Arkona Offshore Wind Farm

Ambient noise monitoring - Field work report

Scientific note from DCE – Danish Centre for Environment and Energy

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Data sheet

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1 Introduction

In July 2022, Aarhus University was contracted by SWECO AB to conduct a one-year baseline study and impact assessment of harbour porpoises as well as noise monitoring within the pre-investigation area for the Arkona Offshore Wind Farm (OWF). Aarhus University recommended passive acoustic monitoring (PAM) within the project site for the Arkona Offshore Wind Farm, for which the deployment of five stations in the area was agreed, with harbour porpoise being monitored at all stations. To better assess the habitat suitability of the area for porpoises, our proposal included monitoring the ambient noise (combination of natural and anthropogenic sources) in the potential windfarm area. This was accomplished by deploying broadband noise loggers alongside porpoise detectors at two of the five stations.

The proposal was based on the following:

- There have never been any PAM or other studies for harbour porpoises conducted in the area. The new stations are needed to examine whether this – like the neighbouring Natura 2000 site – is an important area for porpoises and, if so, which seasons are important.
- The OWF site is in the transition zone between the Belt Sea harbour porpoise population and the critically endangered (assessed by International Union for Conservation of Nature (IUCN)and the Helsinki Commission (HELCOM)) Baltic Proper population of harbour porpoises and thus may be used by both populations.
- The Danish National Monitoring Program have demonstrated that five station in similar sized areas provide sufficient data to cover statistical variation in distribution.
- Ambient noise across the area is assumed to be relatively uniform so two stations are assessed to cover the variation sufficiently.

Here, we will discuss the results from the ambient noise data.

2 Method

The two noise loggers were deployed alongside porpoise detectors at stations AWF1 and AWF5, to monitor ambient noise levels in the region (Figure 2.1). Stations AWF1 and AWF5 were chosen to maximize coverage of the Arkona OWF area. As the harbor porpoise is the only expected cetacean in these waters, we employed CPODs (chelonian.org) as the main marine mammal detection system. This method will allow the use and comparison of the results from other former and ongoing monitoring studies of porpoises, i.e. the SAMBAH project (2011-2013). For more information, please see Sveegaard (2023).

Instruments were secured 2 m above the bottom using anchors and rope. DSG-ST noise loggers (Loggerhead Instruments, Sarasota, Florida) are fitted with SoundTrap audio processing boards (Ocean Instruments, Inc., New Zealand) and HTI 96-min hydrophones (High Tech, Inc., USA) which have a nominal sensitivity of -185 dB re: 1V/µPa, and a flat frequency response of 2 Hz to 30 kHz. For the duration of the study, broadband audio was recorded 58 minutes out 60 (i.e., 97 % of the time) at a sample rate of 96 kHz for both stations. A duty cycle was employed to reduce errors while data is written to the disk. DSG-ST units were calibrated at 250 Hz prior to deployment by means of a Gras 42AC pistonphone with a custom-made coupler.

