CHAPTER 16

Attraction of harbour porpoises to offshore wind farms: what can be expected?

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The elusive and highly mobile harbour porpoise is the most abundant cetacean in Belgian waters, seasonally reaching average densities of more than 2 animals/km². Operational wind farms may affect the porpoise habitat in various negative and positive ways, such as through the introduction of possibly deterrent noise or the introduction of artificial substrates with associated porpoise prey fish. Porpoises show concentration areas in Belgium, none of which being linked to the wind farms so far. Because of the spatial resolution being too low, aerial surveys will need to be complemented with targeted passive acoustic monitoring in the future.

INTRODUCTION

The most abundant cetacean in Belgian waters, as well as in the North Sea as a whole and in the adjacent Atlantic Ocean, is the harbour porpoise *Phocoena phocoena.* In Belgian waters it is especially common during late winter and early spring. Recent data indicate that their numbers in the southern North Sea have increased also during winter and summer/early fall of the last decade (Haelters et al., 2011a; MUMM, unpublished; SCANS II). There is a lot of speculation about possible attraction to, or expulsion from operational wind farm areas. Harbour porpoises may be attracted to the wind farms because of the high numbers of fish near wind turbine foundations (Chapter 14) or because there is less disturbance due to shipping or fishing (Scheidat et al., 2011). They may however also be scared off because of the increased underwater noise levels within and around operational wind turbines (Chapter 6). We investigated if the current monitoring could reveal attraction or expulsion phenomena.

MONITORING DESIGN

In the framework of offshore wind farm monitoring we combined two methods to study the temporal and spatial distribution and abundance of harbour porpoises: aerial line transect monitoring (Buckland et al, 2001) and passive acoustic monitoring (PAM) using autonomous, moored sensors (Figure 2).

The highly standardised aerial survey flights were carried out following predefined track lines 5 km apart (Haelters, 2009). From the results densities were estimated for 10 by 10 km blocks. These blocks were chosen to reveal broad-scale differences in density of harbour porpoises in Belgian waters between surveys carried out from 2008, when no wind turbines were present, up to 2013, when wind farms were (partly) operational at the Thornton- and Bligh Bank. Between 2008 and 2013, 20 aerial surveys were performed. A number of these were made when pile driving took place in Belgian waters, while others were incomplete. Not every season could be covered by aerial surveys:

most of them were made during late winter and early spring, when harbour porpoises are known to be present in Belgian waters at highest densities. For the analysis we used only the surveys that were complete or almost complete, and that took place when no piling was taking place.

Figure 1. Aircraft used for aerial surveys (Norman Britten Islander), and a cardinal buoy with a chain at its side holding a C-PoD; the C-PoD is hanging at a depth of around 1.5m, and is contained in an open stainless steel tube.

