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THE HARBOUR PORPOISE *PHOCOENA PHOCOENA* IN THE SOUTHERN NORTH SEA, PARTICULARLY THE DUTCH SECTOR

by

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1. Introduction

The distribution and abundance of the harbour porpoise *Phocoena phocoena* (L., 1758) in The Netherlands and the southern North Sea at large is poorly known (Reijnders, 1992). However, it is generally accepted that a population decline commenced in The Netherlands in the 1940s or 1950s (Van Deinse, 1952; Verwey, 1975; Verwey & Wolff, 1981), with a second decline (deduced from stranding data) in the 1960s (Smeenk, 1987). By 1960, observations of live porpoises in Dutch coastal waters had become exceptional (Verwey & Wolff, 1981). An assessment of the status of the harbour porpoise, and a comparison of present and past abundance, are seriously hampered by a scarcity of sightings schemes, particularly those in which observer effort is quantified (cf. Evans et al., 1986; Kinze, 1988). Declines in strandings and in numbers sighted were reported from other areas in the southern North Sea (Evans, 1980; Evans et al., 1986; Evans & Scanlan, 1989).

Quantitative information on distribution and abundance of the harbour porpoise has been collected during systematic counts of seabirds from coastal sites in The Netherlands since 1972 (seawatching) and during ship-based counts of seabirds in the southern North Sea since 1987. Recording seabirds was the main objective in both schemes, but marine mammals were also routinely registered. From both sources, observer effort is known, either in terms of number of observation hours (seawatching), or in terms of kilometres travelled (ship-based surveys), and the status of the harbour porpoise can thus be described, corrected for effort, in terms of patterns in abundance, distribution, and group size.

In this paper, an analysis of all sightings from the above two sources is presented, together with a review of the published sightings in Dutch coastal waters since the 1940s, in order to put the present data into an historical context. Additional information was obtained from aerial surveys in the Dutch sector of the continental shelf as

published by Baptist (1987) and in "Recent reports" in the periodical Sula of the Dutch Seabird Group during 1987-1992, and from various other sources.

2. Methods

The "seawatching" scheme was established in 1972. Amateur bird-watchers recorded seabird passage from sites scattered along the Dutch coast (Club van Zeetrekwaarnemers [CvZ], currently Nederlandse Zeevogelgroep [NZG] = Dutch Seabird Group; cf. Camphuysen & Van Dijk, 1983). Seawatching is conducted by using high-powered binoculars, mounted on a tripod, fixed on the horizon. All birds and marine mammals seen within this field of vision, i.e. from the tideline or at least the surf to the horizon, are recorded per hour. Each record involves species, number and direction of movement (either to the left or to the right). Seawatching data were collected for three subregions: South (Breskens-IJmuiden), Central (IJmuiden-Den Helder), and North (North Sea coast of the Wadden Sea islands), during January 1972-June 1992 (cf. Camphuysen & Van Dijk, 1983). The major sites used for seawatching in The Netherlands are illustrated in fig. 1.

Systematic ship-based seabird surveys in the southern North Sea commenced in February 1987. These surveys, organized by M.F. Leopold for The Netherlands Institute for Sea Research (NIOZ), and by C.J. Camphuysen for the Dutch Seabird Group and Tidal Waters Division (Ministry of Transport, Public Works and Waterways), were concentrated on the Dutch sector, but indeed most of the southern North Sea between 51° and 56° N was covered. Ship-based surveys were conducted from a variety of ships, mainly research vessels, ranging in length from 23 to 90 metres. Birds were recorded continually in 10-minute intervals during steaming within a strip transect, and observations of cetaceans, a byproduct of these counts, were treated just as those of birds (recording time, species, number, and behaviour; cf. Tasker et al., 1984; Leopold et al., 1992). The southern North Sea was divided into 1° latitude × 1° longitude rectangles, and for each rectangle, observer effort was calculated (number of kilometres travelled). Special attention was given to an area off the Dutch Wadden Sea islands, where 0.25° latitude × 0.5° longitude rectangles were used. For all cetaceans seen, the distance to the nearest coast was calculated. Numbers seen per kilometre travelled were calculated for each of the above rectangles. Seasonal pattern and average group size were calculated for larger subregions.

Statistical tests used in this paper include Spearman Rank-correlation coefficients to test trends (cf. Fowler & Cohen, 1986), and G-test with Williams' correction (cf. Sokal & Rohlf, 1981) to assess the relationship between number of sightings during seawatching and the phase of the tidal cycle.

