VIDAR Offshore Wind Farm

Aerial surveys for harbour porpoises

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Data sheet

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1 Background

In July 2024, the Danish Centre For Environment And Energy at Aarhus University (DCE) was contracted by KonTiki vind AB to conduct three aerial surveys for harbour porpoises, spanning from July to October 2024 and covering the pre-investigation area for the VIDAR Offshore Wind Farm (OWF).

The VIDAR OWF area has previously been studied using passive acoustic monitoring (PAM) but the data from PAM is limited due to loss of equipment (Oral information from KonTiki vind AB). The PAM studies indicated that the VIDAR OWF area is mostly used by harbour porpoises in the summer and fall and thus it was agreed for DCE to conduct three aerial surveys from July to October 2024 to estimate the density and abundance of porpoises within the area.

The aim of the three surveys was thus to report on abundance, density and distribution of observations of harbour porpoises as well as provide information on the presence of calves to examine if the investigation area is a potential calving ground.

Here, we report on the results based on the data collected during the three aerial surveys.

2 Method

The survey area was designed to not only encompass the VIDAR OWF area but also a buffer zone of 15 km around the area (Figure 1). The buffer zone of 15 km was chosen since several studies have estimated the maximum distance of porpoise disturbance during construction to be between 10 and 15 km (Dähne, et al., 2013; Dähne, et al., 2017; Brandt, et al., 2018). Consequently, the 15 km buffer was included to ensure that areas of high porpoise density that could be affected during the construction phase were not missed.

Furthermore, a large Natura 2000 site appointed for harbour porpoises (SE0520170 Kosterfjorden-Väderöfjorden) is located between the VIDAR OWF area and the Swedish coast. This area was also included. This design led to a total survey area of 3067 km^2.

The survey transects were placed in a parallel design of east-west lines in the investigation area i.e. perpendicular to the depth contours as recommended for this method. This means that the data is representative of the entire survey area. In total, ten transects lines were planned with a 5.5 km spacing and an average length of 54 km (range: 36-163 km, total length: 542 km). This design enabled the survey area to be covered in one day.

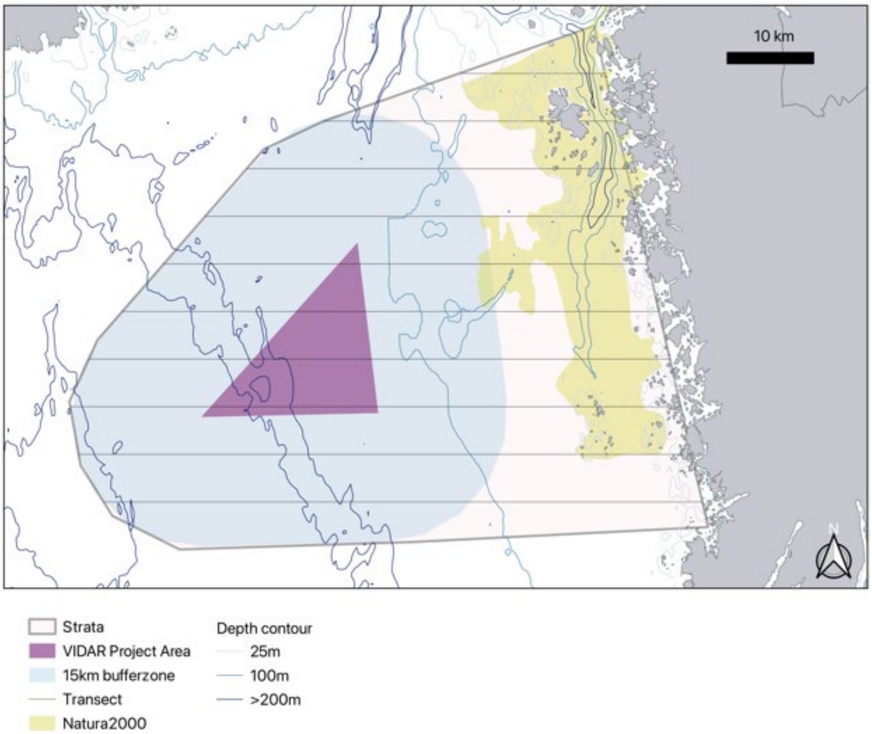


Figure 1. The survey area (grey line) with the VIDAR OWF project area shown in purple, the 15 km buffer zone in blue. Transects are shown in grey. Green area is the Natura 2000 area for harbour porpoise named Kosterfjorden-Väderöfjorden. Depth contours are depicted by 25m (light blue), 100m (blue) and 200m and greater (dark blue).

