Document AC10/Doc. 32(O)
Dist. 28 March 2003

Agenda Item 4.1: **ASCOBANS Baltic Recovery Plan ("Jastarnia Plan") Implementation**

The relative abundance of harbour porpoises (*Phocoena phocoena*) from acoustic and visual surveys in German, Danish, Swedish and Polish waters during 2001 and 2002

Submitted by: **IFAW**

ASCOBANS

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The relative abundance of harbour porpoises (*Phocoena phocoena*) from acoustic and visual surveys in German, Danish, Swedish and Polish waters during 2001 and 2002.

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Abstract

Boat-based acoustic and visual line transect surveys for harbour porpoises were conducted during summer 2001 and 2002 in the Baltic Sea and adjacent Kiel and Mecklenburger Bights. Acoustic data were collected at all times using a towed automatic high frequency click detector. During daylight hours, in sea states of Beaufort two or less, two observers were stationed on a platform at an eye height of approximately 5.3m.

Although porpoises were detected acoustically in all areas surveyed, results indicate that the relative abundance of porpoises is one to two orders of magnitude lower in the Baltic (0.1 detections / 100km) than in the Mecklenburger Bight (3.2/100km), Kiel Bight (North) (16.8/100km) and Kiel Bight (South) (10.5/100km).

In 2002, three porpoises were detected acoustically in the Baltic Sea, east of the Darss Sill, in 2946 km of survey track (0.1 detections / 100km). However, only one of these detections was east of Rügen island, approximately 45 km southeast of Oland. In surveys of the Polish coast in 2001, no porpoises were detected while the vessel was on a pre-planned survey track, although a single animal was detected off track. No porpoises were detected in 5.5 days of monitoring by 3 stationary porpoise click detectors (PODs) deployed in Puck Bay, Poland, in 2001.

These results indicate very low densities of porpoises in Baltic waters, and do not support the hypothesis that there is a part of the Baltic population, of a significant size, in previously unsurveyed Polish coastal waters. The Baltic harbour porpoise is endangered and may go extinct in the near future unless actions are taken to prevent future anthropogenic mortalities.

Introduction

Harbour porpoises (*Phocoena phocoena*) are subject to year-round bycatch in gillnets and other fishing gear in their entire distribution range in the northern hemisphere. This has led to increased concern over the status of this species in recent years (Berggren 1994, Perrin *et al*. 1994, HELCOM 1996, ICES 1997, ASCOBANS 2000, IWC 2000). Several studies in European waters have shown that bycatch levels in gillnet fisheries may not be sustainable, e.g. in the Celtic Sea (Tregenza *et al*. 1997), the central North Sea (Vinther 1999), the Skagerrak and Kattegat Seas (Carlström and Berggren 1998, Harwood *et al*. 1999) and the Baltic Sea (Berggren *et al*. 2002).

The issue is of particular concern in the Baltic Sea, where action is urgently needed to reduce bycatch to conserve Europe's most threatened population of harbour porpoises (ASCOBANS 2000). No independent, scientific observer programmes to estimate bycatch on board fishing-vessels have been conducted in the Baltic Sea, but current estimates of anthropogenic mortality in the Baltic Sea are not believed to be sustainable (Berggren *et al*. 2002).

Porpoises were still believed to be common in parts of the Baltic until the late 19th and early 20th centuries, and were distributed all the way up into the Bothnian Sea (Berggren 1995, Berggren and Arrhenius 1995a,b, Koschinski 2002). However, in Swedish waters of the Baltic, Kattegat and Skagerrak Seas, harbour porpoise abundance has declined drastically between the 1960s and 1980s (Berggren and Arrhenius 1995a) with no subsequent recovery (Berggren and Arrhenius 1995b). Porpoises have also become less common during the last decades in other areas in the Baltic region, including Danish (Clausen and Andersen 1988), Polish (Skora *et al*. 1988) and Finnish (Määttänen 1990) waters. Very occasional sightings and bycaught porpoises have been recorded in Finnish and Estonian waters in recent years (Määtänen 1990, Mattsson 1995, S. Karalius, *pers. comm.*).