For PAM we used C-PoDs, devices that record characteristics of noise such as frequency, duration, repetition and bandwidth. Using dedicated software (see www.chelonia.co.uk) the most probable source of the noise (dolphin, porpoise, SONAR) is attributed to every noise event. As such, PAM yields a detailed temporal indication (detection rate) of the presence or absence of harbour porpoises at the mooring location (Haelters et al., 2011b). Between 2009 and 2013 we moored C-PoDs near the edge of territorial waters in the eastern and western part of Belgian waters (respectively at the Thorntonbank or Gootebank and at the Oostdyck Bank), and a few km off Blankenberge (MOW1; Figure 2). Data collected during or shortly after piling operations were omitted in the analysis presented here, as these operations have shown to affect harbour porpoise presence, and as such detection rates, over a large area (Haelters et al, 2012a). As a measure of harbour porpoise presence we used the percentage of *detection positive 10 minutes per day* (DP10m/d): this is the fraction of 10 minute periods in a day in which harbour porpoises were detected.
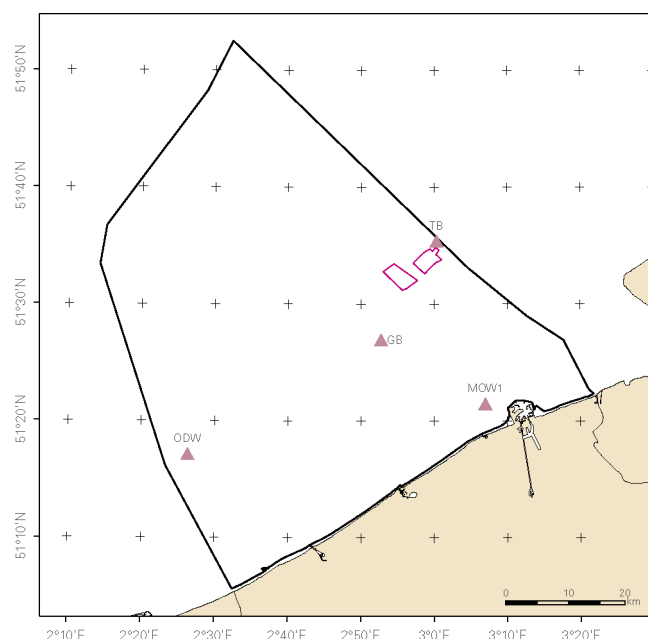
Figure 2. Location of the C-PoDs (TB: Thorntonbank; GB: Gootebank; MOW1: Meetdienst Openbare Werken 1; ODW: Oostdyck West).

Legend

☐ Belgian continental shelf

☐ C-Power Wind farm

▲ C-PoDs

SPATIAL AND TEMPORAL DISTRIBU-TION OF HARBOUR PORPOISES

The highest average densities of harbour porpoises were mostly recorded during March and April, with up to 2.7 ind./km² in March 2011, although large inter-annual fluctuations occurred (for instance between 2008 and 2013 in May, and between 2010 and 2011 in April) and data presented wide confidence intervals (Figure 3). The lowest densities recorded were 0.05 animals/km² (August 2009) and 0.16 animals/km² (May 2009 and January 2010).