The aerial surveys followed a design-based line-transect distance sampling to estimate abundance and density of harbour porpoise on three surveys between the months of July-October 2024. All surveys were conducted onboard a Partenavia 68, chartered from Bioflight and flown by a pilot familiar with the survey protocol for marine mammal surveys.

The plane moves at a constant altitude (600 feet = 183 m) and speed (100 knots). Apart from the pilot, the survey team consists of three persons. Two observers are located at the bubble windows on the left and right side of the plane and one team member are in the front seat beside the pilot (called the navigator or data recorder). The navigator is responsible for continuously recording environmental information e.g. sea state, cloud cover, level of glare from the sun and the individual evaluation of sightability of porpoises for each observer (good, moderate, poor) as well as sighting data such as number of animals, species, presence of calves. Calves were defined as a much smaller individual next to a large individual. Behaviour as well as the vertical angle to the animal were also recorded. The angle was estimated with an inclinometer, converted to a distance from the track line to the sighting which, in the analysis, is used to estimate the detection probabilities of sightings; a key element in the abundance estimation analysis. Rotation between the navigator and one of the observers occurred when the plane was on the ground during the midday break.

Analysis

After the survey, the collected data were analysed to estimate abundance and density of harbour porpoises and presence of harbour porpoise calves.

Analysis of abundance was conducted in the software R using a special script developed during SCANS-IV (Gilles et al. 2023). The analyses included variables that could impact sightability, such as weather and sea state to estimate the abundance and densities covering the observation period.

The number of harbour porpoise sightings within an area depends not only on the number of individuals observed, but also on the probability of the individual being visible (called availability bias) and the probability of an observer detecting it (called perception bias). The parameter quantifying the combined probability is known as g(0). This factor has been estimated during previous surveys conducted in German and Danish waters by using the "racetrack" method. Details of the racetrack method and the analyses are described in Hiby and Lovell (1998) and Hiby (1999). For the analysis of data from the survey area, methodology and the survey plane were consistent with the one used during SCANS-IV in 2022 in European waters and thus the g(0) value and other relevant information such as the effective strip width used during SCANS-IV (Gilles et al. 2023) was applied. The effective strip width is the distance from the transect line within which the number of detected sightings equals the number of sightings that would be detected if detection were perfect (i.e. all were observed also individuals deep under water), providing a measure to correct for detection probability in distance sampling. The major advantage of this method is that it takes into account both availability and perception bias with the same data collected. Abundance of harbour porpoise is estimated for the entire survey area.

Harbour porpoise abundance in the survey area (v) was estimated as:

$$\hat{N}_v = \frac{A_v}{L_v}\left(\frac{n_{gsv}}{\hat{\mu}_g} + \frac{n_{msv}}{\hat{\mu}_m}\right)\bar{s}_v$$

Where Av is the area of the survey area, Lv is the length of transect line covered on-effort in good or moderate conditions, ngsv and nmsv are the number of sightings collected in good conditions and moderate conditions respectively, $\hat{u}g$ is the estimated effective strip width (ESW) in good conditions, $\hat{u}m$ is the estimated ESW in moderate conditions and $S\bar{v}$ is the mean observed group size in the stratum. ESW will be small if the weather conditions are poor and larger in good condition. Coefficients of variation (CVs) and 95% confidence intervals (CIs) were estimated by bootstrapping (999 replicates), using transects as the sampling units. More details on survey method and abundance estimation are described in Scheidat et al. (2008), Gilles et al. (2009), Hammond et al. (2013) and Nachtsheim et al. (2021).

To visualize the spatial patterns of the harbour porpoise distribution, a Kernel Density Estimation was performed on all survey observations combined. The Kernel tool will find the smallest possible area containing a predefined percentage of the observations. Each observation was given equal weight, using a Gaussian kernel function to generate a continuous surface representing the density of observations in the survey area.