Studies of skull morphology, mitochondrial DNA and contaminants show that this population is distinct. Current information on the number of porpoises in Danish, German, Swedish and International waters of the Baltic Sea (ICES rectangles 24 and 25) derives from an aerial survey conducted in 1995 (Hiby and Lovell 1996). The abundance estimate for the area surveyed was 599 (CV = 0.57) animals. The ASCOBANS Baltic Discussion Group (2001) accepted this estimate, but noted that this was:

(a) downwardly biased, because it did not cover an area of Polish waters where harbour porpoises are known to occur.

(b) an estimate with poor precision, due to low numbers of detected animals in the survey.

Further surveys were recommended to address these issues.

This paper presents the results of boat-based acoustic and visual surveys for porpoises carried out by the International Fund for Animal Welfare and collaborators during the summers of 2001 and 2002. The primary aim was to further investigate the distribution and relative abundance of porpoises in the Baltic, and particularly, in 2001, to examine the hypothesis of a 'reservoir' of porpoises off the Polish coast. For these purposes acoustic detection rates were compared between several survey blocks. Visual rates were also compared in this way, but acoustic rates were the primary measure because acoustic data may be collected in a wider range of conditions (at night and in poor weather). In order to provide comparative data for detection rates in the Baltic (including Polish coastal waters), surveys were also carried out in regions of German and Danish waters, known, from previous surveys (Hammond *et al*. 1995), to be relatively populous.

The acoustic survey method currently in use provides information on detection rates, but has not yet been used to estimate detection probability as a function of perpendicular distance from the trackline. Therefore, at present, acoustic surveys can only be used for measuring relative, as opposed to absolute, abundance. Combined visual and acoustic data can potentially provide absolute abundance estimates (Borchers 1999), but the methods are still under evaluation. Absolute abundance estimates based on dual acoustic and visual data may be reported in the future.

Results of the 2001 survey were presented to the IWC scientific committee meeting (Paper SC/54/SM3) in May 2002. Preliminary results from the 2002 survey were made available to the German government to provide data on the distribution of porpoises for a review of porpoise distribution in German waters. This report includes both the 2001 and the 2002 results that have been combined and updated following a further analysis of the acoustic data.

Methods

Survey Design

In 2001, dedicated survey transects were laid out only in Polish coastal waters (between the German border and the Bay of Gdansk – Figure 1). In 2002 the survey was expanded to include the Kiel and Mecklenburger Bights and waters north of the Polish coastal waters surveyed in 2001, as far as the Swedish coast. The 2002 survey was split into four blocks (Figure 1):

Northern Kiel Bight is exclusively in the Danish territorial waters known as the Lille Bælt.

Southern Kiel Bight encompasses both Danish and German waters, including the Flensburger Fiord, all waters south of Ærø and Langeland and as far east as the islands of Fehmarn and Lolland.

Mecklenburger Bight covers waters surrounding the island of Fehmarn and all those south of Lolland, extending east to the Darss Sill, approximately 50 km west of Rügen Island.

The Baltic block includes waters east of the Darss Sill. These lie within the territorial waters of Denmark and Germany (surrounding Rügen Island), the Polish coast as far east as the Bay of Gdansk, the southern coast of Sweden and the Danish islands of Bornholm and Christiansø.

To aid comparison of data, these blocks corresponded to the blocks used by other researchers conducting aerial surveys for harbour porpoises in 2002 (Scheidat *et al*. 2003; Berggren, unpubl.), with the exception that the 'Kiel Bight' block was split into two regions (north and south). The reason for the split was that the original aerial survey tracks frequently crossed land and would have been impractical for boat-based surveying.

The boat followed the planned transects as closely as possible given the constraints of navigational safety and requirement of 10m minimum depth for deployment of the hydrophone. Each acoustic detection and sighting has been designated as 'on' or 'off' track according to whether the vessel was on one of the predetermined survey tracks. Survey effort in 2002 alternated between blocks over the period of the survey in order to reduce any effects from seasonal changes in distribution. Individual transects were not surveyed in any particular order but were selected based on the requirements of port visits for crew changes and the weather conditions on any particular date.

Data Collection

The surveys were conducted from the 14m auxiliary powered sailing vessel *Song of the Whale*. The vessel was operated under engine power in low wind conditions and when visual surveys were taking place (to maintain an approximately constant survey speed and so as not to obstruct the forward view of the observers). When not surveying visually, the vessel was sailed whenever the desired course could be maintained at a survey speed of approximately six knots. GPS data (position, speed, course over ground) were logged automatically to a database every 10 seconds. Environmental data (wind speed and direction, water temperature and depth) were logged automatically every minute. Other data, which could not be collected automatically, were entered manually into the database every 30 minutes (wave height, sea state, weather, cloud cover, barometric pressure, visibility) or whenever they changed (glare, engine and generator on/off).

