Agenda Item 5.1

Implementation of the Triennium Work Plan (2010-2012) – Other Issues
Review of New Information on Population Size, Distribution, Structure and Causes of Any Changes

Document 5-08

Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011

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Survey for small cetaceans over the Dogger Bank and adjacent areas in summer 2011

Anita Gilles[1], Verena Peschko[1], Meike Scheidat[2], Ursula Siebert[1]

[1]Institute of Terrestrial and Aquatic Wildlife Research (ITAW), University of Veterinary Medicine Hannover, Foundation, Werftstraße 6, 25761 Büsum, Germany

[2]IMARES Wageningen UR, Institute for Marine Resources and Ecosystem Studies, PO Box 167, 1790 AD Den Burg, The Netherlands

Abstract

The distribution of small cetaceans in the offshore areas of the North Sea has been in the interest of researchers for many years. Information on abundance and distribution is essential to assess the impact of bycatch and other anthropogenic threats, and as basis for management plans to ensure the favourable conservation status of these species. In 2011 we conducted a dedicated aerial line transect survey of the Dogger Bank and adjacent areas (UK, NL, DK, GE waters) in order to investigate the importance of this marine feature as summer habitat for marine mammals. The survey design comprised a set of eight strata within the 66,768 km^2 study area where 6,460 km survey effort on 74 parallel transects was planned. We achieved a very good coverage in good conditions: between 28 July and 1 September 2011 a total of 5,997 km survey effort was carried out during 10 survey days. In total 1,104 harbour porpoises were sighted, of these 97 calves. The highest encounter rates were achieved in UK and Danish/German waters. We estimated porpoise density in the entire study area to be 1.82 (CV=0.31). Highest porpoise density was estimated for the western and north-eastern part of the survey area whereas over the sandbank itself and to the southeast relatively low densities were estimated. The number of sightings of other cetacean species was too low to estimate density. We recorded 7 minke whale and 11 white-beaked dolphin sightings, 15 seals and a small number of sharks; all of them distributed at the slopes of the Dogger Bank. This also holds for most harbour porpoise sightings underlining the hypotheses that the high biological production level at the slopes attracts top predators. We collected baseline data important for mitigating activities that have the potential to disturb the natural behaviour and distribution of these marine mammals.

Introduction

The distribution and status of small cetaceans in the offshore areas of the North Sea, particularly the harbour porpoise *Phocoena phocoena,* has been in the interest of researchers for many years (Reijnders & Lankester 1990). Only few data on the occurrence, distribution and density of small cetaceans in offshore waters exist (Evans et al. 2003, Reid et al. 2003, SCANSII 2008, Gilles et al. 2009, Todd et al. 2009, de Boer 2010), where the largest sandbank in the central North Sea - the Dogger Bank (~ 18,000 km2) - is thought to be an important marine feature unlike any other in the North Sea as high levels of phytoplankton production occur all year round (Brockmann et al. 1990). The maximum dimensions of the Dogger Bank are approximately 320 km from NE to SW and 120 km from NW to SE (Pantin et al. 1991). The southern area of the bank is covered by water rarely deeper than 20 m (13 m at its shallowest part). The bank structure slopes down further in UK, Dutch and German waters and the surroundings are deeper than 50-70 m (Fig. 1). The relatively shallow depth of the Dogger Bank in combination with complex hydrodynamics results in high biological production levels nearly down to the sea floor. This in turn provides good growth conditions for fish populations and a rich, although patchy, food source for foragers such as sea birds and marine mammals. Most of the water column remains mixed all year round on the sandbank itself. From May to September stratification occurs in deeper waters around the bank and relatively high primary production values have been reported in summer (c.f. de Boer 2010).