Additionally, observers recorded observations of seals and their distribution in the survey area, irrespective of survey timing, are depicted in figure 6. Anthropogenic presence in the form of fishing, - sail and motorboats, buoys, nets, oil slick and trash of various size are depicted in figure 7.

3 Results

The three aerial porpoise surveys were carried out on 21st of July, 1st of September and 3rd of October 2024.

Harbour porpoise aerial survey 21st of July 2024

On the survey 21st of July 2024, observations were conducted in Beaufort Sea State 1-3, with 264 km, or 49%, conducted in Sea State 1 or 2. Beaufort Sea State is a definition of wave height and is used here to determine when the waves were too high (when above 3) for observing harbour porpoises. The subjectively assessed sightability for each observer is displayed in Figure 2. Here, 80% of the effort (length of transect lines covered) was conducted when at least one observer recorded subjective sightability as either good or moderate. The sightability was poor in the central part of the survey area. Variation in sightability is included and adjusted for in the Distance sampling analysis when estimating the abundance and density.

In total, 19 observations of harbour porpoises were made (including 4 calves; Table 1). Even though observations of harbour porpoise are by chance made in subjectively poor survey conditions only effort and observations made where sightability is noted as good or medium conditions, are used for analysis. Four observations were made in subjectively poor conditions and therefore excluded from the analysis (Figure 2). The harbour porpoise observations were distributed in the buffer zone around the VIDAR OWF area and only one observation was inside the VIDAR OWF area (Figure 2). The abundance of harbour porpoises in the survey area was estimated to 1325 harbour porpoises (95% CI = 559-2463; CV = 0.36). The average density within the area was 0.43 individuals/km² (95% CI = 0.18-0.80.

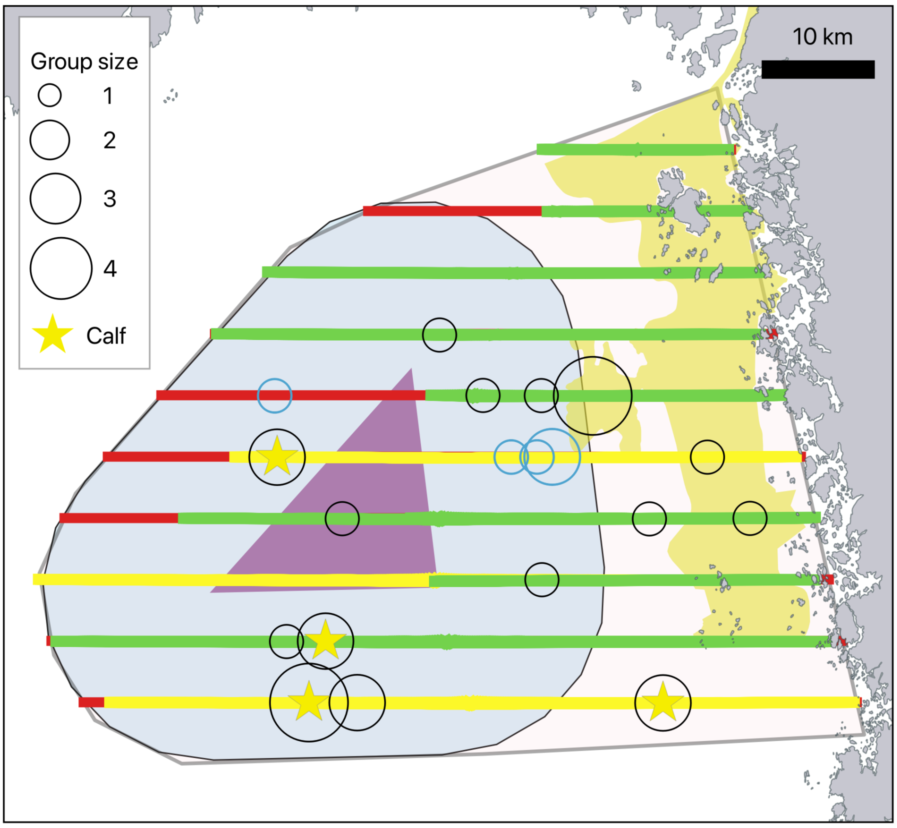


Figure 2. Distribution of harbour porpoise groups and effort (green if at least one observer recorded good subjective survey conditions, yellow if at least one observer recorded medium conditions, red if both observers recorded poor conditions) during the harbour porpoise aerial survey 21st of July 2024. The four observations shown in blue were later excluded from the analysis.

