Does sand extraction near Sylt affect harbour porpoises?

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Abstract

We conducted a one year investigation between 2007 and 2008 to assess impacts of sand extraction west of Sylt using aerial surveys and passive acoustic monitoring devices (T-PODs). The area was surveyed once every month using a double engine aircraft, and porpoise densities were calculated using distance sampling techniques. Porpoises were present in the area all year round with highest densities (up to 3.5 individuals / km²) and a high number of calf sightings in June and August and much lower densities during the winter months (below 1 ind / km²). This confirms the area's high importance as a breeding ground. Avoidance of the sand extraction site could not be detected on the basis of aerial surveys. Porpoise densities calculated from sightings during aerial surveys increased with distance to the coast; only few porpoises were sighted close to the coast of Sylt where sand extraction takes place, and highest concentrations were found at distances further than 18 km from the shore.

Passive acoustic monitoring devices deployed over a period of 5 months revealed a short term avoidance of the vicinity of the dredging ship by porpoises, possibly due to acoustic disturbance. In comparisons of three reference areas, no significant difference in the long term use of the impact area by harbour porpoises could be detected.

Other studies found fish biomass not to be negatively influenced by sand extraction, and thus the area might not decrease in quality as feeding habitat for porpoises. However, acoustic disturbance by the dredging ship might lead to short term avoidance of the area around the ship with a relatively local and short term effect that cannot be detected by aerial surveys.

1. Introduction

Every year Sylt loses more than one million m³ sand at its beaches along the west coast making coastal protection a necessaty if the island is to be maintained. Therefore sand extraction has taken place during the summer months since 1972 a few kilometres west of Sylt in order to replace sand washed from the beaches. Between 1972 and 2006, more than 36 million m³ sand were extracted (ALR 2007).

At the same time nature protection gained more significance and since 1986 the area was established as a National Park. Due to a high abundance of harbour porpoises and a high proportion of calf sightings the National Park was enlarged to the 12 nm zone west of Sylt and Amrum in 1999 and declared a Special Area of Conservation (SAC) for harbour porpoises. With a size of 1240 km², it was the first whale sanctuary in German waters.

Because the permission for sand extraction ended in 2008, a new application had to be submitted and an Environmental Impact Assessment (EIA) was required. Therefore an investigation of the impacts of sand extraction on harbour porpoises was conducted between June 2007 and June 2008. Possible negative effects of sand extraction on harbour porpoises range from temporal displacement due to noise emission and water turbidity during extraction activities, to a reduction in prey availability and large scale habitat destruction.

Sand was extracted in an approximately 12 km² wide area from 1984 until 2008 (Westerland II, about 13 km west of the city Westerland. The planned extension of the area (Westerland III) contains an area of approximately 55 km² enclosing the area Westerland II (Figure 1).

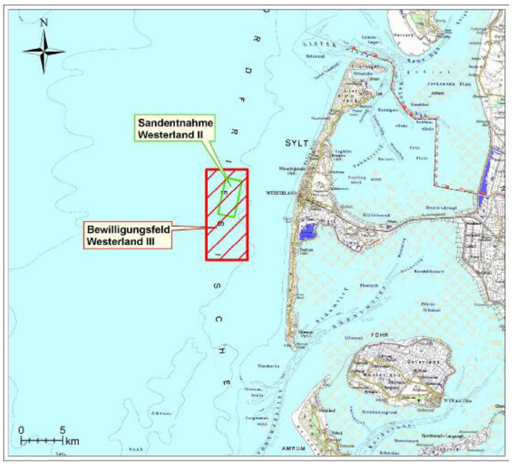

Figure 1: Sand extraction area 1984 – 2008: Westerland II and planned sand extraction area Westerland III.