According to Annex IV of the European Commission's Habitats Directive, all cetaceans are entitled to strict protection in their entire range. In addition, grey (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*), harbour porpoise and bottlenose dolphin (*Tursiops truncatus*) are also listed in Annex II of the Habitats Directive and their conservation requires the designation of Special Areas of Conservation (SACs). Germany has nominated its share of the Dogger Bank (1,624 km^2, Fig. 1) as a SAC due to the sandbank habitat listed in Annex I of the Habitats Directive. The harbour porpoise as well as the grey and common seal are included as non-qualifying features at the site. The same holds for the Netherlands where the Dogger Bank Natura 2000 site (4,715 km^2) is expected to be designated by the Netherlands in 2012. The British part of the Dogger Bank (12,331 km^2) is a candidate offshore SAC (submitted Aug. 2011) and adjoins the Dutch and German Dogger Bank sites (Fig. 1). Many oil and gas seabed installations and pipelines as well as other anthropogenic activities are found within all Dogger Bank Natura 2000 sites. The Dogger Bank was considered to be one of the great fishing grounds in the 19th and 20th centuries, however, North Sea landings of the main roundfish species have declined considerably since the 1980s. Most recently the area has been the focus of heavy industrial fisheries for sandeels where between 26 and 62% of the entire North Sea sandeel catch was taken during 2000 to 2006 (ICES 2007, Engelhardt et al. 2008, Herr et al. 2009). In the near future, the Dogger Bank zone will also be impacted by a large number of wind farm projects. Therefore, accurate baseline data on distribution and abundance of small cetaceans are urgently needed.

Here, we present main findings of a dedicated aerial line transect survey for small cetaceans covering the Dogger Bank and adjacent areas in a synoptic attempt. We initiated the survey in order to investigate the importance of this marine feature as summer habitat for marine mammals. The study has been conducted in close cooperation between Germany, Denmark, the Netherlands and UK.

Materials and Methods

Survey design and data acquisition

The survey design was created using DISTANCE 5.0 (Thomas et al. 2010) and comprised eight strata (DA-DH) within the 66,768 km^2 study area (Fig. 1, Tab. 1). In order to provide equal coverage within each stratum we selected a parallel transect layout with tracks spaced 10 km apart (except area DD where tracks were spaced 12 km apart due to the long transit). We placed transects in east-west direction to run perpendicular to water depth gradients, as transect direction should not parallel physical or biological features (Buckland et al. 2001). Transect lengths were designed to ensure that each stratum could be covered representatively during one day without having to break for refuelling (i.e. max. 6-7h of flight incl. transit). For the coverage of strata DC and DG two survey days were planned respectively as these strata were more easily accessible from the Netherlands and UK. Hence, it was possible to have breaks in between survey flights and increase effort.

Flights were operated from the airfields of Büsum and Westerland (D), Texel (NL), Humberside and Newcastle (UK). We followed standard protocols developed during SCANSII and the (on-going) German and Dutch harbour porpoise aerial surveys (SCANSII 2008, Scheidat et al. 2008, Gilles et al. 2009). Aerial surveys were flown at 90-100 knots (167-185 km/h) at an altitude of 600 ft (183 m) in a Partenavia P68, a twin-engine, high-wing aircraft equipped with two bubble windows to allow scanning directly underneath the plane. The survey team consisted of two observers, one data recorder (navigator) and the pilot. Surveys were only conducted during Beaufort sea states of 0 to <3 and with visibilities >5 km. Environmental conditions were recorded at the beginning of each transect and updated with any change. Conditions included (1) Beaufort sea state, (2) water turbidity (3) percentage of cloud cover, and for each observer side, (4) glare (angle obscured by glare and intensity of glare) and (5) the observer's subjective view of the likelihood that, given all of the conditions, they would see a harbour porpoise should one be present. These subjective conditions could be either good, moderate or poor. Detailed field and analyses protocols are described in Gilles et al. (2009).

Data Analysis

Estimation of effective strip widths and g(0), following the racetrack data collection method (Hiby & Lovell 1998, Hiby 1999), allowed for precise effort correction and accounted for missed animals and sighting conditions (Scheidat et al. 2008) taking into account both the availability and the perception bias (Marsh & Sinclair 1989, Laake et al. 1997). Due to the long transit to the study area survey time was limited and could not be invested in a lot of racetracks (one racetrack takes about 5 min survey time). Therefore, the previously estimated g(0) of the German team was applied to the collected data (see Scheidat et al. 2008, 2012). Yet, as the observer team, methodology and the survey plane were consistent with the German studies and we assume, that the overall subjective assessment of good and moderate conditions was consistent, this approach is reasonable.

All data recorded in poor sighting conditions were excluded from subsequent analysis. The subjective assessment of good and moderate conditions, assessed separately for the left and right side of the transect, was used to define sections completed under consistent conditions. For the spatial analysis in ArcGIS 9.3 a grid with a resolution of 10x10 km was created, corresponding to the inter-transect spacing. The overall number of harbour porpoises (n_i) and the effectively searched area (EA_i) per grid cell i were determined, and mean density estimates were calculated by the ratio n_i/EA_i (see Gilles et al. 2009 for more details).