Table 1. Overview of survey dates (in 2024), total effort on transects in good or moderate conditions (km), total number of sightings including number of calves, density of observations on effort (km) in good conditions and the estimated abundance of harbour porpoises with low and high confidence interval in parentheses, and coefficient of variance (CV).

Date	Effort (km)	Observations		Density	Abundance	CV
		Total no. observations (no. of calf)	Observations used for analysis			
21 July	429	19 (4)	15	0.43	1325 (559-2463)	0.36
1 September	535	26 (2)	26	0.43	1320 (600-2230)	0.31
3 October	482	7 (1)	7	0.10	294 (0-616)	0.50

Harbour porpoise aerial survey 1st of September 2024

On the survey 1st of September 2024, all observations were conducted in Beaufort Sea State 1 and 2, and the total effort was 535 km. The subjectively assessed sightability for each observer is displayed in Figure 3. Here, 100% of the effort was conducted when at least one observer recorded subjective conditions as either good or moderate conditions. The sightability was generally good in the entire area.

In total, 26 observations were made of harbour porpoises, including 2 calves (Table 1). The harbour porpoise observations were distributed in the entire survey area, but with fewer in the southwestern area where the sightability was moderate (Figure 3). The abundance of harbour porpoises in the survey area was the same as the survey in July with an estimated abundance of 1320 harbour porpoises (95% CI = 600-2230; CV = 0.31). The average density within the area was also the same with 0.43 individuals/km² (95% CI = 0.19-0.72).

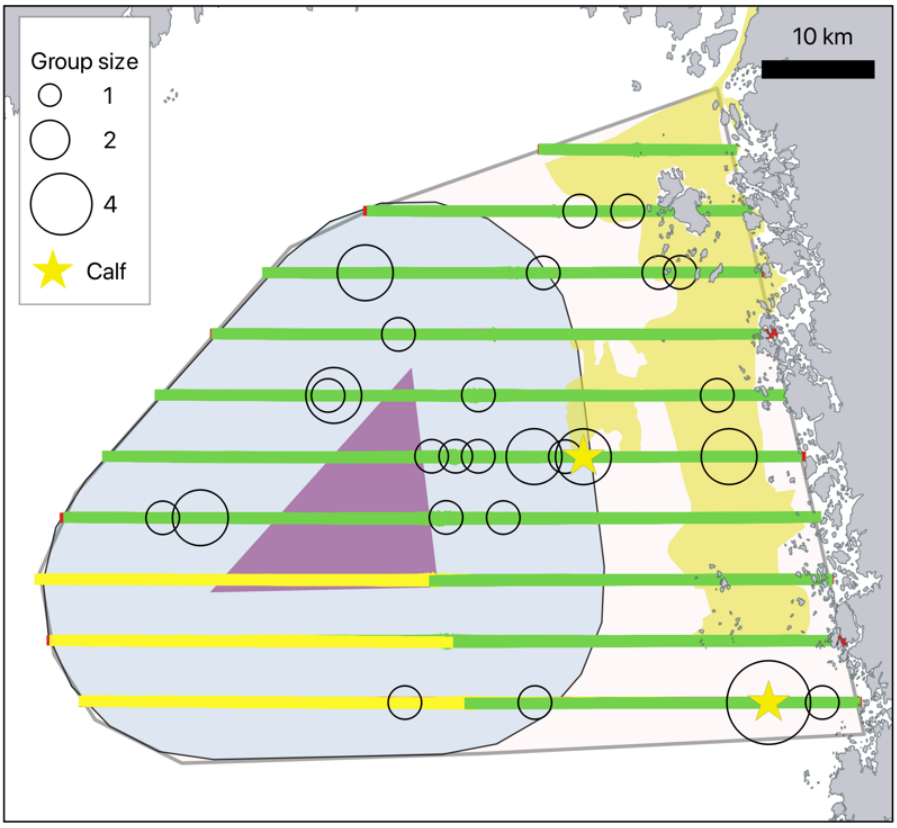


Figure 3. Distribution of harbour porpoise groups and effort (green if at least one observer recorded good subjective survey conditions, yellow if at least one observer recorded medium conditions) during the harbour porpoise aerial survey 1st of September 2024.

