becomes; $1.257/0.33 = 3.78$. As described in Section 2.2, a proportion missed of 0.33 is only obtainable with an optimal survey arrangement, so the overall correction factor is likely to be less.

Comparing relative seasonal density estimates for harbour porpoises, with correction factor, in the survey area, spring had the highest estimated density (Figure 10). Sample sizes were very small as sightings were restricted to those within 300 m of either side of the vessel. This is only an approximate density, as many factors that affect detectability have not been taken into consideration. It was also assumed that each survey covered the same length of transect, which may not have been the case in reality.

The difference in the estimated porpoise density among the seasons was not statistically significant (Kruskal-Wallis chi-squared = 13.9652, df = 7, $p = 0.0518$).

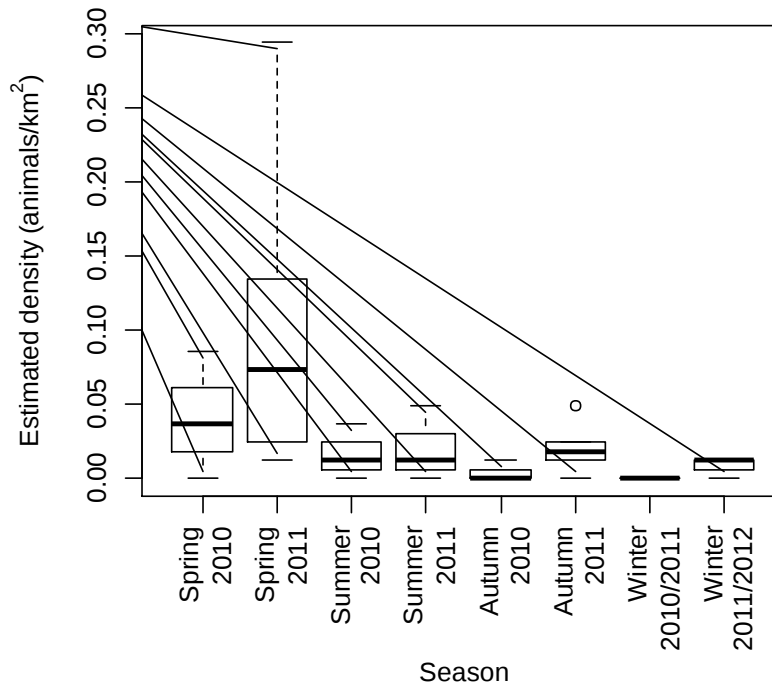


Figure 10. Approximate relative density of harbour porpoises in the planned Rampion offshore wind farm survey area with correction factor. Median values are shown as a thick line, minimum and maximum data values as whiskers, interquartile range as boxes, and outliers as dots. Source: OSC, 2012.

Of the 101 dedicated marine mammal sightings, 84 were of harbour porpoises. Sixty-two dedicated harbour porpoise sightings were within the 300 m cut-off distance, based on perpendicular distances. When factoring-in sightings at sea states of Beaufort 2 or less, only 43 sightings were analysable. For all models tested in the software package Distance 6.0 release 2 the probability density function plots had a horizontal line at 1.0 detection probability which would indicate that the observers were able to detect all passing harbour porpoises. This is unlikely the case in reality.

3.4. Effect of sea state

While it is not possible to model the effect of sea state as the data set is too small, an initial investigation into the effect of sea state on sightings showed that sighting rates tend to decrease when sea state increases (Spearman rank correlation = -0.9429, $p = 0.0167$, $S = 68$; Figure 11).

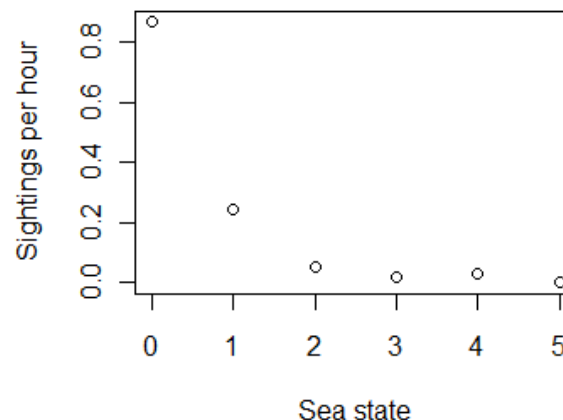


Figure 11. Harbour porpoise sightings per hour from March 2010 to June 2011 for each sea state. Source: OSC, 2011.

4.0. DISCUSSION

The harbour porpoise was the most frequently observed species throughout the 30 surveys. There is limited knowledge on harbour porpoise habitat usage in the English Channel, and it is not known how they use the area, e.g. foraging, breeding, transit route etc. Results from this baseline study have shown that there was a significant difference in the number of porpoises in the area during the seasons, with few/no sightings during the autumn/winter months. A study carried out by MacLeod (2009) on harbour porpoise occurrence in the English Channel found that there was a seven-fold increase from 0.02[/km²] in 1996 to 0.14[/km²]¹ in 2006. Of particular interest is the increase in sightings since 2003, primarily during the summer months, with sightings rate increasing from 0.04[/km²] to over 0.10[/km²] in summer 2005 and 2006 (MacLeod et al., 2009). Since numbers of porpoises in the English Channel are low during autumn and winter months, it has been suggested that there may be an increase in seasonal movements of harbour porpoise into the surveyed area during spring/summer months (MacLeod et al., 2009). Results from this baseline study corroborate the MacLeod et al. (2009) results.