Results

Between 28 July and 1 September 2011 a total of 5,997 km survey effort was carried out during 10 survey days (Tab. 3); 50% of the effort was conducted within sea state 1 and 29% during sea state 2 (Tab. 2). Moderate to poor conditions were only met in stratum DC in Dutch waters. During 5 days flights were started but due to bad weather conditions such as low clouds, fog or high sea state in the survey areas no surveying could be started and the team had to return to the airport. Due to bad weather conditions the 4 northernmost transects of area DF could not be covered during the survey and two transects in stratum DG had to be shortened by ca. 30 km. On 18 August two survey planes were chartered (in DA und DG) as conditions were very good in the overall area. In addition, during all survey days in the UK airspace, (military) danger areas covering large parts of DG and DH were active for several hours in the morning and/or afternoon (unfortunately during best survey conditions), hence, making it even more difficult to survey in that area.

The effective effort conducted during each survey day as well as harbour porpoise sightings, number of individuals, calves and the encounter rates are shown in Tab. 3. In total 1,104 harbour porpoises were sighted, of these 97 calves. The highest encounter rates were achieved in stratum DG and DB surveyed on 12 August and 1 September. The mean encounter rate calculated for all survey days was 0.12 sightings per km.

The effective survey effort, conducted during good and moderate survey conditions, and all harbour porpoise sightings are shown in Fig. 2. Largest porpoise groups with up to 15 animals were sighted in the strata DF, DG and DH. Many mother-calf pairs were sighted in these areas as well as in the strata DA and DB.

Harbour porpoise density per 10x10 km grid cell (effort and g(0) corrected) is shown in Fig. 3. Highest porpoise density was estimated for the western (strata DH and DG) and eastern part of the entire survey area. At the north-western slope of the Dogger Bank (northern part of DG) high harbour porpoise densities were estimated as well. In the central part of the Dogger Bank, the eastern part of area DG and parts of DC, relatively low porpoise densities were estimated.

Density and abundance of harbour porpoises estimated for the entire survey strata are listed in Tab. 4. Highest densities were estimated for strata DG (3.14 Ind./km^2, 95% KI=1.59-6.36) and DB (2.12 Ind./km^2, 95% KI=0.59-4.53).

Other marine mammal sightings as well as sightings of large fish species are shown in Fig. 4. Many sightings were made at the slopes of the Dogger Bank. Minke whales (7 sightings with 8 individuals) were sighted in area DB, DF and DG; white-beaked dolphins (11 sightings with 35 individuals) were recorded in the strata DF, DG and DH (Fig. 3). A total of 15 seals were sighted. Overall, the number of sightings was too low to estimate density for other species than the harbour porpoise.

All visually detected signs of anthropogenic activities (as sighted on the transects) are shown in Fig. 5. We recorded a lot of trash and remains of fishing nets (ropes, ghost nets, etc.) in all areas. (Please note that, due to a change in field protocol, no data on trash has been collected in stratum DC.) In area DH many (presumably) set nets and three fishing vessels were recorded. The set nets in DH were marked with red and white buoys, unlike the ones we normally detect in German waters (red flags). In the western part of DG many small and large oil patches were sighted in total covering a large area. The oil spill of the Scottish platform *Gannet Alpha* occurred at the same time as our survey (10 Aug. first, 16 Aug. second leakage). However, as the number of oil rigs is in general high in stratum DG, the exact source of the observed oil pollution is not detectable.

Discussion

Our study in the area of the Dogger Bank is unique in that way that we covered this large offshore area in a short time and at a finer scale than in earlier studies. The design of the SCANS surveys is comparable to a certain extent, but only a few of the zigzag transects surveyed the Dogger Bank. We estimated a high density of harbour porpoises whereas only a few sightings of other cetaceans were recorded at that time of the year. Gilles et al. (2009) conducted dedicated aerial surveys between 2002-2006 in the German part of the Dogger Bank and estimated that harbour porpoises densities were highest in summer (0.95 ind/km^2; CV=0.41). Recently, within the framework of the German Natura 2000 monitoring programme, the same area has been re-surveyed in June/July 2009 and densities were estimated to be 3.93 ind./km^2 (CV=0.40; Gilles & Siebert 2010); the highest density ever estimated in this area. Within the Dutch part of the Dogger Bank a harbour porpoise density of 0.40 (CV=0.40) in July 2010 and 1.03 ind./km^2 (CV=0.38) in March 2011 was estimated (Geelhoed et al. 2011).