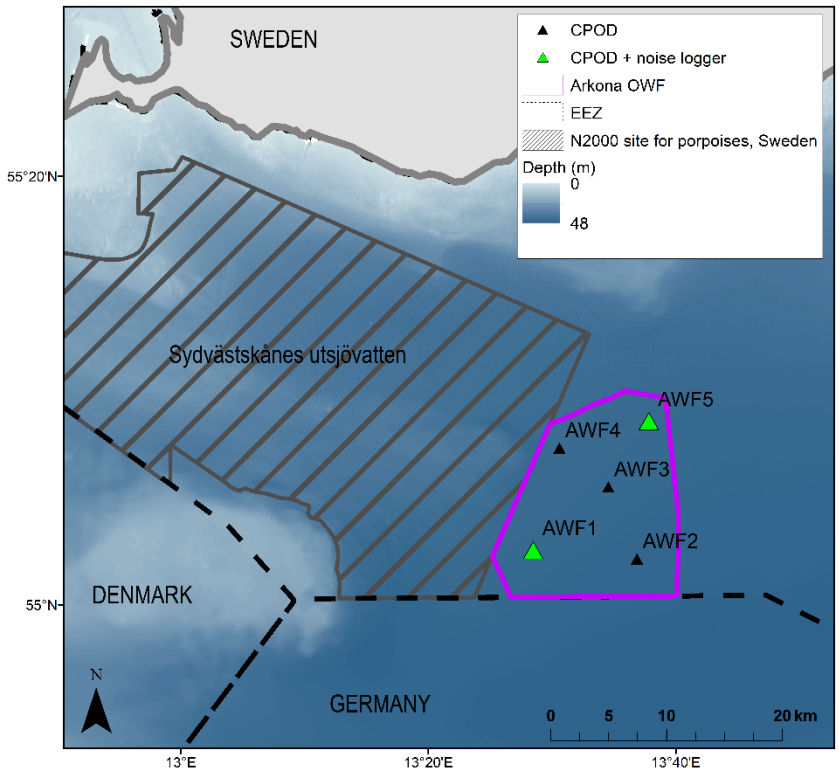


Figure 2.1. PAM stations within the Arkona Offshore Wind Farm investigation area (indicated in purple). Shaded area is the Natura 2000 site "Sydvästskånes utsjövatten."

For all deployments (A-D, see *Table 2.1*), equipment to be moored at each station was prepared by AU personnel, while the deployment and retrieval were handled by Karlskrona Taxi. Each deployment was approximately 90 days with deployment A occurring between August-November 2022, deployment

B between November 2022-February 2023, deployment C between February-May 2023, and the final deployment D between May-August 2023. Days which stations were serviced (deployed/retrieved) were excluded from analysis as results may be affected by the service vessel. For example, while deployment D has 91 days between its deployment (14/05) and retrieval (12/08) date, only 89 full recorded days are included in this analysis (15/05-11/08).

Additional gaps in the data exist with deployments A, B, and C. With deployments A and C, the batteries in the noise loggers were depleted before their retrieval, therefore the full deployment was not covered. While only a few days of data are missing from deployment C, deployment A lost approximately a month of data. This data loss is due to a substantial delay between when the units were prepared by AU staff (early July) and when they were deployed by Karlskrona Taxi (late August). This delay was due to several factors, including weather and ship availability. Timing between equipment preparation and the deployment team was better coordinated for subsequent deployments to reduce this error. For the deployment, B, both noise loggers experienced errors leading to data loss. At station AWF5 the noise logger was retrieved flooded with water, therefore no data was recovered from this instrument (See Error Report #01 for more information). At AWF1, the noise logger experienced a power supply issue, resulting in incorrect timestamps and corrupted files (See Error Report #02 for more information). These data are considered unusable.

Tabel 2.1. Deployment periods of the passive acoustic monitoring stations within the proposed Arkona OWF with noise loggers, and available data at each station.

Deployment ID	Station	Deployment date	Retrieval date	Data Starts	Data Ends	Entire days recorded*
A	AWF1	22/08/2022	13/11/2022	23/08/2022	16/10/2022	55
	AWF5	22/08/2022	13/11/2022	23/08/2022	11/10/2022	50
B	AWF1	13/11/2022	14/02/2023	Equipment Failure		-
	AWF5	13/11/2022	14/02/2023	Equipment Flooded		-
C	AWF1	14/02/2023	14/05/2023	15/02/2023	10/05/2023	84
	AWF5	14/02/2023	14/05/2023	15/02/2023	11/05/2023	85
D	AWF1	14/05/2023	12/08/2023	15/05/2023	11/08/2023	89
	AWF5	14/05/2023	12/08/2023	15/05/2023	11/08/2023	89

The data were processed using a custom Matlab script (MathWorks, Inc., USA), adhering to the JOMOPANS standard for processing measured noise data (Ward et al., 2021). This is the current method recommendation by HELCOM and the Danish National Monitoring (HELCOM, 2018; Tougaard, 2019). In which, we extract the sound pressure level (SPL) per decidecade band with a 1 second time resolution. With a sample rate of 96 kHz, we were able process all bands between 10 Hz – 40 kHz. The data was further summarized by examining the broadband exceedance levels (L_5, L_{10}, L_{25}, L_{50}, L_{75}, L_{90}, L_{95}), calculated as the sum of the decidecade levels in the frequency range 10 Hz to 10 kHz.