The boat was equipped with an automatic porpoise detection system (Gillespie and Chappell, 2002), which was developed to detect the high frequency sounds produced by harbour porpoises. The porpoise detector was deployed at all times, including passages between the UK and the study area. It consisted of a two-element hydrophone towed 100 m astern of the survey vessel, specialist electronics modules and a computer running purpose written software on board the survey vessel. Details of the acoustic processing are given in Gillespie and Chappell (2002).

Acoustic surveying continued around the clock whether the vessel was on a track-line or not. During daylight hours (06:00 to 20:00) in sea states of Beaufort two or less, two observers were stationed on an A-frame observation platform. This provided them with a clear view ahead, with an eye height of approximately 5.3 m. The port side observer scanned from -90° to 15° and the starboard observer from -15° to 90° relative to the vessel's heading. Observers tracked porpoises as far astern as possible to assist with linking sightings and acoustic detections. Observers scanned with the naked eye and

estimated ranges to sightings visually, but used angle boards to measure bearings to sightings. Sightings were recorded on paper forms by a third person (so that the observers did not need to take their eyes off the sighting to record their observations). All data were transcribed by hand into the database and cross-referenced to the vessel's GPS positions. Incidental sightings (made by non-observers) were also recorded in the database.

Visual and acoustic data collection continued even when the vessel was off track (provided the sea state criteria were met for visual). These detections have not be used in the relative abundance estimates as they were not made as part of the survey track design, but can provide useful information, for example for estimating detection functions, mean group size or for examining responsive movement.

In addition, six harbour porpoise click detectors (PODs) were deployed in two locations in 2001 where porpoises have previously been sighted or bycaught: Wolinksi Park (west Poland) and Puck Bay (east Poland) to monitor the occurrence of porpoises by recording high frequency click sounds (for more information see http://www.chelonia.demon.co.uk). PODs were anchored near the seabed with a line and buoy at the surface. Unfortunately, the two PODs in Wolinksi Park and one in Puck Bay were lost leaving three PODs in Puck Bay from which data were retrieved.

Acoustic Data Analysis

Visual representations of the acoustic data from the towed hydrophone have been scanned by an analyst to search for clusters of porpoise-like clicks using the interactive software described in Gillespie and Chappell (2002). Clicks were classified as 'porpoise-like' if they had minimum amplitude of 105 dB re.1 µPa and a signal strength in the 'porpoise band' (a frequency band at 115-145 kHz) of at least 25 dB above the mean signal strength measured at two lower control frequencies. During the initial scan of the data, all clusters of more than four 'porpoise-like' clicks were marked. Clusters of clicks were then classified as harbour porpoise if there were at least 7 clicks in the cluster, and where these clicks were detected on both hydrophones on a consistently varying angle relative to the axis of the array. Clusters with fewer than 7 clicks, or clusters of clicks with inconsistent angles were excluded from the remaining stages of the analysis.

All PODs were programmed to make six 10-seconds scans for porpoise clicks at 90 and 130 kHz every minute 24 hours a day. POD data were collected during 5.5 days in Puck Bay. To identify which of the recorded clicks and click trains that had been produced by porpoises a click train detection algorithm was used (http://www.chelonia.demon.co.uk). The porpoise click train detection algorithm scans the data files and identifies clicks in trains using a probability based pattern recognition algorithm and delivers the number of detected clicks and click trains per user defined time interval.

Results

The total distance surveyed acoustically and visually on track in each block or sea area and the number of detections is shown in Table 1. Off track data for areas in which there was no on track effort and for the Polish coastal region are shown in Table 2[1].

The complete route of *Song of the Whale* and acoustic detections in 2001 is shown in Figure 2. The details of the track in the Baltic, along with the positions of the two sightings, are shown in Figure 3. It can be seen (Figure 2) that considerable numbers of porpoises were detected acoustically along the Dutch and German North Sea coasts and in the Mecklenburger Bight as far east as the island of Rügen. To the east of Rügen, however, there was only a single acoustic detection, < 1 km from the coast, approximately 28 km to the east of the Polish port of Swinousjie (Figure 3). Visual surveys in 2001 only took place in Polish coastal waters and around Rügen. One animal was sighted in German waters to the west of Rügen, another in Polish waters 18 km northeast of the acoustic detection.