In July 1994 harbour porpoise density in SCANS block G (central North Sea) was estimated to be 0.34 (CV=0.34) and in July 2005 to be 0.56 (CV=0.23) in block U (Hammond et al. 1994, SCANSII 2008). Although these SCANS blocks cover larger areas with the Dogger Bank situated in the centre and are not directly comparable, the recent Dutch and German national surveys as well as results of this study indicate a higher summer density of porpoises in that area.

The density of minke whales is probably higher in spring: De Boer (2010) surveyed along the north-eastern slopes of the Dogger Bank in 2007 and reported a high density of minke whales in May indicating that this offshore bank slope is an important spring habitat for minkes in the North Sea.

We observed most cetacean sightings at the slopes of the Dogger Bank, where especially the porpoises formed loose aggregations. This finding supports our hypothesis that due to good mixing of water masses and upwelling of nutrients at the flanks of the sandbank, a predictable rich food source for top predators is formed. Our future research will concentrate on linking this unique data set with either fisheries data or physical and biological ocean properties that might serve as proxies for prey abundance and could, thus, provide environmental cues for harbour porpoises to locate feeding areas (e.g. Gilles et al. 2011). We propose to re-survey the same set of transect lines in about two to three years, at that time eventually in spring (e.g. May) to improve the data basis for other cetacean species like the minke whale.

This survey provides important baseline data for mitigating activities that have the potential to disturb the natural behaviour and distribution of marine mammals. The information on abundance and distribution is essential to assess the impact of bycatch in fishing gear and of other anthropogenic threats, and as input to management actions to ensure the favourable conservation status of these species.

Acknowledgements

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Tab. 1: Survey design. Surface area of strata, planned transect length and number of designed transects per stratum.

Stratum	Area (km^2)	Transect length (km)	No. of transects
DA	6202	557	5
DB	6766	680	8
DC	9582	947	12
DD	6134	550	4
DE	4671	427	5
DF	7464	702	8
DG	17104	1712	16
DH	8845	885	16
Total	**66768**	**6460**	**74**

Tab. 2: Survey effort (% surveyed) in different sea states (Bft.) in 2011.

Sea state (Bft.)	28.07.	03.08.	05.08.	12.08.	17.08.	18.08.	22.08.	31.08.	01.09.	Mean
0	45	0	0	0	0	8	0	0	0	5
1	35	20	0	36	57	91	3	0	72	50
2	20	30	0	41	43	1	97	0	21	29
3	0	44	10	24	0	0	0	100	7	12
4	0	6	90	0	0	0	0	0	0	4

Tab. 3: Effort summary and numbers of harbour porpoise groups and individuals (of these calves) detected in each stratum.

Date (DD.MM.YY)	Stratum	Effort (km)	Sightings	Indiv.	Calves	Encounter rate (sight./km)
28.07.2011	DD	543	45	59	8	0.08
03.08.2011	DC	623	28	43	3	0.04
05.08.2011	DC	253	2	2	0	0.01
12.08.2011	DB	675	122	162	20	0.18
17.08.2011	DH	707	97	202	21	0.14
18.08.2011	DA	553	55	70	8	0.10
18.08.2011	DG	1171	202	273	18	0.17
22.08.2011	DE	423	16	24	2	0.04
31.08.2011	DH	193	3	3	0	0.02
01.09.2011	DG	442	92	193	10	0.21
01.09.2011	DF	415	49	73	7	0.12
∑		**5997**	**711**	**1104**	**97**	**0.12**

Tab. 4: Harbour porpoise abundance at the Dogger Bank area in August 2011. CI=Confidence interval, CV=Coefficient of variation; *DF was post-stratified as the 4 northern transects were not surveyed. Surface area of stratum F was hence reduced to 4,536 km^2.

