

Responses of harbour porpoises to pile driving on a temporal and spatial scale

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Introduction

The expansion of offshore renewables in the German EEZ has raised concerns over potential disturbance to marine mammals, in particular the harbour porpoise (*Phocoena phocoena*). Recent environmental impact assessment studies for offshore wind farms have generally identified noise emission during construction as the most influential disturbance having an impact on harbour porpoise populations (reviewed in Madsen et al. 2006). Specifically, high sound levels during pile driving can cause temporal displacement effects and may even inflict serious physical damage to their sensory system. However, our knowledge about the temporal and spatial scale of such disturbances is limited and current results do not reveal a coherent picture. The construction of the offshore wind farm "BARD Offshore 1" (80 Tripiles, largely without acoustic mitigation measures) offered the opportunity to investigate the temporal and spatial scale of behavioural responses of harbour porpoises to pile driving using passive acoustic monitoring devices (C-PODs).

Methods

Mobile C-PODs were deployed in a flexible gradient sampling design allowing to follow the construction site from pile to pile while keeping distance (categories: 750m, 2000m, 5000m, 8000m) at a constant level. Additionally, we analyzed data from two permanent C-POD stations located in a distance of 5000-11000m and 18000-26000m, respectively. Temporal (hour relative to pile driving) and spatial effects (distance categories) of pile driving on porpoise acoustic activity (porpoise positive minutes per hour: PPM*h⁻¹) were analyzed by generalized additive models (GAM).

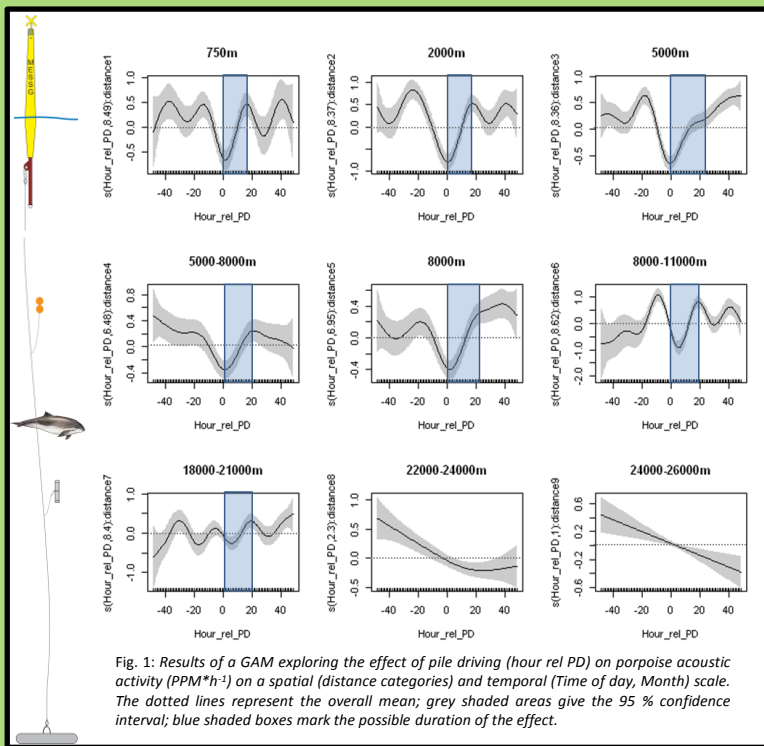


Fig. 1: Results of a GAM exploring the effect of pile driving (hour rel PD) on porpoise acoustic activity (PPM*h⁻¹) on a spatial (distance categories) and temporal (Time of day, Month) scale. The dotted lines represent the overall mean; grey shaded areas give the 95 % confidence interval; blue shaded boxes mark the possible duration of the effect.

Results

- Using porpoise acoustic activity (PAA) as a measure of abundance, we found that porpoises left the immediate vicinity of the wind farm during pile driving as PAA was reduced by almost 100 % up to a distance of 5 km.
- This process of abandoning the area was initiated ~10 h prior to pile driving.
- After pile driving PAA stayed below normal levels for on average 10-25 h, the amplitude of the effect and time period gradually decreasing with increasing distance.
- Unfortunately, we had no data available in the range from 11 km to 18 km.
- However, a small but still significant negative effect was detectable out to a distance of at least 18 km.
- Possibly due to limited data, the relationship between PAA and pile driving in the most remote distance categories (22000 – 26000 m) unclear and must be treated with caution.

Discussion

- Our results are in the range of the few studies published so far (Tougaard et al. 2009, Bailey et al. 2010, Brandt et al. 2011), and thus add to the still limited literature on behavioural responses of small cetaceans to noise emissions during pile driving.
- The deployment of a mobile C-PODs has proven to provide a flexible tool allowing to follow the noise emissions at the construction area over time, thereby keeping distance levels constant. We suggest to use this methodological advancement of mobile PODs instead of using a design with PODs located in a fixed array.
- The still ongoing monitoring at "BARD Offshore 1" aims at filling the gap of lacking data in the range from 11 km to 18 km, which appears to be the critical distance threshold.
- Given the rapidly increasing number of wind farm construction sites in the North Sea, this information should be taken into consideration when assessing cumulative effects.

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Literature

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