Results show that bottlenose dolphins were often observed in large groups, and on one occasion, in association with seabirds, for example: Great skua (*Stercorarius skua*), gannets (*Morus bassanus*), kittiwakes (*Rissa tridactyla*) and herring gulls (*Larus argentatus*). It is therefore possible that dolphins were using this area as a feeding ground, as seabird/cetacean feeding associations have been reported elsewhere (e.g. Camphuysen, 2001; 2002; 2005).

When bottlenose dolphins were recorded in large numbers throughout the survey area, this coincided with smaller numbers of harbour porpoise sightings, for example July and November 2010 surveys. There is evidence from previous studies in the Moray Firth (Patterson et al., 1998; Ross and Wilson, 1996), Cardigan Bay (Simon et al., 2010), and the Pacific (Cotter et al., 2011), that suggest there is interspecific aggression from bottlenose dolphins towards harbour porpoises. Ross and Wilson (1996) carried out a study in the Moray Firth, and results highlighted that more than 60% of stranded harbour porpoise had suffered multiple skeletal fractures and damaged internal organs from violent interactions with bottlenose dolphins. Reasons for such violent interactions still remain unclear and divided. For example, Patterson (1998) suspects these interactions may be related to intraspecific infanticidal behaviour, with violent interactions also observed between adult bottlenose dolphins and dead bottlenose dolphin calves. While the data in this study are too few to make inferences on dolphin/porpoise interactions, future research in the English Channel area should monitor occurrence of bottlenose dolphin and harbour porpoise sightings to establish if interspecific aggression also occurs in this area.

The literature cites a number of environmental features that influence cetacean distribution, most likely because they lead to changes productivity (Walker, 2005). These include water depth (Baumgartner et al., 2001; MacLeod et al., 2004; Moore and DeMaster, 1988), sea floor gradient (Bonaccorsi and Sacchi, 1999; MacLeod et al., 2004; Tetley, 2004), Sea Surface Temperature (SST) and salinity (Tynan et al., 2005), thermocline depth (Tynan et al., 2005), primary

¹ Units were not specified in the paper, so presumed to be km².



productivity (Burtenshaw et al., 2004; Davis et al., 2002), bottom topography (Yen et al., 2003), thermal fronts (Tynan et al., 2005; Weir and O'Brien, 2000) and areas of upwelling (Tynan et al., 2005). English Channel waters are influenced oceanographically from the west (Atlantic) and the east (North Sea), which results in a great variety of wildlife at the water surface and within the water column, of both plankton and nektonic forms (Jones et al., 2004). Weir and O'Brien (2000) carried out a study on the association of cetacean species with frontal systems, in particular harbour porpoises in the Irish Sea, which found that porpoises were found predominately over mixed water or in the region of an upwelling with a consistent temperature and chlorophyll-*a* concentrations (Weir and O'Brien, 2000).

In March 2011, the highest harbour porpoise sightings rate was recorded in the survey area. In March 2011, the higher numbers of harbour porpoise also coincided with an early spring bloom in the English Channel. Plankton blooms normally occur in the English Channel from late spring to early summer, but this early bloom was a result of stormy weather stirring up nutrients to the surface, followed by a period of calm conditions allowing increased reproduction of phytoplankton. During a bloom, the concentration of chlorophyll-*a* increases over a period of several days. Figure 12 shows chlorophyll-*a* concentration in the English Channel area during the March 2011 survey, in comparison to March 2010, highlighting localised patches of primary production and fronts (Mann and Lazier, 2006), which are known to increase food availability to top predators, e.g. harbour porpoise (Gilles et al., 2011).

Harbour porpoises are small animals with a high metabolic rate, compared to other cetaceans, that need to remain in close proximity to their food resources and need to consume around 13% of their body weight in food daily (Evans, 1987). Since harbour porpoise diet varies seasonally (Gilles et al., 2009; Santos and Pierce, 2003), it can be expected that the relationship between porpoise occurrence and the environment will change on a seasonal basis (Gilles et al., 2011). While the data from this study are insufficient to provide conclusive evidence to support these hypotheses, the aggregation of harbour porpoises in the English Channel at this time may well have been as a result of enhanced productivity and availability of food resources, making the area an energetically efficient place to forage (Weir and O'Brien, 2000).

During the same week there was also an increase in SST within the English Channel, and Figure 13 shows SST between years 2010 and 2011. Macleod (2007) carried out a study on marine mammal habitat preferences in the west of Scotland, and found that harbour porpoise distribution was significantly linked to areas with a higher local variation in SST in shallow waters.