Density surface maps resulting from the aerial surveys illustrate an uneven distribution of harbour porpoises in Belgian waters in space and time (a selection is presented in figure 4). While the results of the surveys of February indicate a fairly even density, the majority of the porpoises was found in the western part during March and April. This suggests a seasonal shift in distribution between February and April from the northern and north-eastern part of Belgian waters towards the south-west and west.
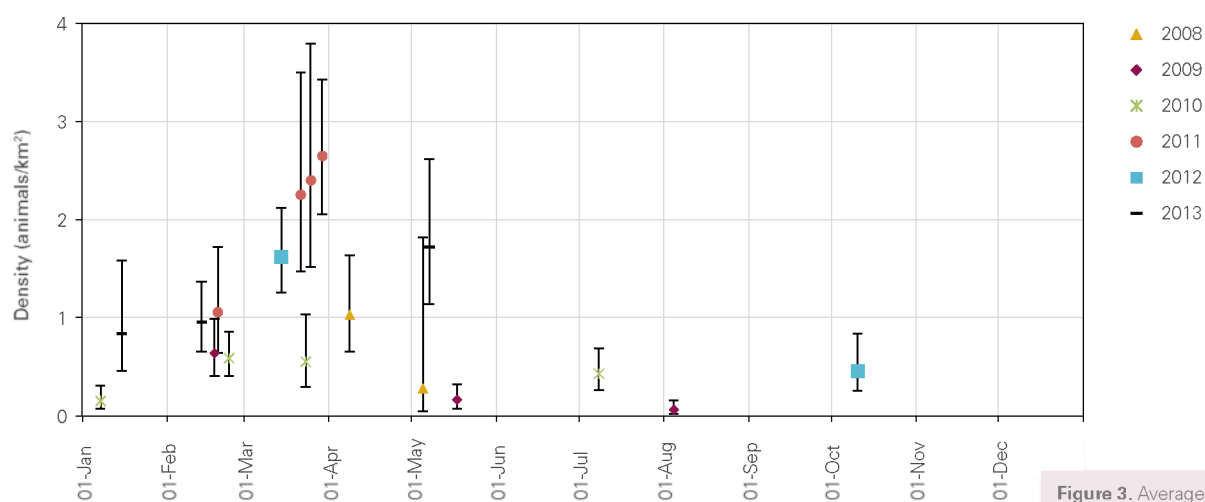
Figure 3. Average density of harbour porpoises in the survey area, estimated on the basis of aerial surveys performed between 2008 and 2013.
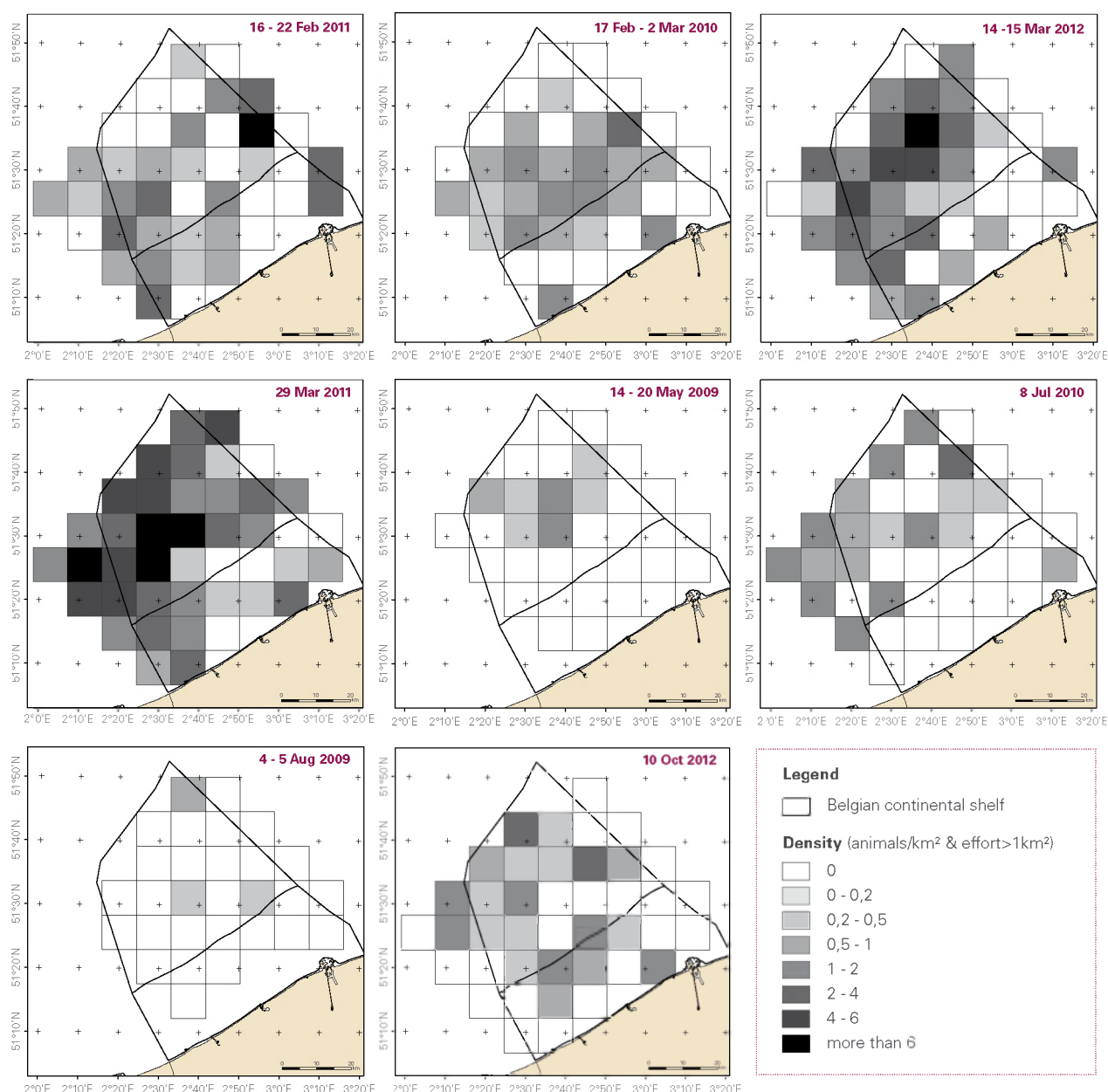