Stratum	Density [Ind./km^2] (95% CI)	Abundance (95% CI)	CV
DA	1.22 (0.48-2.72)	7563 (2950-16899)	0.44
DB	2.12 (0.95-4.53)	14322 (6457-30654)	0.40
DC	0.85 (0.27-1.82)	8136 (2598-17449)	0,43
DD	1.20 (0.59-2.42)	7370 (3642-14865)	0.36
DE	0.58 (0.06-1.55)	2722 (271-7246)	0.62
DF*	1.19 (0.59-2.40)	5412 (2674-10892)	0.36
DG	3.14 (1.59-6.36)	53652 (27184-108822)	0.36
DH	1.95 (0.89-4.29)	17270 (7906-37958)	0.40
Dogger Bank	**1.82 (1.01-3.51)**	**116448 (64423-223881)**	**0.31**

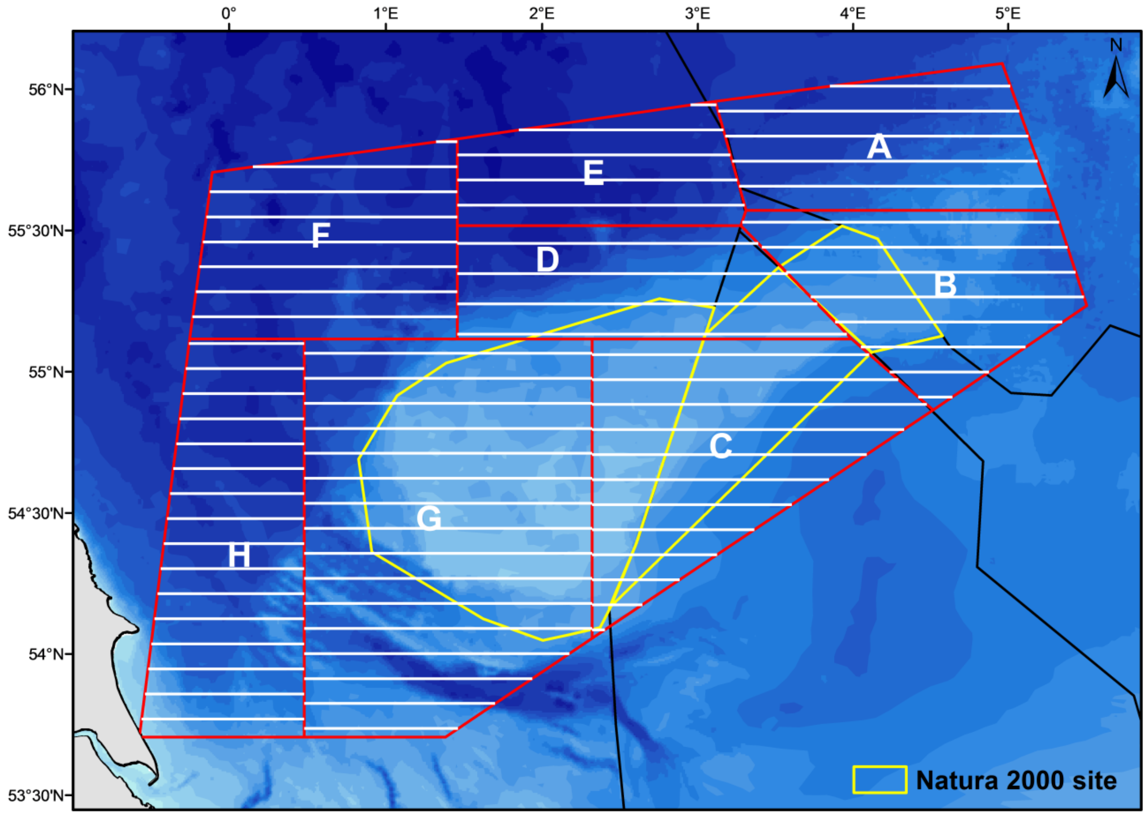

Fig. 1: Map of survey design (Strata D-A to D-H; red line). Parallel transects are spaced 10 km apart (exception area DD: 12 km) and are marked as white lines.