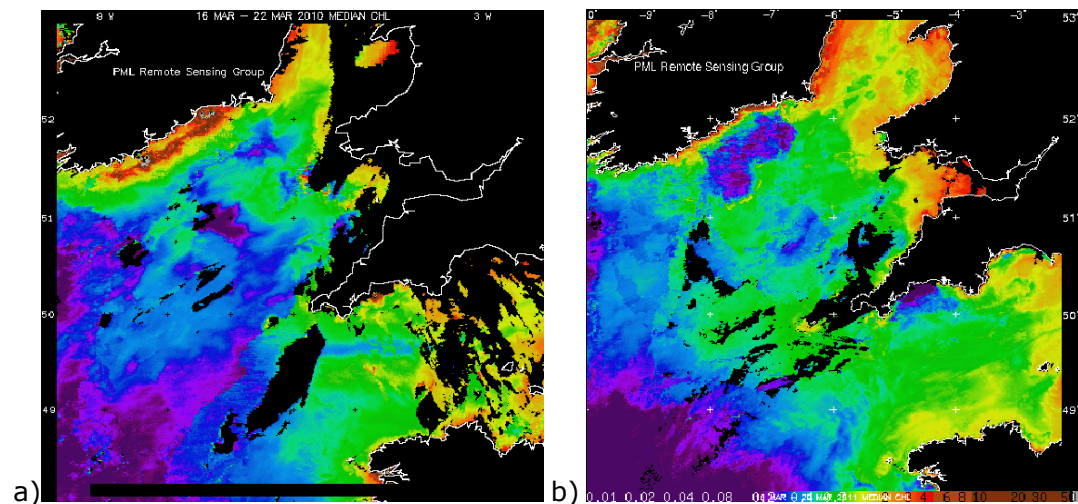


Figure 12. a) Chlorophyll-a concentration (mg/l). 16-22 March 2010 compared to b) chlorophyll-a 16-22 March 2011. Increasing concentrations shown on scale in (b) bottom right (e.g. red high). Source: Plymouth Marine Lab Remote Sensing Group.

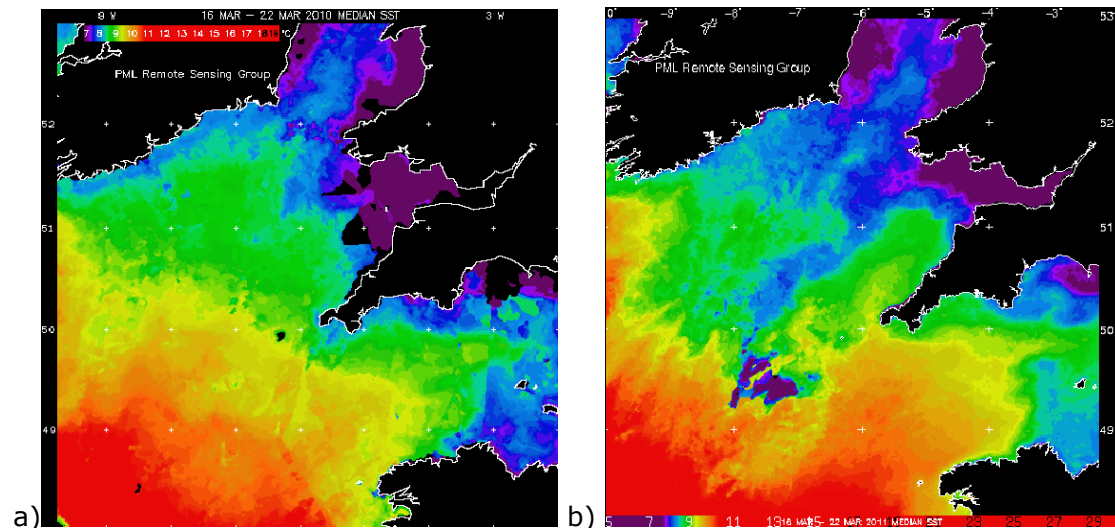


Figure 13. a) Sea Surface Temperature, SST (°C) 16-22 March 2010 compared to b) SST 16-22 March 2011. Scale on (a) top left and (b) bottom right e.g. red warmer, blue cooler. Source: Plymouth Marine Lab Remote Sensing Group.

The lack of sightings during the winter months could be the result of several factors. Firstly, animals may be moving further offshore into continental shelf waters or other regions, as is the case for bottlenose dolphins which are known to be confined to waters in the western Channel during winter months (Evans, 2006). Alternatively, the reduction in sightings could be because surveys during winter months were not carried out in weather conditions considered suitable for detecting marine mammals. Sea conditions during this period ranged from Beaufort two to five, where the wave height and presence of whitecaps hinders the visual detection of marine mammals, particularly small species (Palka, 1996). Streamlined species such as minke whales, despite their size, are also notoriously difficult to detect in anything less than relatively calm conditions. Therefore animals which may have been present could have gone undetected.