Figure 4. Selection of harbour porpoise density (n/km²) maps based on data collected during aerial surveys. Only aerial surveys performed during times when no pile driving was ongoing in Belgian waters, and with a (virtually) complete coverage are presented.

The results of PAM (Figure 5) indicate a generally low detection rate at the MOW1 location, consistent with few harbour porpoises close to shore in the eastern part of Belgian waters. The highest detection rate at this location occurred, although irregularly, during late winter – early spring. The detection rate was seasonally higher further offshore. At the Oostdyck the

PAM data indicate a higher detection rate from the end of February to the end of April (2012). At the Thorntonbank the combined data from 2011 to 2013 indicate a higher detection rate between February and May.
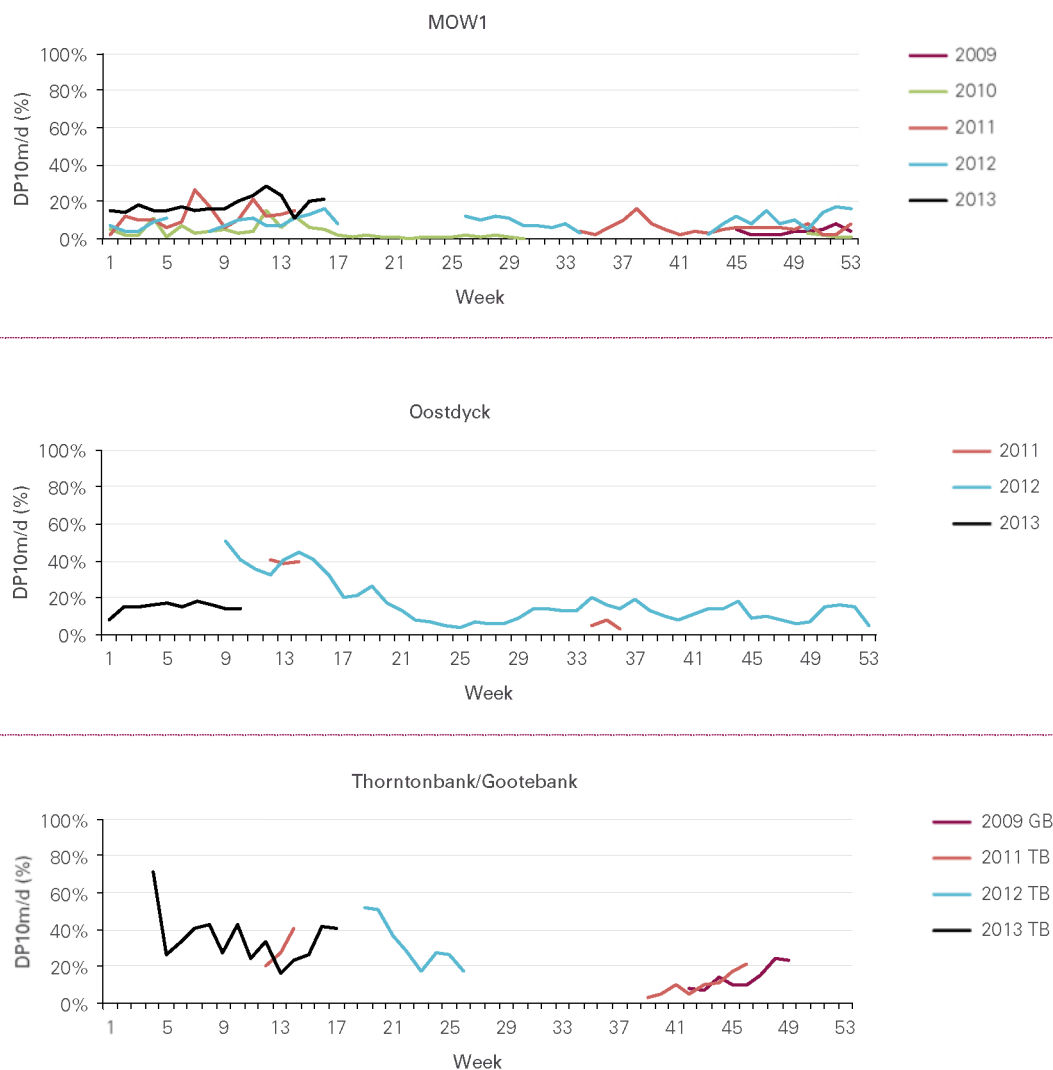
Figure 5. Weekly average detection rate (expressed as percentage of dp10m/d) at MOW1, Oostdyck and Thorntonbank/Gootebank between 2009 and 2013.