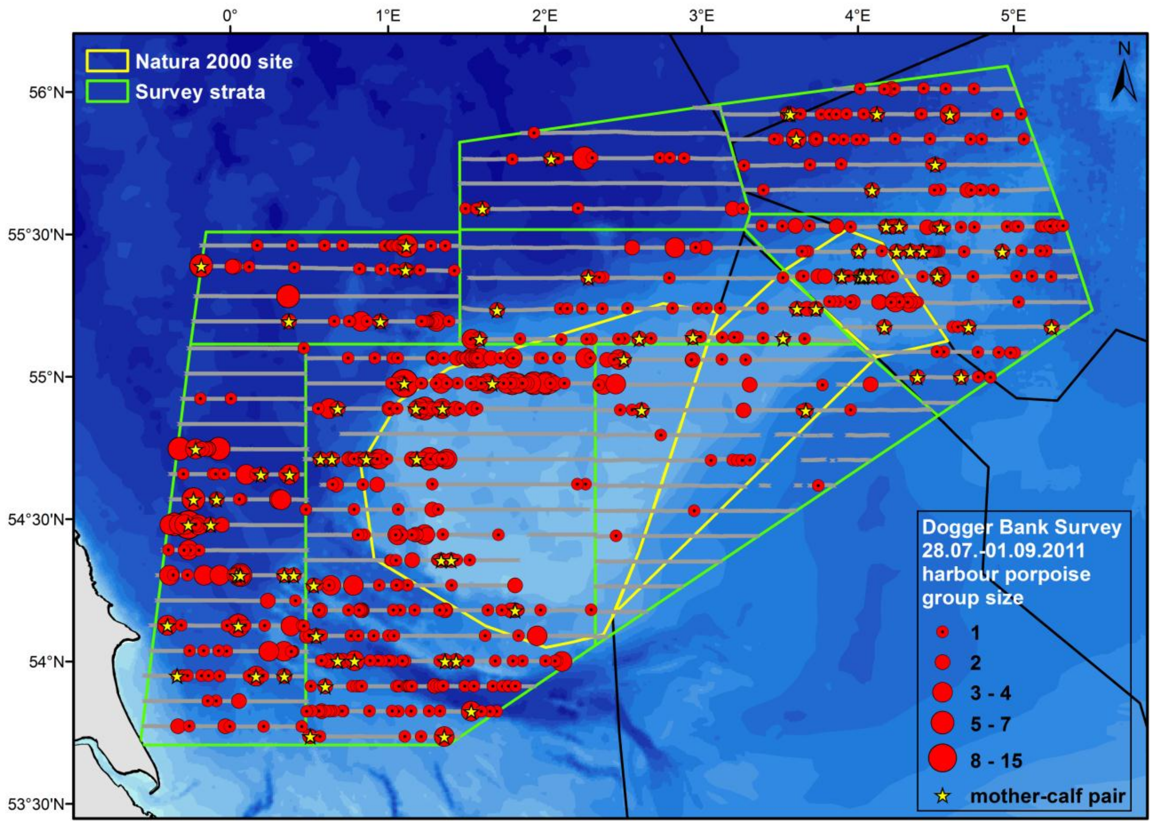

Fig. 2: Realised effort (grey lines) and harbour porpoise group sightings. Only effort in good and moderate sighting conditions is shown.