Harbour porpoise aerial survey 3rd of October 2024

On the survey 3rd of October 2024, observations were made in Beaufort Sea State 1-3, and of this, 364 km, or 68%, were conducted in Sea State 1 or 2. The subjectively assessed sightability for each observer is displayed in Figure 4. Here, 90% of the effort was conducted when at least one observer recorded subjective conditions as either good or moderate conditions. The sightability was generally good except for the southwestern area where Sea State was higher than 2.

In total, 7 observations of harbour porpoise were made (including 1 calf; Table 1). The harbour porpoise observations were distributed in the buffer zone around the VIDAR OWF area (Figure 4). The abundance of harbour porpoises in the survey area was estimated to 294 harbour porpoises (95% CI = 0-616; CV = 0.50). The average density within the area was 0.10 individuals/km^2 (95% CI = 0.00-0.20).

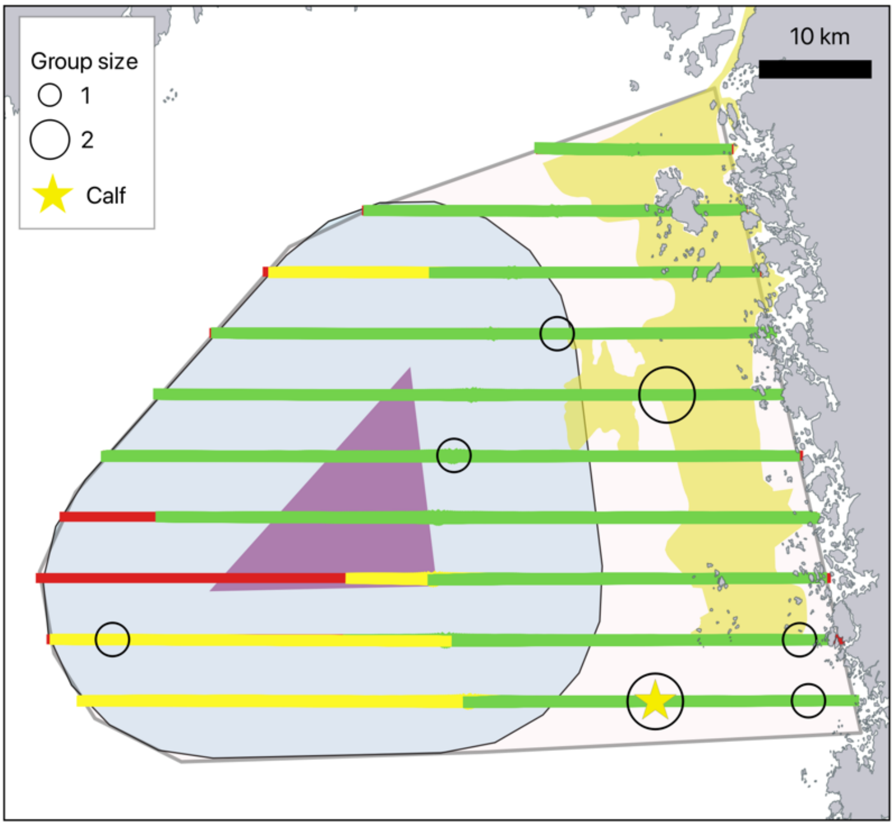


Figure 4. Distribution of harbour porpoise groups and effort (green if at least one observer recorded good subjective survey conditions, yellow if at least one observer recorded medium conditions, red if both observers recorded poor conditions) during the harbour porpoise aerial survey 3rd of October 2024.