[1] The Polish coastal region off track data is shown since it was the only porpoise detected acoustically in that sea area during the two years of survey.

Figures 4 and 5 show the acoustic and visual survey results for 2002. The highest concentration of acoustic detections was in Danish waters in the northern part of the Kiel Bight. Although there were three acoustic detections in the Baltic block, two of these were west of Rügen very close to the edge of the Mecklenburger Bight block. There was only a single acoustic detection east of Rügen, which was in Swedish waters in the far northeast of the survey area.

The average group size of porpoises observed from the A-frame in 2002 (on and off-track data) is 1.4 animals. It is currently not possible to measure group size using the acoustic data. Three of 45 (7%) of porpoises sighted (on and off track data) were calves.

No porpoise click trains were detected during the 5.5 days of POD recordings in Puck Bay.

Discussion

Porpoises were detected acoustically in all areas, but the vast majority of the visual and acoustic porpoise detections were made in the Kiel and Mecklenburger Bights. The acoustic detection rate in the Baltic block is one or two orders of magnitude lower than in the western blocks (Table 1). No porpoises were detected on track in the Polish coastal block (a sub-region of the Baltic) in either year. Very few porpoises were detected acoustically in the southern part of the Mecklenburger Bight (Figure 4), and of the three porpoises detected acoustically (on track) in the Baltic block, two of these detections were close to the western boundary of that block (Figure 4), near the northern Mecklenburger Bight.

The low porpoise detection rate in the survey of the entire Baltic block agrees in a broad sense with the low density found in the 1995 aerial survey (599 porpoises in a 43,000 km^2 study area, Hiby and Lovell 1996) in international waters (excluding the Polish coast). Furthermore, Berggren and Arrhenius (1995a) report only a single sighting in a five-year observer programme in the Baltic Sea. In the present study, in Polish coastal waters, while on track there was a zero detection rate and a single sighting. These results do not support the hypothesis that there is a part of the Baltic population, of a significant size, in Polish coastal waters.

In Polish waters, the single off-track acoustic detection is not appropriate for use in comparisons of relative abundance, not being part of the formal survey. Nevertheless, this and the single on-track sighting are highly significant results, indicating an extant population in the area, albeit small. Information from incidental sightings and bycatch (ICES 1997, Kuklik and Skóra 2003) has indicated that Puck Bay in the east of Poland may have a relatively higher density of porpoises. No porpoise click trains were detected on three PODs deployed for 5.5 days in this area. It is possible that the relatively high occurrence of porpoise bycatch in Puck Bay is an effect of a very intense gillnet fishery in this area, rather than a higher density of porpoises. Further research is needed to clarify this.

The results from the present study confirm the endangered status of this population and the urgent need for immediate actions to prevent future anthropogenic mortalities. Finally, the results also demonstrate the potential for using acoustic surveys to investigate trends in relative abundance of porpoise populations over time and between regions.

Acknowledgements

This work was funded and carried out by the International Fund for Animal Welfare. The authors are particularly grateful to Lex Hiby for his assistance in designing the 2002 survey tracks and providing other advice; and to the IFAW German office for their help with logistics and permits. We would also like to thank our observers Sina Boye, Stefan Bräger, Irene Bystedt, Magnus Dambolt, Sabine Graf, Cordula Herling, Alex Liebschner, Anna Kaliszewska, Alexa Kershaw, Philipp Koester, Radomil Koza, Anna Mickiewicz, Denise Risch, Anna Särnblad, Joh Sidey and Agata Weydmann. Thanks also to Russell Leaper and David Lavigne for many useful comments on previous reports. Permission to conduct the survey was granted by the Polish Government (the Ministry of Transport and Marine

Management and the Ministry of Agriculture and Rural Development); the Swedish Coastguard; the Danish Ministry of Foreign Affairs and the Nature and Wildlife Section, Danish Forest and Nature Agency and the Danish shipping agency (Søfartsstyrelsen). We also thank Dr. Henning von Nordheim (Bundesamt für Naturschutz) and Dr. Labes (Umweltministerium Mecklenburg-Vorpommern) in Germany, and Rüdiger Strempel, Executive Secretary, UNEP/ASCOBANS for endorsing and supporting the survey.