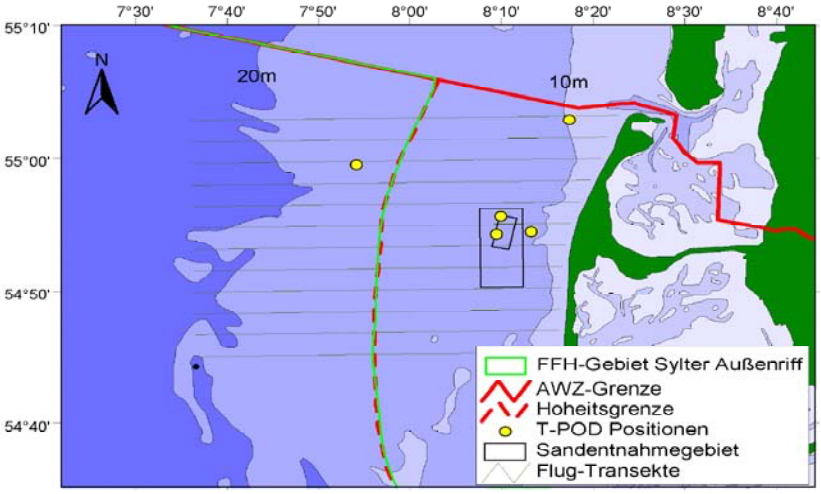

Figure 2: Study area with transect lines for aerial surveys and positions of T-PODs.

2. Methods

In order to gain information on the temporal and spatial scale of the potential effects of sand extraction on harbour porpoise, two different methods were applied. Aerial surveys provide data on the distribution of the animals at a given point in time over a relatively large area with a high spatial resolution. This method also enables us to analyse absolute densities, spatial distribution patterns and the proportion of porpoise calves present in the area.

Passive acoustic monitoring by means of T-PODs provides data with a rather small spatial but a high temporal resolution. Recordings of harbour porpoise clicks show habitat utilization of different areas and can be translated into relative density values. With this method it is possible to detect how long a potential displacement effect might last.

2.1 Arial surveys

Between June 2007 and June 2008, 13 aerial surveys were conducted, with about one survey per month. During each flight 12 parallel transect lines, on average 46 km long and 3 km apart, were flown perpendicular to the coastline and to the depth contours (Figure 2). Total transect length during each flight was approximately 550 km, which represented an area of 1,660 km² covered in one day. The transects started close to the island of Sylt and the area extended into water slightly deeper than 20 m, approximately 50 km west of Sylt.

The aircraft used was a high-winged, twin-engine Partenavia P68, equipped with bubble windows on the rear seats. All survey flights were generally restricted to calm weather and good visibility. Only times which met these criteria were considered valid for further data analysis. Flight altitude was 76 m and the aircraft flew at a speed of 167 to 186 km/h. Three observers searched continuously for animals at the sea surface and recorded their observations with the exact time (synchronised with the GPS-time) on a dictaphone. Recorded parameters were species, group size, presence of calves, swimming direction and behaviour. The position of the aircraft was logged continuously in 3 s intervals by a GPS (Garmin GPS 12CX). Porpoise observations could thus be linked to a specific location.

Data were analysed applying line transect distance sampling (Buckland *et al.* 2001). Beside distribution maps, absolute densities were calculated. For details see Grünkorn *et al.* (2004).

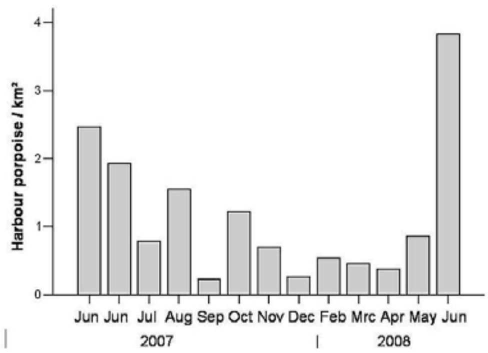

Figure 3: Absolute densities per flight.

2.2 T-PODs

Harbour porpoises orientate under water with short high frequency echo-location clicks. The T-POD takes advantage of this behaviour. The clicks can be recorded with a hydrophone and after presetting different filters, the clicks can be transformed into digital data and saved. The T-POD is housed in a 70 cm long PVC pipe, with