Over the next decade there will be a huge increase in the number of offshore wind farms. For example, in the German North Sea, 27 offshore wind farms have already been approved, and another 57 sites are in the approval process;

therefore, construction activities will be taking place simultaneously at several locations. Effects from construction activities can no longer be viewed as short-term (Gilles et al., 2011) and cumulative effects must be considered.

To date, the harbour porpoise and common seal have been the focus of research in impact studies of offshore wind farms because they are the most common coastal species; however, considering plans for further offshore wind farm development, other species should be included in impact assessments. To date, marine mammal monitoring programmes adopted at international offshore wind farm sites, including the Horns Rev and Nysted, have been more comprehensive than any other monitoring programme in the UK (Philpott, 2009). The round 3 wind farm developments could be further offshore than other developments, and so species such as white-beaked, Atlantic white-sided, and common dolphins; and killer and minke whales, could potentially be affected (Philpott, 2009).

5.0. PREDICTED IMPACTS

Table 2 summarises the predicted general impacts from construction, operation and decommissioning of wind farms on marine mammals.

Construction	Operation	Decommissioning
Behavioural impacts from increased noise during pile driving, drilling and dredging operations	Displacement due to operational noise	Noise from removing piles
Disturbance from vessels	Disturbance from maintenance activities and vessels	Vessel disturbance
Physical injury – ship strike or propeller injury	Electromagnetic impacts	Ship strikes from decommissioning vessels
Auditory injury – Permanent Threshold Shift (PTS), Temporary Threshold Shift (TTS)	Ship strike	Increased turbidity
Indirect effects – displacement of prey species	Indirect effects – change in habitat (including artificial reef effects causing habitat alterations), change in prey and food web (may be positive impacts)	Indirect effects – displacement of prey species

Table 2. Predicted impacts of wind farms during construction, operation & decommissioning.

5.1. Assessment of impacts

The assessment of potential impacts can be achieved by implementing a Before-After Control-Impact (BACI) experimental design. This design is considered to be robust for answering questions related to impact assessment (Tougaard et al., 2006).



For this to be effective it is important that the reference or control area is ideally more than 20 km from the source activity, especially during construction, so that the control area is not influenced by the activities in the impact area (Diederichs et al., 2008; Tougaard et al., 2006). If reference positions are too close to the impact area it is possible that any potential differences will not be detected because the reference area is still too loud. Currently, the control areas in the survey area are too close to the impact area. It is also important that the reference area has similar environmental factors to the impact area. If biotic and abiotic factors differ between the two sites, differences in marine mammal behaviour and presence may be due to these environmental differences and not the differences in noise levels.

It is also important that the study is maintained throughout the construction and operational phase, preferably for at least five years to allow for the assessment of possible long-term impacts (Evans, 2008).

At this stage, only visual surveys have been conducted around the proposed wind farm site. In some areas where sighting rates from visual surveys are very low, this method is considered ineffective for addressing impact levels (Tougaard et al., 2005a). In these situations, it has been recommended to augment visual surveys with static acoustic monitoring, using, for example, the T-POD (now superseded by the digital C-POD). Visual and T/C-POD survey techniques supplement each other and increase redundancy (Brasseur et al., 2004). A visual survey provides a high spatial and low temporal resolution, while a T/C-POD survey provides a low spatial and high temporal resolution (Tougaard et al., 2006). T-PODs have been used in several projects to monitor the presence and seasonal distribution of harbour porpoises around proposed wind farm sites and during construction (Brandt et al., 2011; Brasseur et al., 2004). The use of combined visual and T/C-POD surveys also compensates for some of the individual uncertainties associated with the respective methods on their own (Tougaard et al., 2006).

Correctly distributed, the use of T/C-PODs are also beneficial for monitoring the short term effects of pile driving activities and decommissioning of wind farms that occur over a larger spatial scale during a small temporal scale. The slow speed of observer vessels makes it nearly impossible to gather enough data at different distances from the impact site. If observer vessels were to be used, more than one ship would be required and weather conditions would have to be calm enough to collect sufficient data (Diederichs et al., 2008).

6.0. LITERATURE REVIEW

During the last decade the demand for renewable energy sources has led to the construction of offshore wind farms throughout Europe. The majority of wind farm developments to date have been in productive, near shore and shallow areas of less than 20 m characterised by rich and diverse marine life. The construction and operation of large wind turbines has raised concerns about potential impacts on the marine environment (Koschinski et al., 2003; Madsen et al., 2006; NRC, 2003). Underwater noise is produced both during construction and operation of offshore wind farms. Construction of wind farms are the main cause for concern, as this phase often includes a number of activities ranging from shipping, pile driving, trenching and dredging (Nedwell and Howell, 2004). When considering effects on marine mammals, pile driving is viewed to be of special concern, as it generates signals of very high source level and broad bandwidth (Richardson et al., 1995).