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Table 1. On track survey effort and detections in 2001 and 2002. For visual surveys, number of groups is shown with number of individuals in parentheses.

Block	Year	Area (km^2)	Acoustic Survey			Visual Survey		
			km surveyed	N	N/ 100km	km surveyed	N	N/ 100km
Polish coastal waters	2001	17000	1692	0	0	292	1 (1)	0.34 (0.34)
Baltic	2002	56000	2946	3	0.1	253	0	0
Mecklenburger Bight	2002	6000	713	23	3.2	190	0	0
Southern Kiel Bight	2002	3200	494	52	10.5	97	1 (1)	1.03 (1.03)
Northern Kiel bight	2002	1300	291	49	16.8	158	13 (18)	8.2 (11.4)

Table 2. Off track acoustic survey effort and detections in 2001 and 2002.

Block	Year	Acoustic Survey		
		km surveyed	N	N/ 100km
Polish coastal waters	2001	518	1	0.2
German Baltic (around Rugen Island)	2002	893	7	0.8
North Sea	2001	1267	81	6.4
North Sea	2002	598	9	1.5
English Channel	2001	433	9	2.1

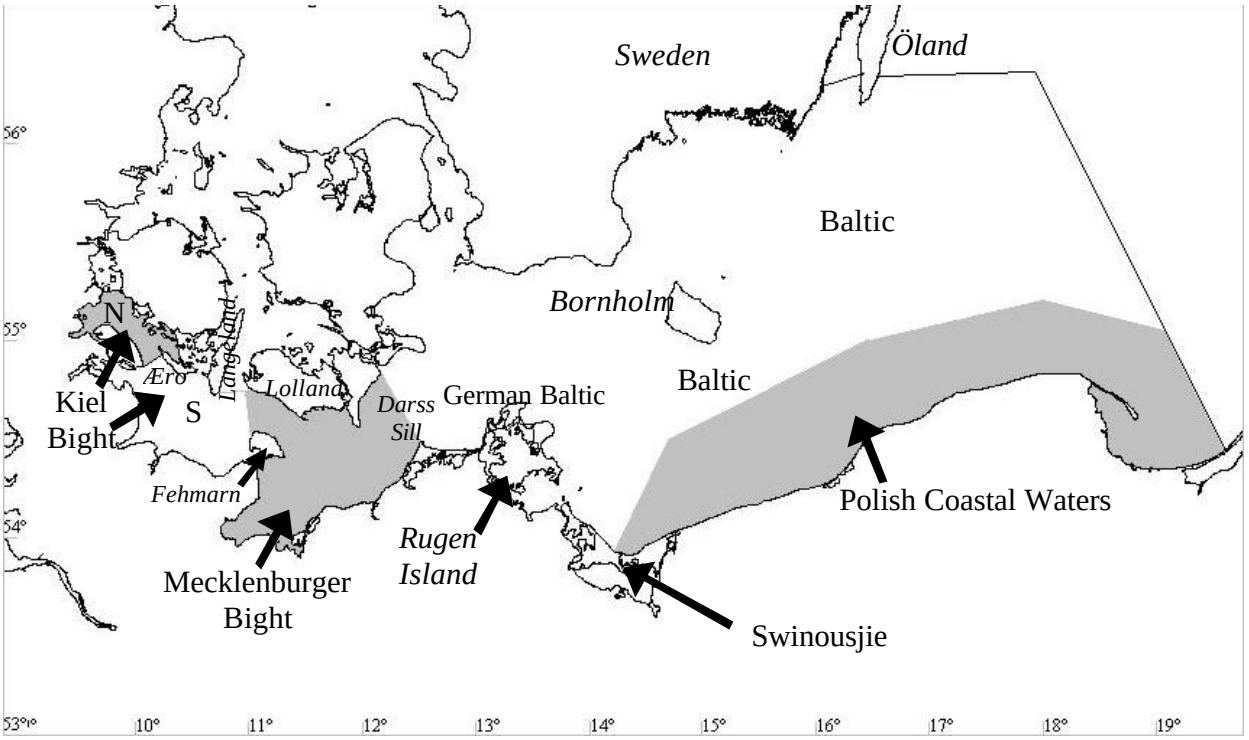

Figure 1. Survey areas in the Baltic and the Kiel and Mecklenburger Bights

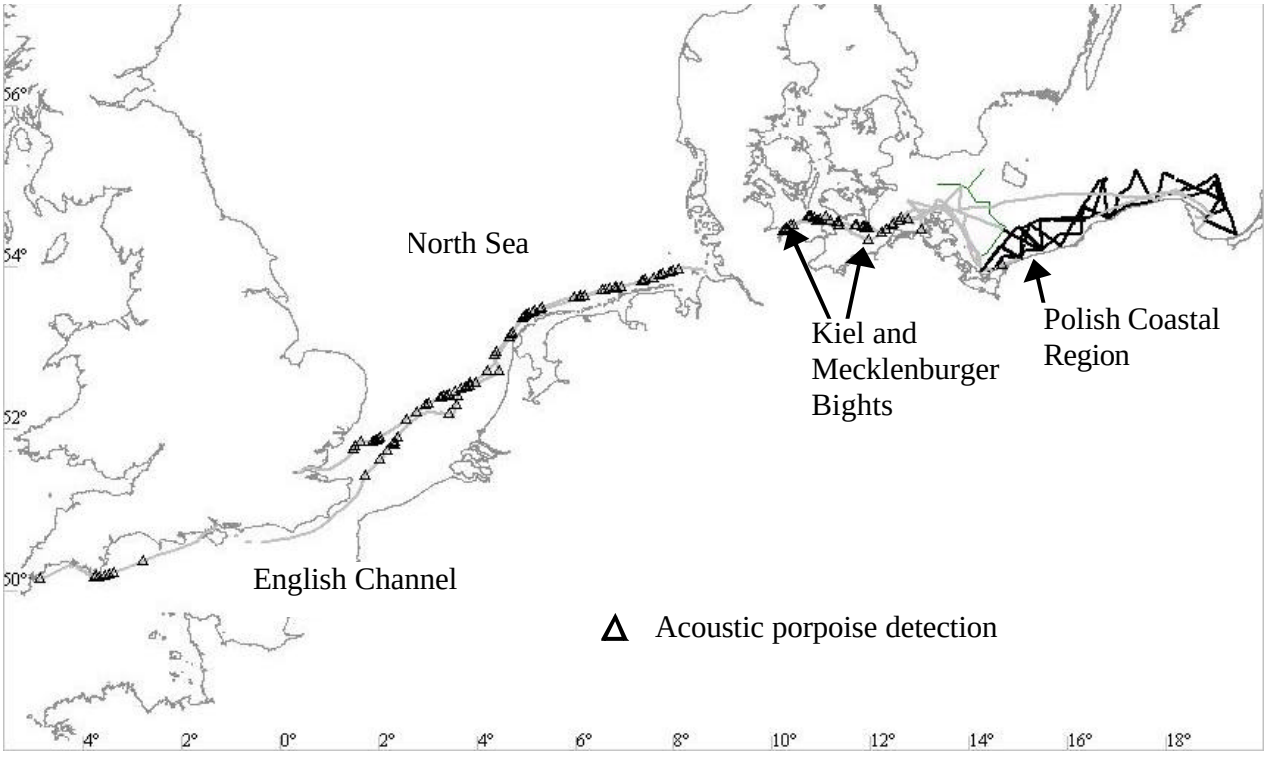

Figure 2. Acoustic survey track in 2001. The black line is sections of the track which were on survey transects. Other sections of the track are in grey.