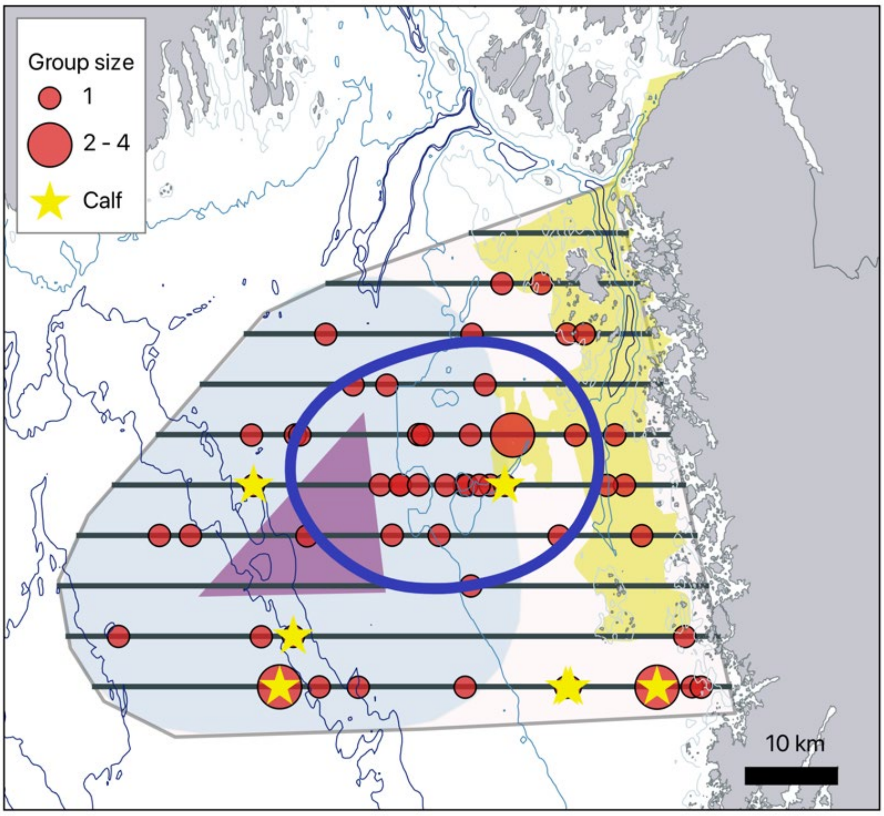
4 Conclusion

Of total effort, 429, 535 and 482 km was covered in sighting conditions with Sea State less than 2, and sighting conditions with good or moderate sightability in 80%, 100%, and 90% of the effort in the three surveys in July, September and October, respectively (Table 1). The density and corresponding abundance in the survey area was similar between the surveys in July and September, whereas fewer harbour porpoises were observed in the area in October (Figure 4). This supports the findings from the PAM studies in the VIDAR OWF area as mentioned in the Background section. It should however be noted that since the aerial surveys only covered the months of July to October, no conclusions about the rest of the year can be drawn. Even though the overall number of harbour porpoises detected in the surveys were low, calves were present during each survey but mainly in July.

To get the general picture of harbour porpoise distribution from July-October, the observations of all three surveys were combined and plotted (Figure 5). Here, a simple kernel spatial analysis indicated that 50% of the observations of harbour porpoises occurred within a central part of the survey area (indicated with the blue line in Figure 5) and the majority of these were located in the area between the VIDAR OWF and the Natura 2000 site Kosterfjorden-Väderöfjorden. Only 1 observation was located within the VIDAR OWF area.

The surveys conducted does not indicate that the VIDAR OWF area itself is of particularly importance for harbour porpoises. However, as higher densities as well as calf observations are found within the 15 km buffer zone, mitigation measures should be implemented to prevent negative impact on harbour porpoises if the impact of construction are assessed to extend beyond the VIDAR OWF area boundary.

Figure 5. Distribution of harbour porpoise groups across the three surveys in 2024. Blue line indicates the 50% Kernel density contour i.e. the smallest possible area where 50% of the sightings (red circles) falls within.