Marine mammals, particularly cetaceans (whales, dolphins and porpoises) use sound for prey detection, orientation and communication. All species of baleen whales (mysticetes) are known to produce low frequency sounds such as moans, thumps and knocks, in the 10–200 Hz range (Au, 2000; Thompson et al., 1979). Some mysticete species also produce pulses, chirps and 'songs', at higher frequencies of up to 10 kHz (Thompson et al., 1979). Toothed whales, dolphins and porpoises (odontocetes) produce a variety of sounds for communication, orientation and echolocation, including narrow-band frequency-modulated (FM) continuous tonal sounds known as whistles (0.5–80 kHz), and broadband sonar clicks (0.25–220 kHz) including burst pulse sounds (Au, 2000; Gordon and Tyack, 2002). The hearing range of cetacean species is less well understood, but it is generally assumed that whales and dolphins hear over similar frequency ranges to the sounds that they produce.

The exact effects of anthropogenic sound upon marine mammals are unknown, but reviews on the topic (e.g. Evans and Nice, 1996; Gordon et al., 2003; Richardson et al., 1995) suggest that increased background noise and specific sound sources might impact marine mammals in several ways: (1) masking of important sounds (including an animal's communication signals, echolocation, the sounds associated with finding prey or avoiding predators and human threats such as shipping); (2) alterations in behaviour (including displacement from feeding/breeding/migration habitat); (3) hearing loss (temporary or permanent); (4) chronic stress; and, (5) indirect effects including displacement of prey species. Disturbance to marine mammals from anthropogenic noise may cause disruption of feeding, breeding, migration and care of young; this has the potential to result in reduced food intake, reduced breeding success or reduced survival rate of offspring (Perry, 2002).

Richardson (1995) has identified four possible zones of noise influences, including; the zone of audibility, the zone of responsiveness, the zone of masking and the zone of hearing loss. The zone of audibility is characterised as the area within which the animal is able to detect the sound (Thomsen et al., 2006b). The area in which an animal reacts behaviourally or physiologically is defined as the zone of responsiveness, while the zone of masking is characterised as the area in which the noise is strong enough to interfere with detection of other sounds, for example; communication or echolocation clicks (Thomsen et al., 2006b). The final zone is the zone of hearing loss and is the area closest to the noise source where the received level is high enough to cause either temporary threshold shift (TTS) or permanent threshold shift (PTS) (Thomsen et al., 2006b).

The development of shallow water offshore wind farms has the potential to affect marine mammals in a variety of ways. Of those species inhabiting shallow waters around the UK, there are three main species of concern; the harbour porpoise, bottlenose dolphin, and common seal (Madsen et al., 2006). The harbour porpoise is the most common cetacean species in European waters and is also one of the most acoustically sensitive cetacean species (Au, 1999; Kastelein et al., 2002; Teilmann et al., 2002; Thomsen et al., 2006b; Verfuß et al., 2005). The harbour seal also has a well-developed underwater hearing system (Kastak and Schusterman, 1998; Riedmann, 1990). The construction of wind farms, particularly the noise generated from pile driving operations is high enough to damage the hearing system of both these species if found near the noise source, while also potentially disrupting their behaviour at considerable distances (Madsen et al., 2006; Nedwell and Howell, 2004; Nedwell et al., 2003; Thomsen et al., 2006a; Tougaard et al., 2003; Tougaard et al., 2005a).



Construction of wind turbines can include different foundation types such as steel monopile and gravitational concrete foundations. Monopile foundations are driven into the seabed using a pile driver (McKenzie Macon, 2000) or by vibration. It can take a number of hours to drive one monopile into the sea bed, depending on the sediment type. Driving a monopile 20-30 m into the seabed can produce very loud sound pressures exceeding 230 dB re 1 μ Pa peak-peak in source levels detectable at distances of tens of kilometres (Bailey et al., 2010). Pile driving is not used for gravitational concrete foundations in sheltered waters, therefore the peak-level noise impact from implementation of this foundation type is much lower and of a different nature (Madsen et al., 2006).

A study was carried out on the potential impacts of pile driving on harbour porpoises, before, during and after construction of the Horns Rev wind farm in the Danish North Sea. Observations found that porpoises left the area during pile driving and returned a few hours after piling operations ceased (Tougaard et al., 2005b). Differences in porpoise foraging activities were also observed at distances of up to 15 km from the construction area during pile driving sequences, compared to periods before and after (Tougaard et al., 2005b). Data from autonomous underwater porpoise echolocation-click detectors (T-PODs) also highlighted that pile driving had an effect on the acoustic activity of porpoises, with animals either leaving the area (or being silent), or changing their acoustic behaviour which resulted in fewer porpoise signals being detected by the T-PODs during pile driving; acoustic activity returned to normal within 3-4 hours after pile driving ceased (Tougaard et al., 2003).

Abundance of harbour porpoises was monitored during construction of the Nysted offshore wind farm also using T-PODs (Tougaard et al., 2005a). Data from baseline observations concluded that porpoises often frequented the Nysted offshore wind farm area, but left the area during construction, returning once more at the end of pile driving sequences (Tougaard et al., 2005a).