3 Results

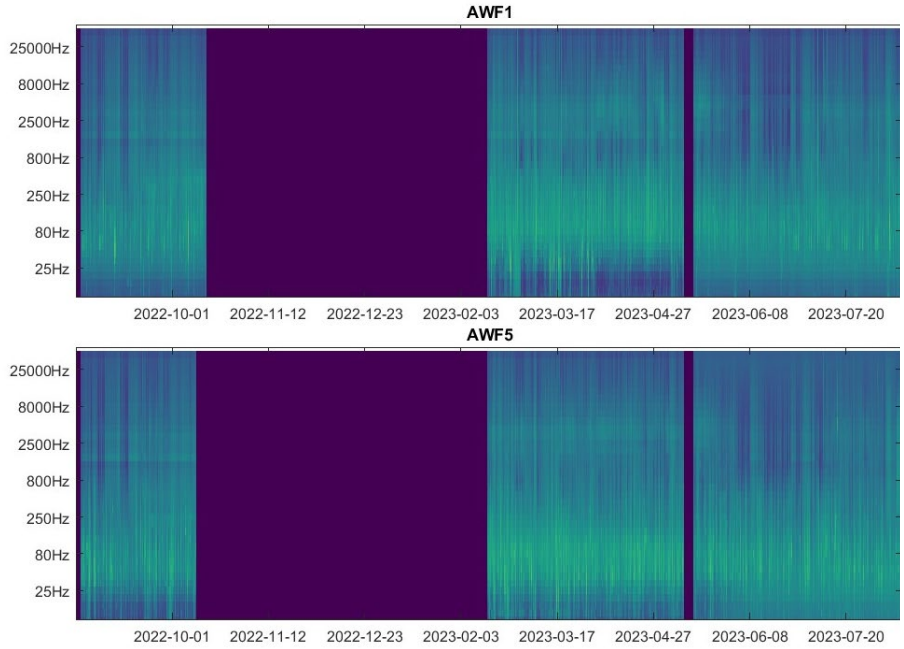


Figure 3.1. Long-term Spectral Average (LTSA) of data available for the survey duration (August 2022-August 2023), processed into decidecade values. These data are presented as the arithmetic mean of SPL values at an hourly resolution.

Of the available recording sections for the year, we had 62% data coverage (Figure 3.1). The less than complete data coverage was primarily due to the 100% data loss during deployment B, and the partial data loss during deployment A. The small gap in May represents 3-4 days of missing data between deployment C and D.

Data recovered from these locations revealed a stable noise environment. When binned by week, median broadband (10 Hz – 10 kHz) levels for stations AWF1 and AWF5 ranged between 107 – 113 dB re 1µPa (st dev: 2 dB) and 108-115 dB re 1µPa (st dev: 2 dB), respectively (Figure 3.2). The range of SPLs at the 90% percentile (L05-L95) range across the entire year was 101 – 122 dB and 100 – 125 dB, respectively. The density of the data within the quartile percentile range (Figure 3.3) ranged between 104 – 116 dB for station AWF1 and 104-118 dB for station AWF5.