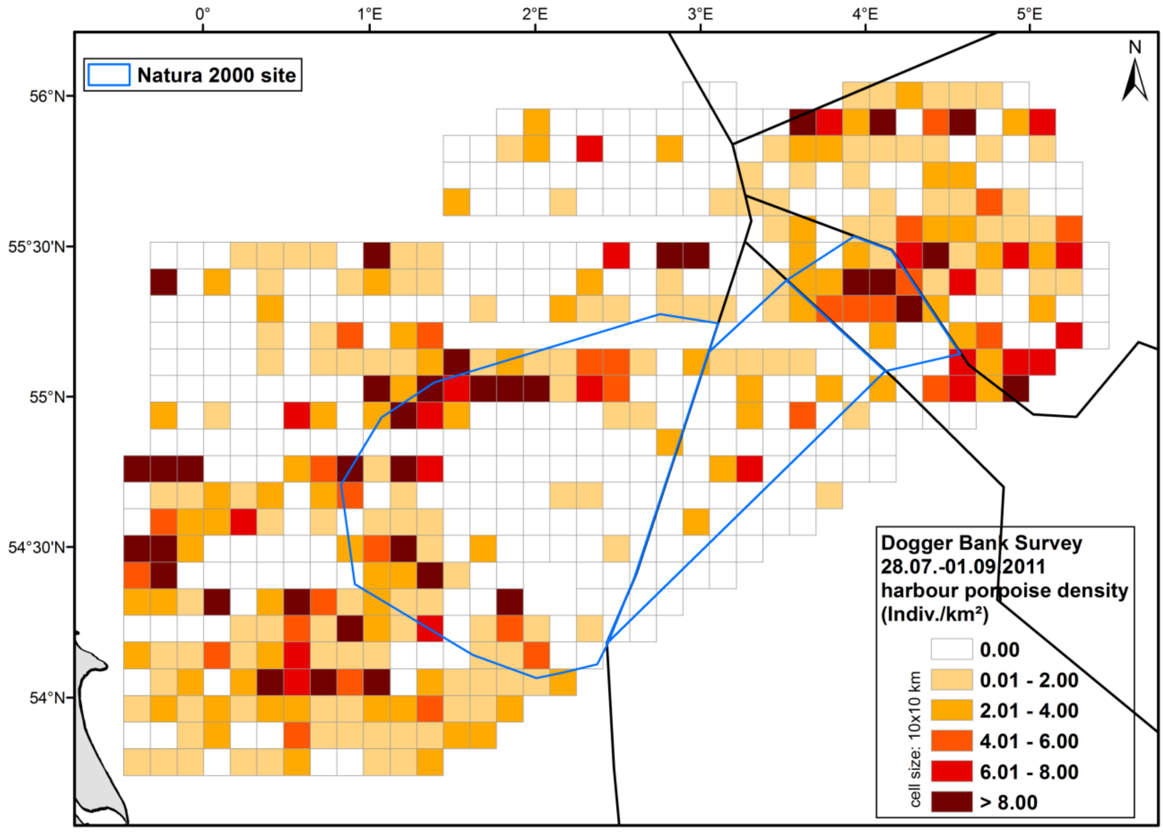

Fig. 3: Spatial distribution of harbour porpoise density (indiv./km^2) during the survey at the Dogger Bank in summer 2011. Grid cell size: 10x10 km.