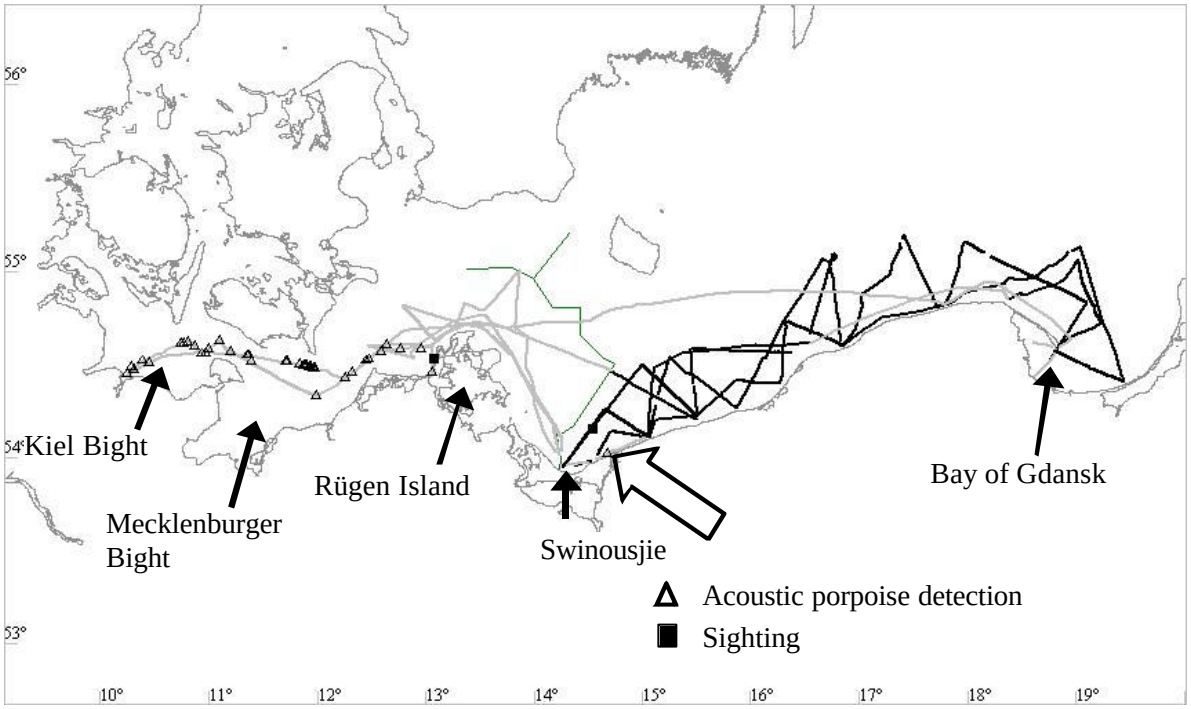

Figure 3. 2001 survey track in the Kiel and Mecklenburger Bights and the Baltic showing acoustic and visual porpoise detections. On track effort is shown in black and off track in grey. The porpoise detection in Poland is marked with an arrow.