A small study was carried out in Scotland, in the Moray Firth (Beatrice offshore wind farm) on the impact of piling on harbour porpoise and bottlenose dolphins (Thompson et al., 2010). The results from this study found that there was a decrease in acoustic activity of harbour porpoises and bottlenose dolphins during pile driving activities, compared to periods of no pile driving (Thompson et al., 2010). The study found that there was no reduction in acoustic activity of small cetaceans at a site 40 km away from pile driving noise, suggesting that the impact zone was less than 40 km (Thompson et al., 2010).

There has only been one documented study on pile driving impacts on seals. This study took place again during construction of the Nysted offshore wind farm. The results from this study found that 20-60% fewer grey and common seals hauled out during pile driving activities compared to periods without pile driving. Furthermore, during the common seal pupping period in July (coinciding with pile driving), the amount of seals present was significantly less than both the previous year and the following year (Edren et al., 2010).

There is little information on the effects of operational wind farm noise on marine mammals. A study carried out by Tougaard (2005b) on the effects of the Horns Reef wind farm in operation on harbour porpoises highlighted that wind farms could potentially affect harbour porpoises in three ways: changes to habitat (which could be positive and/or negative), disturbance from turbines and disturbance from service and maintenance activities. Changes in habitat may



result in change in abundance and species composition of fish around the wind farm as a result of the introduction of hard bottom substrates (Tougaard et al., 2005b). Changes in fish fauna can result in possible negative impacts to harbour porpoise and other marine mammals with a reduction in potential prey species. On the other hand, the introduction of wind turbines may result in the formation of an artificial reef, with the attraction of important prey species to the wind farm site from the increased epifauna attached to the wind turbine structures (Tougaard et al., 2005b). Research has shown that the introduction of structures such as wind turbines, wave powered devices and also oil platforms, act as an artificial reef with increased marine organisms and fish aggregations around these sites (Baine, 2001; Todd et al., 2009; Whitmarsh et al., 2008).

The physical presence of the wind farm should not have a major impact on porpoise presence; however, the noise generated from the turbines is the main concern. A study carried out by Tougaard (2009) measured noise from three types of operational wind turbines in Denmark and Sweden (Middelgrunden, Vindeby, and Bockstigen-Valar). Total sound pressure level was found to be in the range 109-127 dB re 1 μ Pa rms up to 20 kHz, measured between 14 and 20 m from the foundations (Tougaard et al., 2009). The results highlighted that turbine noise was identifiable above background noise, and audible to harbour porpoises extending 20-70 m from the foundations; however, for common seals, noise can be audible from less than 100 m up to several kilometres. It has been suggested that noise from turbines will not reach dangerous levels, and is incapable of masking acoustic communication in porpoises and seals (Tougaard et al., 2009). Using auditory evoked potential and simulated operational wind turbine noise Lucke et al. (2007) found that there was a masking effect at 128 dB re 1 μ Pa at 0.7, 1.0, and 2.0 kHz but no significant masking at 115 dB re 1 μ Pa.

Disturbance from service and maintenance activities is likely to be brought about from the noise of service ships (Tougaard et al., 2005b). Studies of shipping impacts on harbour porpoises for example; found that porpoises were likely to avoid vessels of all sizes and have been known to sometimes move away from an area completely; however, it was also found that porpoises were more likely to avoid the infrequent vessels more than the routine vessels (Evans et al., 1994; Perry, 2002).

7.0. MITIGATION MEASURES

7.1. During construction

During the construction of wind farms, various activities have been identified which may have an impact on marine mammals. In order to minimise the impacts, numerous mitigation measures can be adopted. It is important that there are no marine mammals in the immediate vicinity of any loud noises created during construction. A construction monitoring programme should be designed to reflect what is already known about the area taken from data collected during the baseline study. Marine mammal species differ in their reactions and sensitivities to human activities and so different monitoring approaches may be required to assess impacts.

The combination of visual and acoustic monitoring of marine mammals could increase chances of detecting marine mammals. Monitoring of noise levels and marine mammal abundance and distribution should be closely observed particularly during the construction phase (Philpott, 2009). Other mitigation measures employed during the construction phase include soft start for piling



operations and use of deterrent devices (pingers and seal scarers), designed to allow marine mammals to move away from the area of noise. Acoustic harassment devices (AHD) have been used for seals and porpoises, and have proven to be effective in keeping animals away from the noise source (Culik et al., 2001; Yurk and Trites, 2000). A study carried out by Culik (2001) demonstrated that the use of pingers created an avoidance zone of 500 m for harbour porpoises. The use of such devices, in particular AHDs, would be subject to separate licensing from the relevant authorities.

Timing of construction should also be timed around sensitivities, for example; migration peaks or breeding seasons (Thomsen et al., 2006b). There are also other mitigation options that could be considered, including: 1. mantling of the ramming pile with acoustically-isolated material (e.g. plastic; decrease of 5–25 dB in SL) and, 2. air-bubble curtain around the pile (decrease of 10-20 dB, depending on frequency; (Würsig et al., 2000)). Air bubble curtain is expensive and unfortunately may only be effective in shallow waters (Thomsen et al., 2006b).

