Seasonal and diurnal variation in echolocation activity of wild harbour porpoises

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Introduction

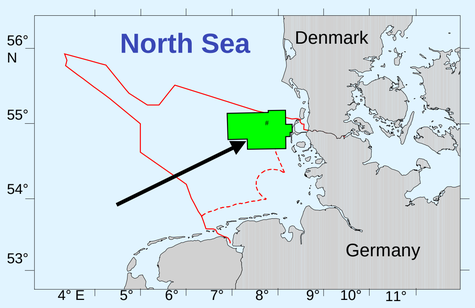

Fig. 1: Study area for aerial surveys.

The density of harbour porpoises calculated from results of monthly aerial surveys over four years shows a clear seasonal pattern over a 2.500 km² wide area within the inner German Bight. Maximum numbers were reached in May/June while only few animals were counted during winter.

Since July 2002 we have moored T-PODs in the centre of the survey area to investigate to what extent PODs can be used to monitor the changing abundance and behaviour of harbour porpoises within this area. Following questions should be answered:

- ? **Do we observe a seasonal pattern in activity over the year?** (similar to density derived from aerial surveys)
- ? **Are there diurnal variations in echolocation behaviour?**

Method

Between 2001 and 2004, 38 monthly aerial surveys covered an area of 2.500 km² during each flight (Fig. 1). Densities were analysed using the line transect distance sampling method (DISTANCE 4.1).

The PODs were situated at two locations in the centre of the study area (Fig. 2). They were moored two metres above the seafloor and marked with a small buoy on the surface (Fig. 3). We used high sensitivity settings as there was little ambient noise present in the area. Because **p**orpoise **p**ositive **m**inutes (PPM) per day was the highest correlated parameter between different PODs moored close together we used PPM to calculate mean daily click activity at each position.

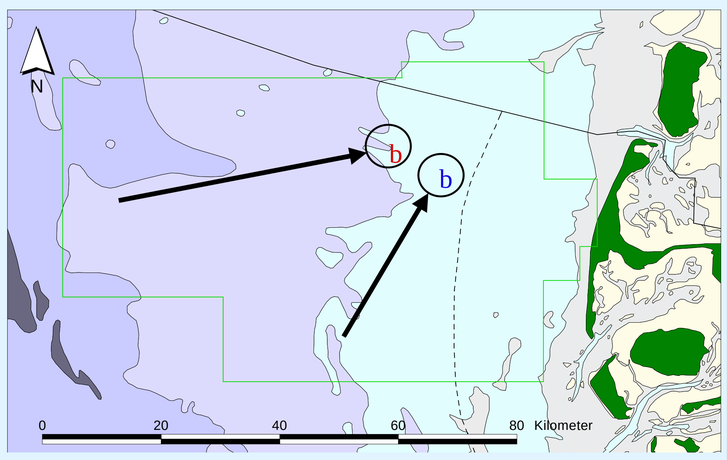

Fig. 2: POD investigations sites in the North Sea, 30 - 40 km west of Sylt, Germany.

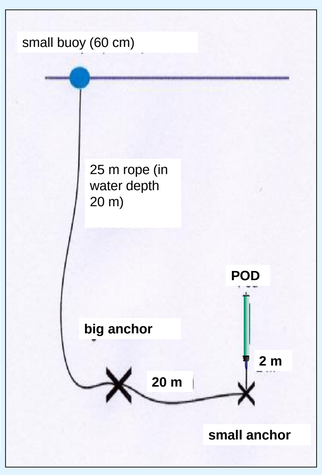

Fig. 3: Mooring system.

Seasonal Change

The mean density analysed from results of aerial surveys shows a clear seasonal pattern with maximum values of more than 5 ind./km² in May/June and a minimum in winter (Fig. 4). This pattern was stable over the past four years.

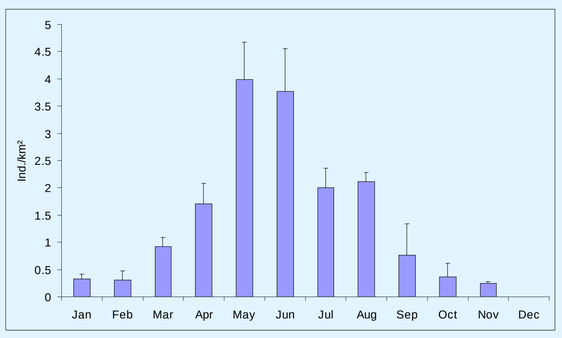

Fig. 4: Seasonal density pattern analysed from results of aerial surveys between 2001 and 2004: Mean values for each month with standard error. No survey in December.