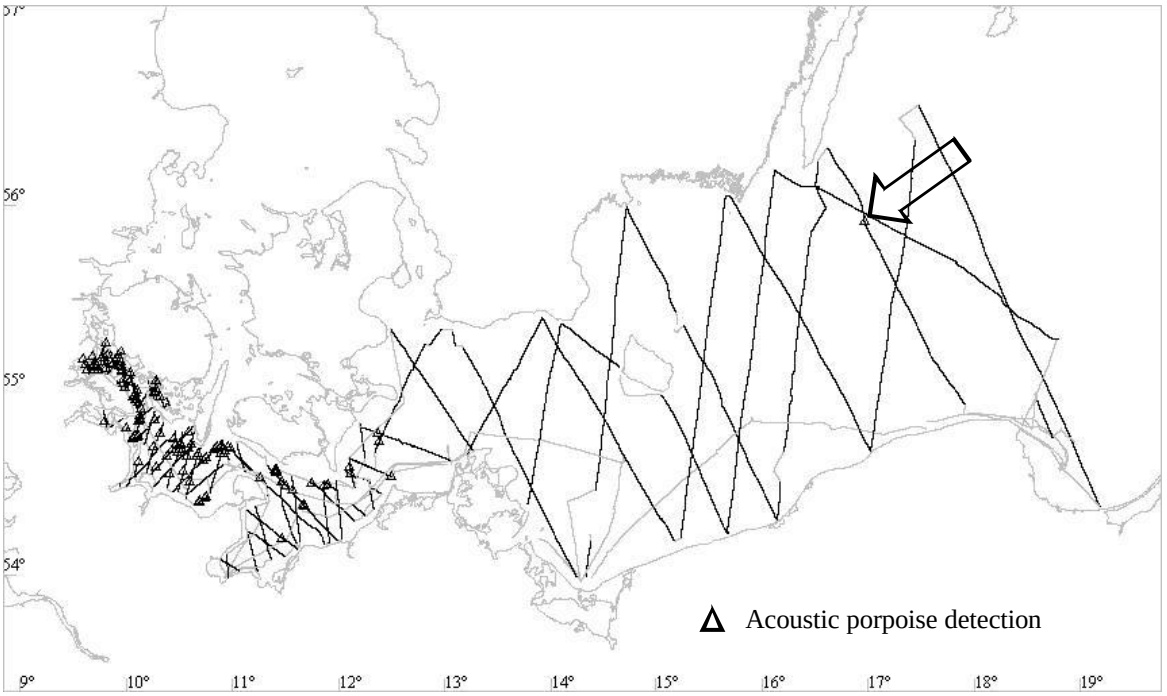

Figure 4. 2002 Survey tracks in the Kiel and Mecklenburger Bights and the Baltic showing acoustic detections. On track effort is shown in black and off track in grey. The Porpoise detection SE of Öland is marked with an arrow.

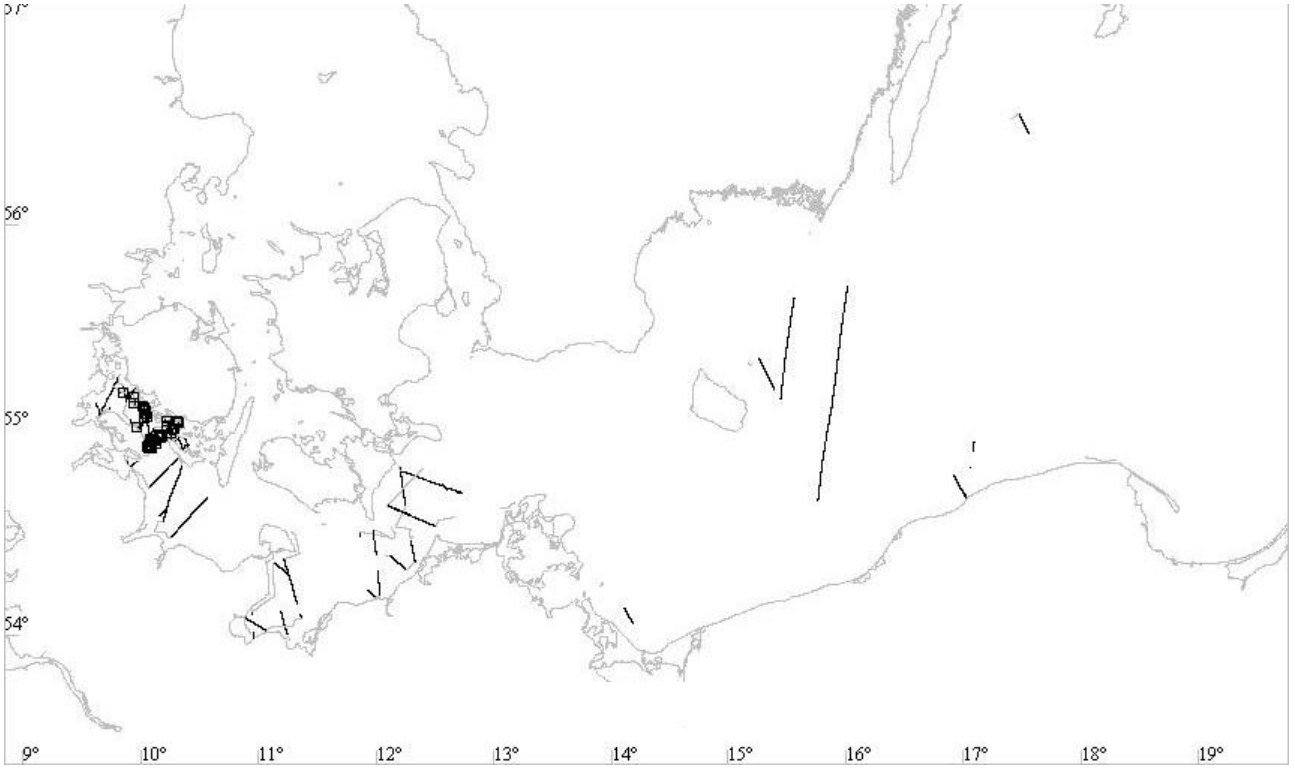

Figure 5. Visual survey tracks in 2002 showing visual sightings. On track effort is shown in black and off track in grey.