Effects of construction, operation and decommissioning of wind farms on marine mammals should also be monitored on a temporal and spatial scale (Diederichs et al., 2008). Monitoring marine mammals on a spatial scale, allows for assessment of differences between wind farm site and areas less affected by the wind farm. Monitoring on a temporal scale allows for comparisons to be made between the different stages of development (e.g. before during and after construction and during operation of the wind farm) (Diederichs et al., 2008).

The Joint Nature Conservation Committee (JNCC) has produced guidelines to help minimise disturbance to marine mammals during piling operations. Marine Mammal Observers on board survey vessels should carry out visual observations for marine mammals during daylight hours ensuring JNCC guidelines are adhered to. Passive Acoustic Monitoring (PAM) is increasingly being used as a mitigation tool, either using towed arrays, or deploying T/C-PODs at set locations detecting vocalising marine mammals, with PAM 24-hour monitoring for marine mammals can be carried out.

7.2. During operation

In order to assess impacts and/or magnitude of impacts, post construction surveys should be carried out. Baseline studies are crucial in investigating the occurrence of marine mammals in an area, while also providing information on habitat use and if there is any seasonal variation. Post construction surveys can then compare results to pre-construction or baseline data. Noise monitoring should be carried out on operational turbines, measurements of ambient noise before, during and after construction could help specify the potential effects from wind farms (Madsen et al., 2006). A positive effect brought about from the development of wind farms is the artificial reef effect, which could counteract any other negative impact, and actually positively enhance environmental conditions for marine mammals, in particular harbour porpoises (Todd et al., 2009).

7.3. During decommissioning

The decommissioning process is the reverse of the construction phase, although there will be no pile driving during this phase. There is currently no information on the decommissioning of wind farms.

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Appendix

Marine mammal sightings in the planned Rampion offshore wind farm survey area from March 2010 to February 2012.

Sighting	Date	Time	Species	Perpendicular distance (m)	No. of individuals	Area
1	13/03/10	12:57	Harbour porpoise	300+	2	Site
2	13/03/10	13:32	Harbour porpoise	100-200	1	Control
3	13/03/10	14:12	Harbour porpoise		1	Buffer
4	13/03/10	15:59	Harbour porpoise	0-50	2	Control
5	17/04/10	17:40	Harbour porpoise	300+	1	Site
6	17/04/10	17:44	Harbour porpoise	200-300	1	Buffer
7	17/04/10	17:54	Harbour porpoise	300+	1	Buffer
8	17/04/10	18:47	Harbour porpoise	50-100	2	Site
9	18/04/10	09:19	Harbour porpoise	300+	1	Buffer
10	18/04/10	10:16	Harbour porpoise	300+	1	Buffer
11	18/04/10	10:19	Harbour porpoise	300+	2	Buffer
12	18/04/10	14:28	Unidentified dolphin	0-50	4	Buffer
13	18/04/10	14:29	Harbour porpoise	50-100	2	Buffer
14	18/04/10	15:38	Harbour porpoise	200-300	1	Site
15	18/04/10	18:10	Harbour porpoise	100-200	1	Buffer
16	13/05/10	13:22	Harbour porpoise		1	Buffer incidental
17	13/05/10	13:36	Unidentified dolphin	300+	4-5	Buffer
18	15/05/10	10:22	Harbour porpoise	200-300	1	Incidental
19	22/06/10	09:18	Harbour porpoise	0-50	1	Buffer
20	23/06/10	07:38	Harbour porpoise	300+	1	Site
21	06/07/10	09:00	Harbour porpoise	300+	1	Control incidental
22	06/07/10	09:07	Harbour porpoise	100-200	3	Buffer incidental
23	06/07/10	14:49	Bottlenose dolphin	400	3	Site
24	06/07/10	14:51	Bottlenose dolphin	500	30	Site
25	08/07/10	11:04	Harbour porpoise	800	1	Buffer
26	08/09/10	14:09	Unidentified whale	376	1	Site
27	09/09/10	17:41	Harbour porpoise	26	2	Incidental
28	04/10/10	14:08	Harbour porpoise	212	1	Buffer