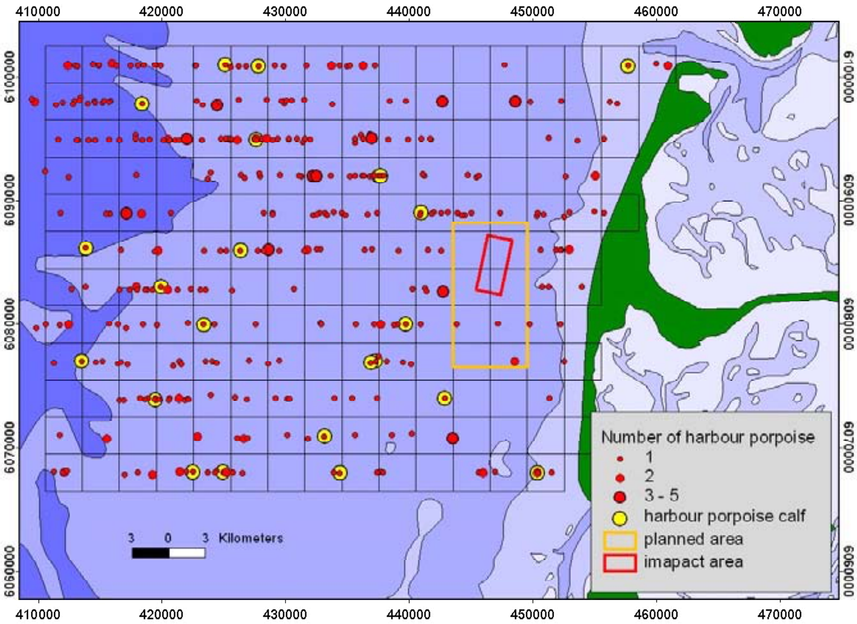

Figure 4: Distribution of all harbour porpoise sightings during all 13 flights from 01.06.2008 until 02.06.2008. Red dots = adult animals; yellow dots

an external hydrophone on one end and a lid screwed on the other. All PODs used in this study were calibrated in a test tank as well as in the field. Recorded clicks were analysed using different parameters. The main parameter is the so-called porpoise positive time per time unit (mostly the number of porpoise-positive 10 minute blocks per day). This parameter was used to measure the presence of harbour porpoises within the detection range of each T-POD.

The T-PODs were deployed with an easily retrievable two-anchor system, in which they were placed two meters above the seabed. The study design was chosen so that two T-PODs were deployed inside the actual extracting area Westerland II, representing the impact area. Two reference positions were chosen, one close to the extracting area (P3) and one a few kilometres north at the same distance to the island as the extraction area. Results of both PODs were combined to "reference area coast". One additional reference position was chosen outside the whale sanctuary approx. 25 km west of the island within the Exclusive Economic Zone (EEZ). This position is called "reference EEZ". All positions are shown in Figure 2. The devices were deployed from June to October 2008.

One position inside the impact area was located within 500m of an area where sand extraction took place during the study period. From this POD, the parameter "waiting time" was analysed in combination with the presence of the sand extraction ship. Waiting time was defined as the time between two consecutive porpoise recordings where the elapsed time was more than 10 minutes.

3. Results

Harbour porpoises were observed during every survey. A total of 373 porpoise sightings with 476 individuals were made. Sightings were not evenly distributed over the surveys and showed a distinct seasonal pattern (Figure 3). Most sightings occurred in early summer (June) in both years when densities reached maximum values between 1.9 and 3.8 ind./km². Lowest numbers were observed during winter and early spring (December to April) with densities below 0.5 ind./km².

Calves were observed between June and October (Figure 4). With 11.8% the proportion of calves was highest in June 2007.

Harbour porpoises were observed throughout the study area (Figure 4). Especially during the surveys in June 2007, sightings of porpoises accumulated in the north western part of the study area at a distance of about 25 to 40km to the coastline of Sylt. Densities significantly increased with distance to the coast ($r=,09$, $p<0,01$, $n=2331$, Figure 5). When the study area was divided into two parts (one coastal area up to a distance of 18km to the coastline and one offshore area beyond 18km), densities were significant higher in the offshore area (Mann-Whitney U-Test; $Z_{779,1412}=-4,49$; $p<0,01$).

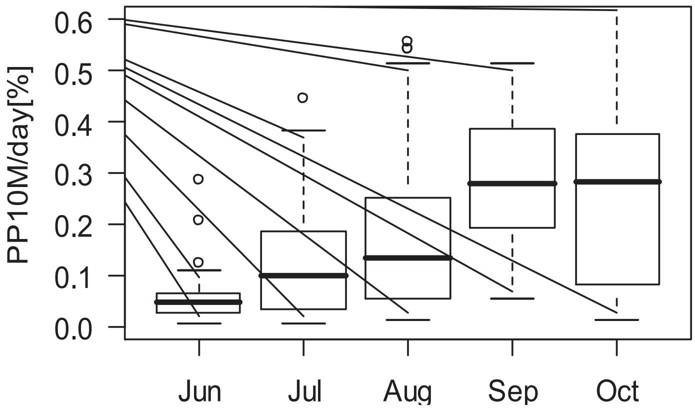

Figure 5: PP10M/day for each month for positions in the impact area.