MAY WE CONCLUDE ON ATTRACTION OR (PARTIAL) EXCLUSION?

Aerial surveys suggest that harbour porpoises occur throughout Belgian waters. They seem to shift from the north towards the south-west and west in late winter-early spring. In spring they occur in the highest densities in the western part of Belgian waters. Close to shore they reach a higher density in the west than in the east. Off the central part of the Belgian coast, and up to around 30 km offshore, there is an area with a consistently lower density.

The reason for a differential distribution of harbour porpoises in Belgian waters throughout the year is related to a seasonal movement, in the first place most likely the consequence of the local food availability. Such food availability can be dependent on factors such as turbidity or water temperature. Harbour porpoises need to feed on a daily basis to stay fit. Therefore they are

forced to move to the best feeding grounds or to follow mobile prey. As the offshore wind farm areas are relatively small compared to the area that can be covered in a short period of time by this highly mobile species, differences in distribution within and outside wind farms are probably inferior to seasonal variations within the southern North Sea caused by movements to find suitable prey resources. However, when all foreseen wind farms will be operational, differences in prey density within and outside them may influence the local distribution of porpoises on a relatively small temporal and spatial scale.

The data collected up to now do not allow for detecting the fine spatial scale distribution of harbour porpoises needed to evaluate the attraction to, or expulsion from operational offshore wind farms. They can be used as a background, and do give us

an idea of the natural spatio-temporal patterns and trends in harbour porpoise distribution and abundance in Belgian waters. They consist currently, however, of data not in a sufficiently high temporal (aerial surveys) nor spatial (aerial surveys, PAM) resolution to elucidate possible attraction or exclusion effects. A much finer-scale monitoring would be needed to reveal such patterns, preceded by an assessment of how cost-effective it would be: what would be its power to detect change? Continuation of the current monitoring beyond construction will enable us to ascertain population level effects in Belgian waters.

It should be noted that wind turbine foundations attract fish that consist potential prey for harbour porpoises (Haelters et al., 2012b; Chapter 14). Therefore it is likely that feeding op-portunities within wind farms are better than in the areas just outside them. This would favour – on a small scale – the presence of harbour porpoises within wind farms, rather than outside them. We expect, given the noise levels generated by an operational wind farm (Tougaard et al., 2009; Norro et al., 2011) and the hearing sensitivity of harbour porpoises (Kastelein et al., 2002), that disturbance would be limited, and that therefore exclusion effects on the long term, and perhaps after some habituation, are unlikely to occur (ICES, 2010; Murphy et al., 2012). The question remains if the currently and naturally preferred feeding grounds present – on a large scale – a more favourable habitat than the wind farm area.

FUTURE MONITORING

Linking PAM and aerial survey data?