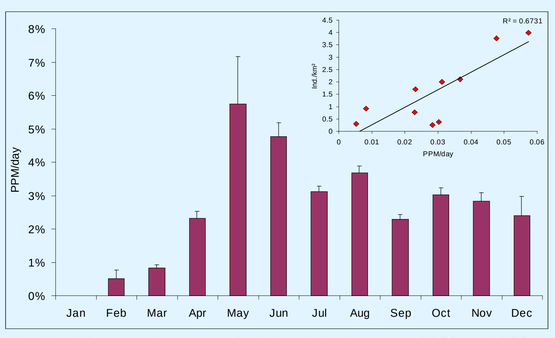

Fig. 5: a) Seasonal pattern of click activity between 2002 and 2004. Mean values for each month with standard error. No POD data in January. b) Correlation between monthly means of PPM/day and density.

The echolocation activity analysed from 10 T-PODs over 2.5 years also shows a seasonal variation expressed in means of PPM/day (ANOVA, dF = 10, F = 23,97, p < 0,001; Fig. 5). Maximum values in May are 10-fold higher than in February. Between both monthly means exists a strong positive correlation (p < 0,001). However, in autumn the decrease is not as strong as expected.

Diurnal Rhythm

Within a 24 hour cycle, the echolocation activity recorded by all PODs in the area west of Sylt showed a clear diurnal click activity pattern with low nocturnal activity and high activity from early morning until afternoon. This pattern is most pronounced in May and June (ANOVA, dF = 23; F = 8,24; p < 0,001, Fig. 6) and has been stable over three years.

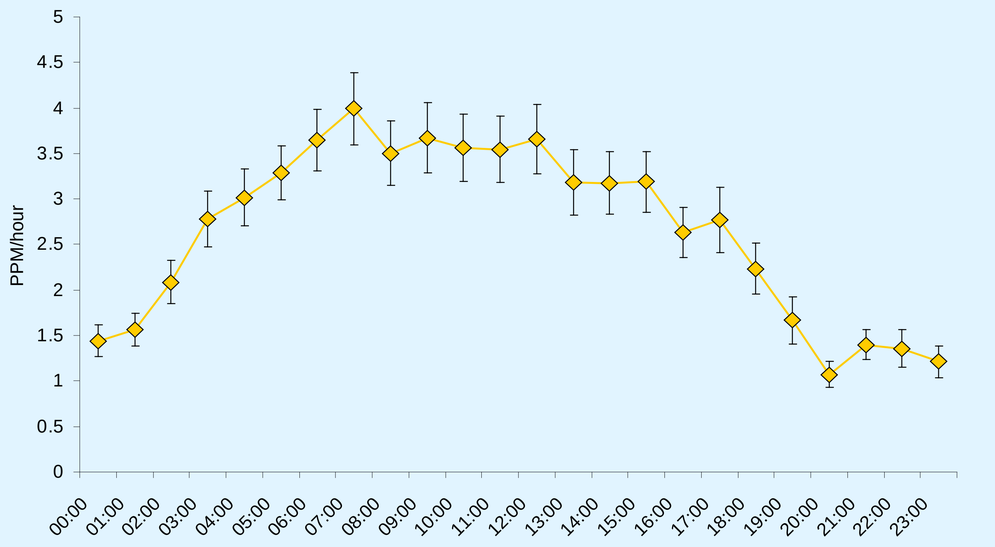

Fig. 6: Average number PPM/hour (with SE) over 24 hour cycle during May and June in 2003 and 2004 for 5 PODs at the same position.

This diurnal echolocation pattern indicates different possibilities for detection of porpoises near the sea floor, where the T-PODs were moored. As a hypothesis we suggest that this click pattern reflects the diurnal behaviour of fish species which are known to move from the sea floor where they spend the day into the water column for the night.

Echolocation and Behaviour

We investigated the click train pattern in more detail to check if a porpoise's click train structure differs between day and night. It is suggested that, when a porpoise is targeting an object (e.g. prey) at a very short distance, the interclick interval (ICI) decreases from 20 - 80 ms to less than 2 ms. Fig. 7 shows that there is no difference in the proportion of trains with a minimum ICI of less than 10 ms in relation to all recorded click trains during a 24 hour cycle. On average 6 % of all recorded click trains had a minimum ICI of less than 10 ms. The click train structure gives no indication of different behaviour at the sea floor during the day.

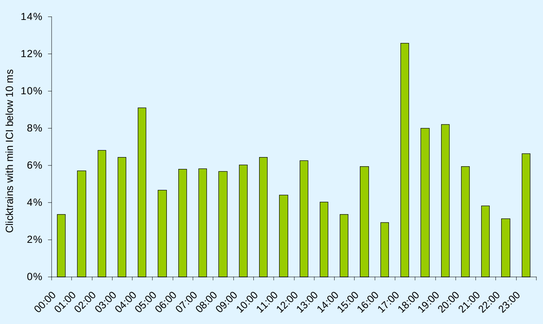

Fig. 7: Proportion of click trains with minimum inter click intervall of less than 10 ms in relation to 13.145 recorded click trains in June 2003 and 2004 .

Conclusions

- = **Echolocation activity recorded by T-PODs represents relative porpoise density in a specific area.**
- = **Clear diurnal click pattern suggests different probability of finding porpoises in different water depths.**
- = **Click train structure recorded by T-PODs moored at the sea floor is similar during the day.**