Several seal observations, irrespective of species or survey date, are shown in Figure 6. Seals are mainly observed on rocks and in the eastern part of the survey area. Anthropogenic activity, such as the presence of boats and set nets, was predominantly observed near the shoreline whereas debris of different origin was scattered throughout the survey area (Figure 7).

Figure 6. Distribution of seals (group size 1 or 2-4) from all three surveys.

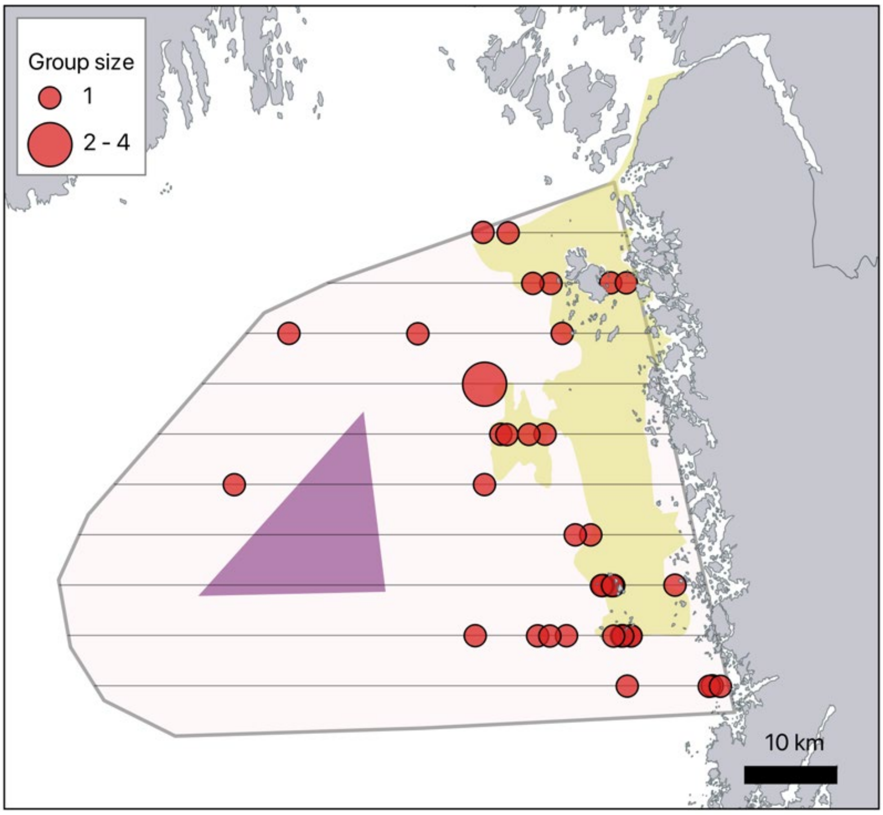
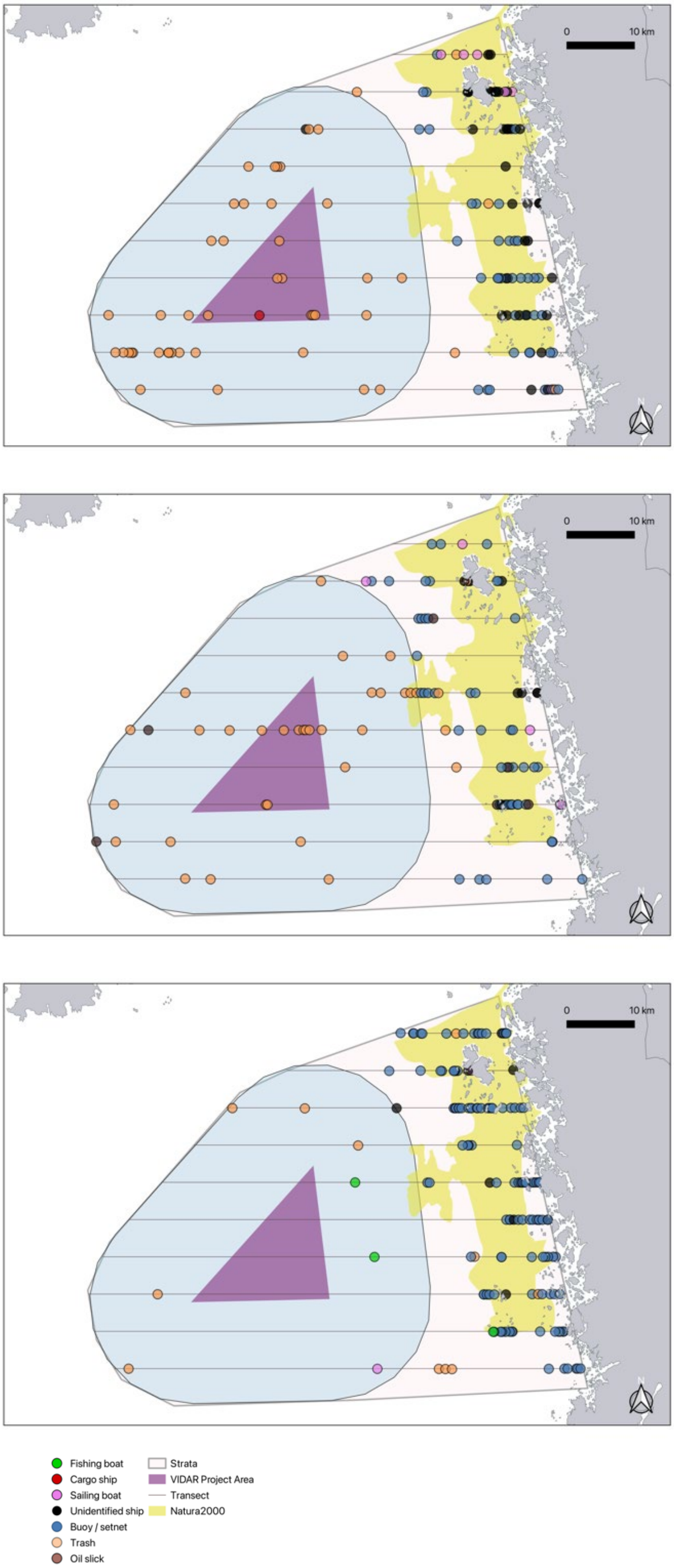