It would be useful, given the limited temporal resolution of aerial survey data, to be able to attribute an absolute density to PAM data of acoustically active animals. This is, however, problematic for several reasons. Detections may concern single animals or groups, detection gradients from the PAM devices remain unknown, detection ranges between PAM devices vary, vocalisations can be directional and the animals may exhibit diurnal rates in movement and in vocalization rate. The consequence is that it constitutes a complex and challenging mathematical problem (Kyhn et al., 2012; Thomas and Marques, 2012; Marques et al., 2013). However, there may be a more pragmatic way to try to link relative PAM with absolute densities obtained through aerial surveys, even if only a limited number of aerial surveys were performed, and the number of PAM devices deployed is low. We have compared the average density of groups of harbour porpoises estimated during aerial surveys in the most appropriate grid cells in which C-PoDs were deployed (absolute density divided by the average group size during that month) with the detection rates at this C-PoD averaged over 5 days or over the most appropriate period in case the aerial survey was not completed in one day (Figure 6).

We find a highly significant, and almost linear, relationship between detection rate and group density of harbour porpoises. Such a relationship should in fact not be expected to be a linear one, at least not over the whole range of density/detection rate, as a saturation can be expected in high density areas. However, the issue still remains a complex one, with many factors influencing both detection rate in passive acoustic monitoring and density estimates obtained through aerial surveys.

Spatio-temporal resolution of data

The best method to increase the spatio-temporal resolution of data in order to elucidate possible attraction/repulsion effects would be to deploy a relatively high number of PAM devices within and outside an operational wind farm area during a period in which no construction takes place in adjacent wind farms (Scheidat et al., 2011). Even with a relatively large number of replicates, discussion can remain on the interpretation of data.

Noise levels vs. hearing sensitivity of harbour porpoises

Although some noise measurements have been made at operational wind farms, these took place only during conditions with low sea states and limited wind speeds. Data on underwater noise is needed throughout the range of sea state conditions, which is only possible through the use of moored noise measuring equipment. There may also be important differences in both the amplitude and predominant frequencies of the noise generated by different types of turbine and foundations, and also the seascape and seafloor constitution play a role in noise generation and transmission. Harbour porpoises living in the relatively noisy southern North Sea may be more tolerant to noise than harbour porpoises living in quiet areas such as west of Scotland. Therefore underwater noise data is needed for each scenario to ultimately be compared with the hearing sensitivities of harbour porpoises and with data collected through PAM.

$$y = 7E\text{-}05x^2 + 0.0308x$$
$$R^2 = 0.56676$$

$$y = 6E\text{-}05x^2 + 0.0254x$$
$$R^2 = 0.69344$$
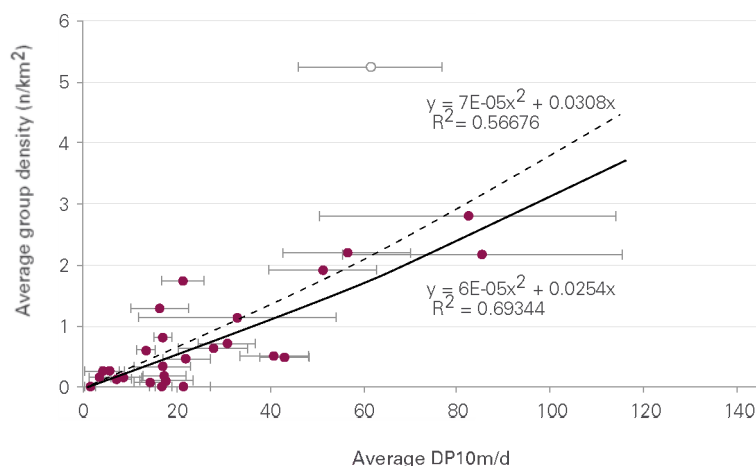
Figure 6. Results of PAM (DP10m/d averaged over 5 days or relevant period; incl. CI) vs. results of aerial surveys (groups/km² averaged over the relevant 10x10km grid cells); the dotted line includes the outlier (open data point), the full line does not take account of it in calculating the trend line.