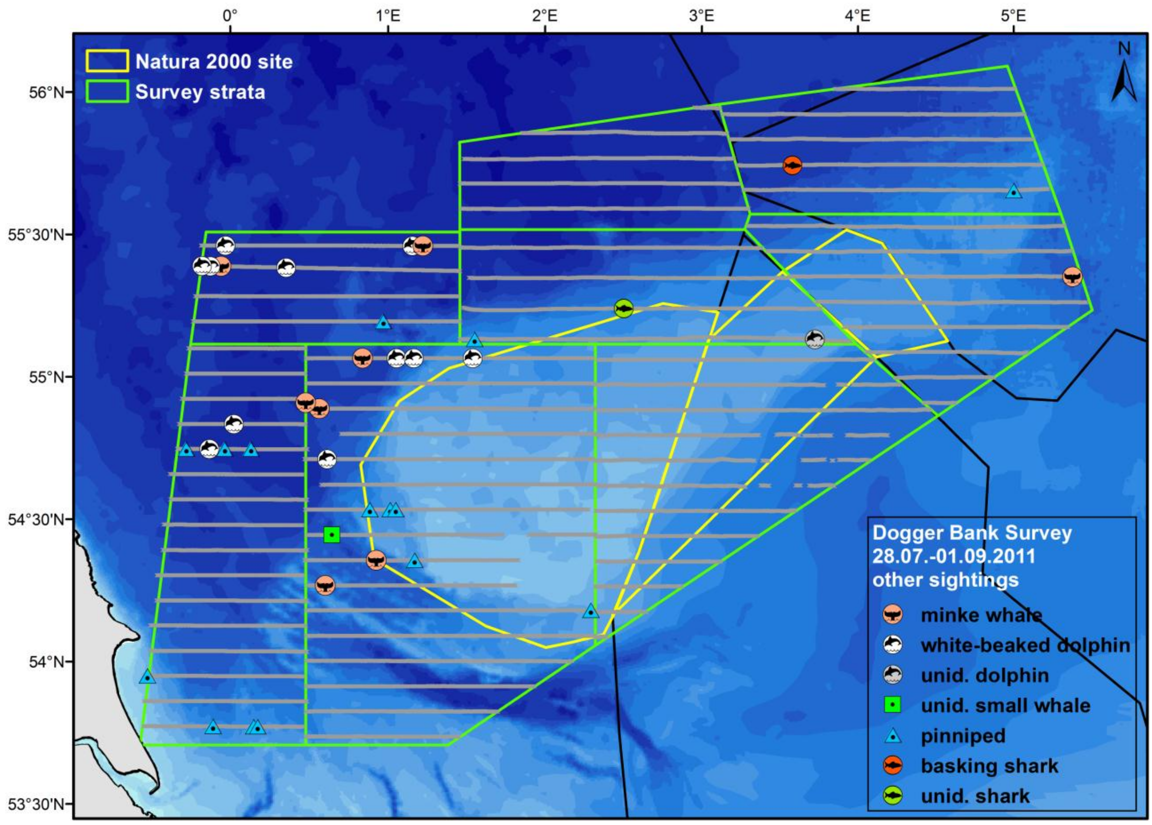

Fig. 4: Realised effort (grey lines) and sightings of other species. Only effort in good and moderate sighting conditions is shown.

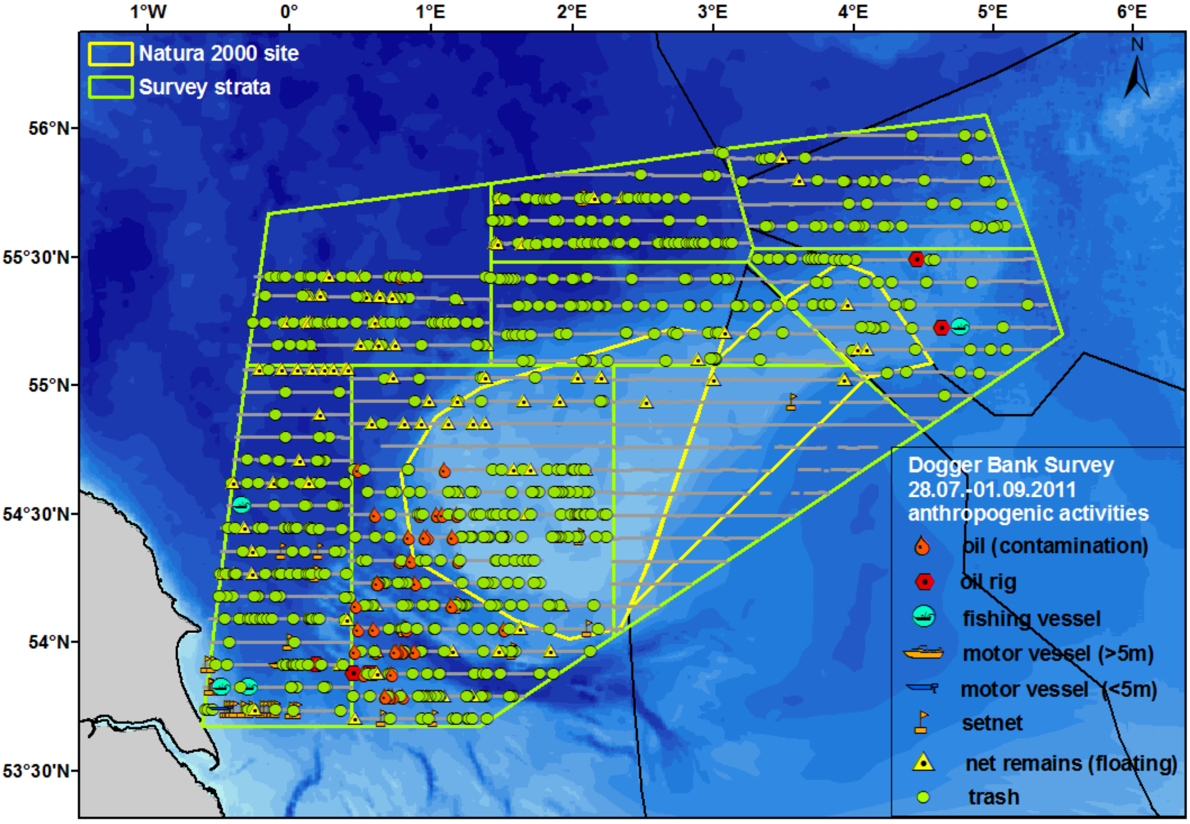

Fig. 5: Realised effort (grey lines) and sightings of anthropogenic activities. Note: in stratum DC (Dutch waters) - trash was not recorded.