Figure 7. Observations of commercial fishing boat (green), container/cargo ship (red), sailboat (pink), unidentified ship (black), buoy or setnet (blue), trash (orange) and oil slick (brown) from the three surveys on 21st July (top panel), 1st September (mid panel) and October 3rd (lower panel).



5 References

Brandt, M., Dragon, A.-C., Diederichs, A., Bellmann, M. A., Wahl, V., Piper, W., Nabe-Nielsen, J., & Nehls, G. (2018). Disturbance of harbour porpoises during construction of the first seven offshore wind farms in Germany. *Marine Ecology Progress Series*, *596*(213-232), 213-232.

Dähne, M. Gilles, A., Lucke, K., Peschko, V., et al. (2013). Effects of pile driving on harbour porpoises (Phocoena phocoena) at the first offshore wind farm in Germany. s.l.:Env Res Lett 8:025002 .

Dähne, M. Tougaard, T., Carstensen, J., Rose, A., & Nabe-Nielsen, J. (2017). Bubble curtains attenuate noise from offshore wind farm construction and reduce temporary habitat loss for harbour porpoises. s.l.: Mar Ecol Prog Ser 580:221-237.

Gilles, A., Authier, M., Ramirez-Martinez, N., Araújo, H., Blanchard, A., Carlström, J., Eira, C., Dorémus, G., Fernández-Maldonado, C., Geelhoed, S.C.V., Kyhn, L., Laran, S., Nachtsheim, D., Panigada, S., Pigeault, R., Sequeira, M., Sveegaard, S., Taylor, N.L., Owen, K., Saavedra, C., Vázquez-Bonales, J.A., Unger, B., & Hammond, P.S. (2023). *Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys*. Swedish Museum of Natural History. https://nrm.diva-portal.org/smash/get/diva2:1801103/FULLTEXT01.pdf

Lockyer, C., & Kinze, C. (2003). Status, ecology and life history of harbour porpoise (*Phocoena phocoena*), in Danish waters. *NAMMCO Scientific Publications*, *5*, 143–175. https://doi.org/10.7557/3.2745