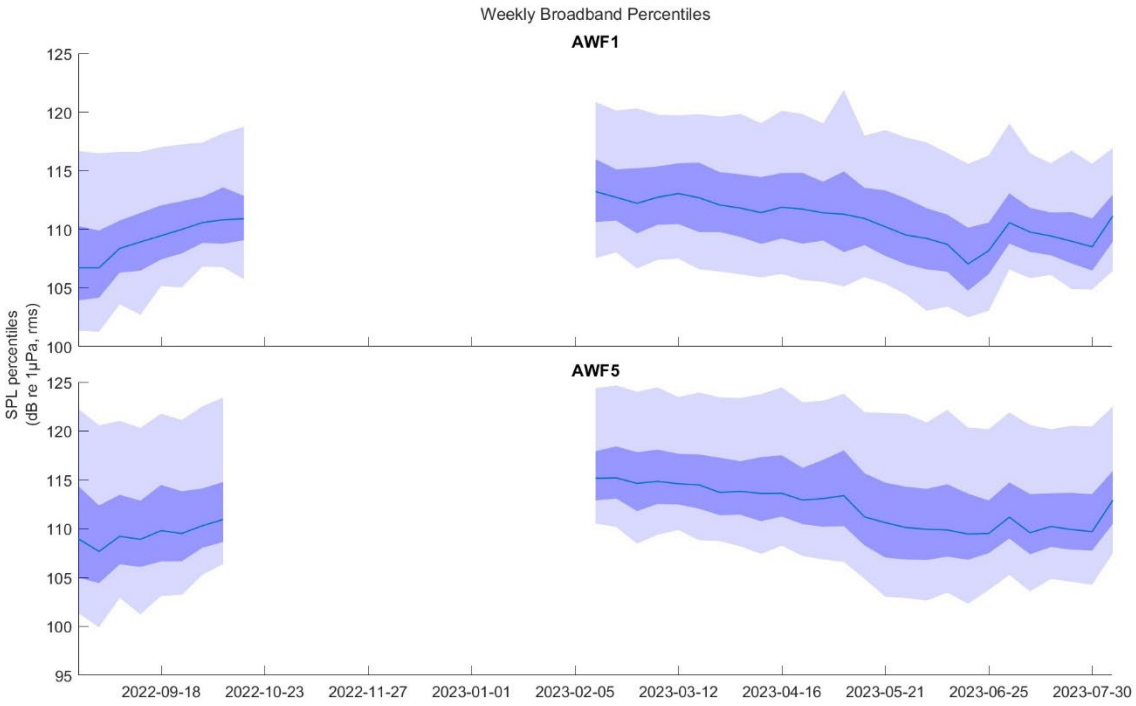
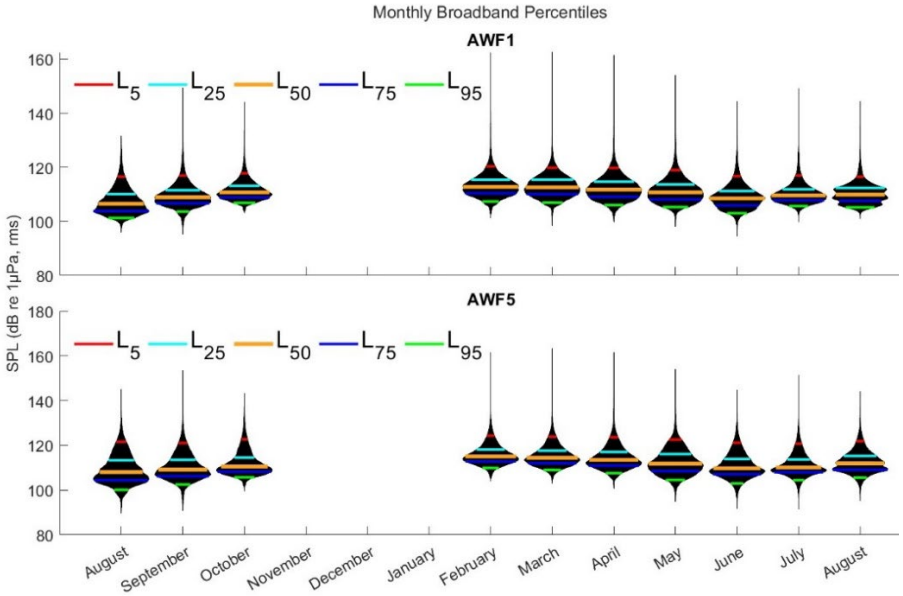


Figure 3.2. Weekly bins at the broadband (10 Hz – 10 kHz) sound pressure level (SPL) expressed as L_5-L_{95} range (light blue area), L_{25}-L_{75} range (quartiles, dark blue area), and the L_{50} median (thin blue line).

Figure 3.3. Violin plots of the broadband levels (10 Hz - 10 kHz). These plot viualize both the percentile values as well as a kernel density plot, to represent the distribution of the measured data per month. Each month had a week or more data to contribute.



4 Conclusion

The measured noise levels at these stations were comparable to each other, indicating noise levels across the study area are consistent. Noise levels were some dBs higher in the winter months, likely a combined effect of higher winds in winter and changes in the sound velocity profile (SVP) due to seasonal temperature and salinity changes, which affects sound propagation from the shipping route south of the area (Tougaard & Mikaelsen, 2020; Wells et al., 2021). The importance of these factors can be studied by modelling of natural ambient noise and ship noise, the latter based on AIS data, as has been done for example in the recent HOLAS 3 assessment (HECLOM, 2023).

Even with missing data, our measured data has a small standard deviation. Reported SPL quartiles from neighbouring Stevns Klint over an entire year also exhibited a small standard deviation, with a slight increase during the winter months (Griffiths & Tougaard, 2021; Tougaard et al., 2023). Although it is impossible to state with certainty, it is likely that the noise levels to not vary greatly between the November and January months at the Arkona investigation area.

The dataset recorded provides a valuable baseline for future studies in the area and can also serve as a highly valued source of measurements for validation of later sound modelling efforts in connection with impact assessments for future wind farm projects.

5 References

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