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29	19/11/10	08:58	Bottlenose dolphin	1732	13	Buffer
30	19/11/10	09:00	Bottlenose dolphin	141	4-5	Buffer
31	19/11/10	09:00	Unidentified dolphin	2121	5-10	Buffer
32	09/12/10	15:01	Unidentified seal	100	1	Control
33	21/01/11	08:42	Unidentified seal	130	1	Buffer
34	10/02/11	12:12	Bottlenose dolphin	0	1	Control
35	15/03/11	13:56	Grey seal	0	1	Buffer
36	16/03/11	09:42	Harbour porpoise	278	2	Buffer
37	21/03/11	10:32	Harbour porpoise	100	1	Buffer
38	21/03/11	11:03	Harbour porpoise	25	1	Incidental
39	21/03/11	11:43	Harbour porpoise	303	1	Buffer
40	21/03/11	13:03	Harbour porpoise	217	2	Buffer
41	21/03/11	13:16	Harbour porpoise	98	1	Buffer
42	21/03/11	14:23	Harbour porpoise	100	2	Site
43	21/03/11	14:34	Unidentified seal	173	1	Site
44	21/03/11	16:07	Harbour porpoise	520	1	Site
45	21/03/11	16:31	Harbour porpoise	707	1	Buffer
46	21/03/11	16:42	Harbour porpoise	141	1	Control
47	21/03/11	16:43	Harbour porpoise	606	1	Control
48	21/03/11	17:31	Harbour porpoise	300	1	Site
49	21/03/11	17:45	Harbour porpoise	173	1	Site
50	22/03/11	07:05	Common seal	20	1	Cable route
51	22/03/11	09:21	Harbour porpoise	141	2	Buffer
52	22/03/11	09:32	Harbour porpoise	400	1	Control
53	22/03/11	12:09	Harbour porpoise	141	1	Buffer
54	22/03/11	12:10	Harbour porpoise	0	1	Control
55	22/03/11	12:10	Harbour porpoise	0	1	Control
56	22/03/11	12:42	Harbour porpoise	354	2	Control
57	22/03/11	13:13	Harbour porpoise	0	1	Site
58	22/03/11	13:15	Harbour porpoise	250	1	Site
59	22/03/11	13:27	Harbour porpoise	250	1	Site
60	22/03/11	14:21	Harbour porpoise	433	1	Site
61	22/03/11	14:24	Harbour porpoise	283	1	Site
62	22/03/11	14:26	Harbour porpoise	260	2	Site
63	22/03/11	14:39	Harbour porpoise	71	1	Buffer
64	22/03/11	14:43	Harbour porpoise	689	1	Buffer
65	22/03/11	14:46	Harbour porpoise	354	1	Buffer



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66	22/03/11	15:34	Harbour porpoise	283	1	Site
67	22/03/11	15:41	Harbour porpoise	104	1	Site
68	23/03/11	10:49	Harbour porpoise	0	1	Control
69	04/04/11	11:33	Harbour porpoise	106	2	Control
70	06/04/11	10:59	Harbour porpoise	106	2	Site
71	06/04/11	12:54	Harbour porpoise	71	1	Site
72	06/04/11	13:16	Harbour porpoise	71	2	Incidental
73	06/04/11	15:21	Harbour porpoise	350	1	Site
74	06/04/11	17:13	Harbour porpoise	106	2	Buffer
75	07/04/11	11:48	Harbour porpoise	150	1	Buffer
76	20/04/11	09:28	Harbour porpoise	0	2	Buffer
77	20/04/11	10:44	Harbour porpoise	125	2	Buffer
78	20/04/11	10:50	Harbour porpoise	400	1	Buffer
79	20/04/11	14:55	Harbour porpoise	300	1	Site
80	20/04/11	15:58	Common seal	300	1	Cable route
81	20/04/11	18:18	Harbour porpoise	200	3	Site
82	09/05/11	14:13	Harbour porpoise	100	1	Site
83	09/05/11	15:33	Harbour porpoise	35	1	Site
84	09/05/11	18:26	Harbour porpoise	300	1	Site
85	09/05/11	18:30	Harbour porpoise	100	1	Site
86	10/05/11	08:03	Harbour porpoise	200	1	Site
87	10/05/11	08:33	Harbour porpoise	246	1	Buffer
88	10/05/11	08:43	Minke whale	1000	1	Incidental
89	10/05/11	08:46	Harbour porpoise	103	1	Incidental
90	10/05/11	11:58	Harbour porpoise	283	1	Site
91	19/05/11	11:18	Harbour porpoise	141	1	Control
92	07/06/11	10:29	Harbour porpoise	150	1	Control
93	11/07/11	13:55	Bottlenose dolphin	1500-2000	15-20	Site
94	11/07/11	18:47	Harbour porpoise	400	1	Site
95	15/08/11		Harbour porpoise	200	2	Buffer
96	15/08/11		Harbour porpoise	5	2	Site
97	16/08/11		Bottlenose dolphin	94	2	Buffer
98	17/08/11		Unidentified dolphin	386	2	Control
99	15/09/11		Harbour porpoise	172	2	Incidental
100	15/09/11		Harbour porpoise	250	1	Control
101	15/09/11		Harbour porpoise	400	4	Site
102	15/09/11		Harbour porpoise	150	1	Site



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103	27/09/11		Harbour porpoise	500	1	Control
104	27/09/11		Harbour porpoise	0	1	Site
105	27/09/11		Harbour porpoise	230	2	Buffer
106	28/09/11		Harbour porpoise	100	1	Control
107	12/10/11		Harbour porpoise	18	1	Buffer
108	20/10/11		Harbour porpoise	106	1	Buffer
109	09/11/11		Harbour porpoise	17	1	Buffer
110	09/11/11		Harbour porpoise	188	1	Buffer
111	09/11/11		White-beaked dolphin	5	1	Site
112	08/01/12		Harbour porpoise	197	2	Control
113	06/02/12	15:21	Harbour porpoise	98	2	Control