T-POD data

Porpoise recordings by the T-PODs showed that animals were present at all positions every day. When applying a linear mixed effect model (LMER) including season, distance to coast and sensitivity as fixed factors and the parameter "porpoise positive 10 minutes per day" as dependent factor, there was no significant difference between impact and reference areas (ANOVA, Chi2=0.6863, Df=1, p=0.41).

The reference position in the EEZ showed a similar seasonal pattern to that observed during aerial surveys. However, the seasonal pattern observed at the positions close to the coastline showed a differing pattern with highest relative abundance in autumn and lowest in June (Fig. 5).

Analysis of waiting times after the sand extraction ship was closer than 600m to the T-POD location, shows that it took three times longer before a porpoise was again recorded than during times without sand extraction (Figure 6). However, the second waiting time after the ship was gone revealed no differences to those observed during periods without sand extraction.

4. Discussion

The results of this study clearly show that sand extraction did not lead to a long term avoidance of the sand extraction area by porpoises. Aerial surveys could prove that absolute densities increased with distance to the coast. This finding is in line with studies done by Gilles *et al.* (2007), Scheidat *et al.* (2004) and Grünkorn *et al.* (2004). All studies

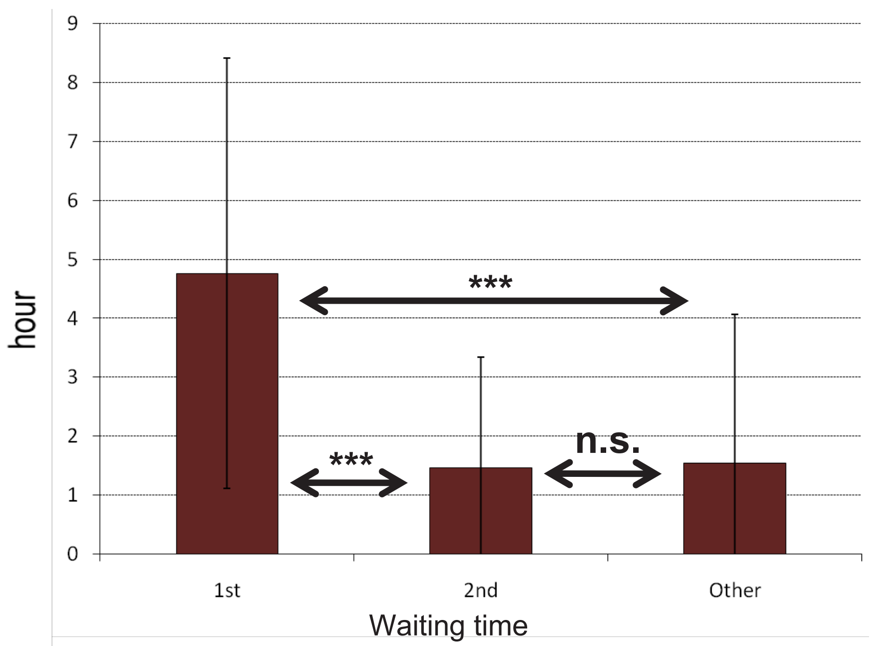

Figure 6: Mean waiting time during sand extraction exercises (1st), after the ship left the area (2nd) and when no sand extraction activities took-place in the area (other).

show highest densities in the Natura 2000 area „Sylt Outer reef" and lower densities close to the coast within the whale sanctuary. However, the high density during summer and high proportion of calves confirms the whole study areas' high importance as a breeding ground.

However, T-POD data showed that the stations close to the coast recorded most harbour porpoise activity during autumn. It is possible that densities close to the coastline follow a different cycle than in the large scale area at a greater distance to the coast. The reason for this remains unclear.

Results of aerial surveys show that the impact area is of lower importance for harbour porpoises than the area further offshore. T-POD data revealed that harbour porpoises used the impact area to the same degree as the surrounding area in a similar distance to the coast. From several studies it is known that harbour porpoises feed on pelagic and demersal fish species (Börjesson *et al.*, 2003, Santos and Pierce 2003, Santos *et al.*, 2004). As other than benthic organisms, pelagic fish are probably not affected by sand extraction, this food resource is probably still available to harbour porpoises even in the impact area.

The only effect of sand extraction on harbour porpoise that could be found was a temporal avoidance of the vicinity of the sand extraction ship for three hours, probably due to sound emission. Noise measurements showed that with 150 dB in 300 m distance from the ship, sound clearly exceeded the hearing threshold of the animals. As this effect is only short and at a very small spatial scale, we conclude that sand extraction has only a minor effect on harbour porpoises.

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