3. Observer effort

The seawatchers completed over 2500 one-hour-total record cards per annum (Camphuysen & Van Dijk, 1983; files CvZ/NZG). Many seawatching sites were manned throughout the year, but most frequently during spring and autumn seabird-migration (i.e. March-May and August-November; fig. 1), during which the more important sites were manned virtually every day. Observer effort in winter (December

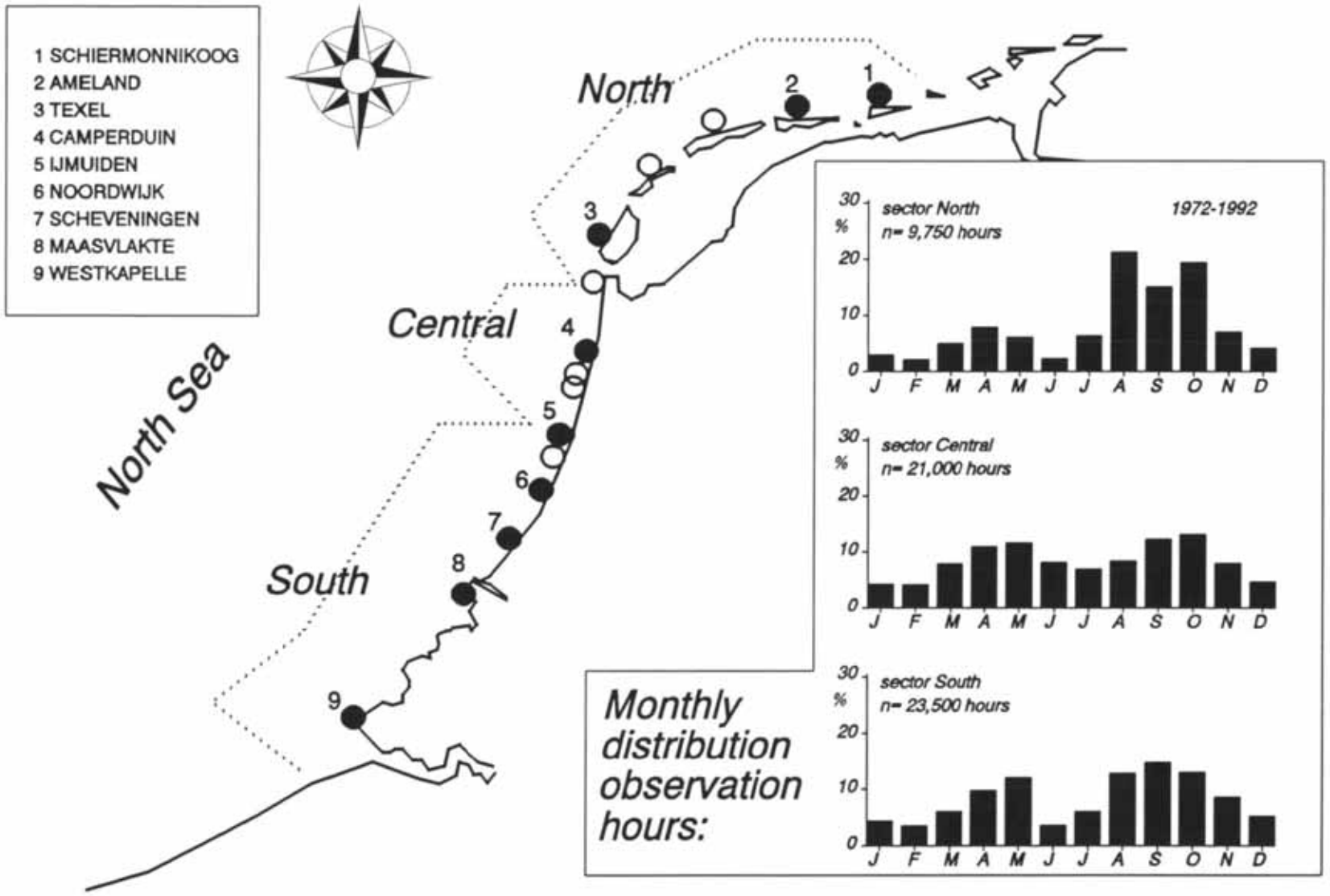


Fig. 1. Sites used for seawatching in The Netherlands, and sectors used for data analysis (black dots indicate frequently manned sites). Inset: Seasonal pattern of seawatching observation hours, 1972-1992, in sector North (n = 9,750), Central (n = 21,000) and South (n = 23,500).

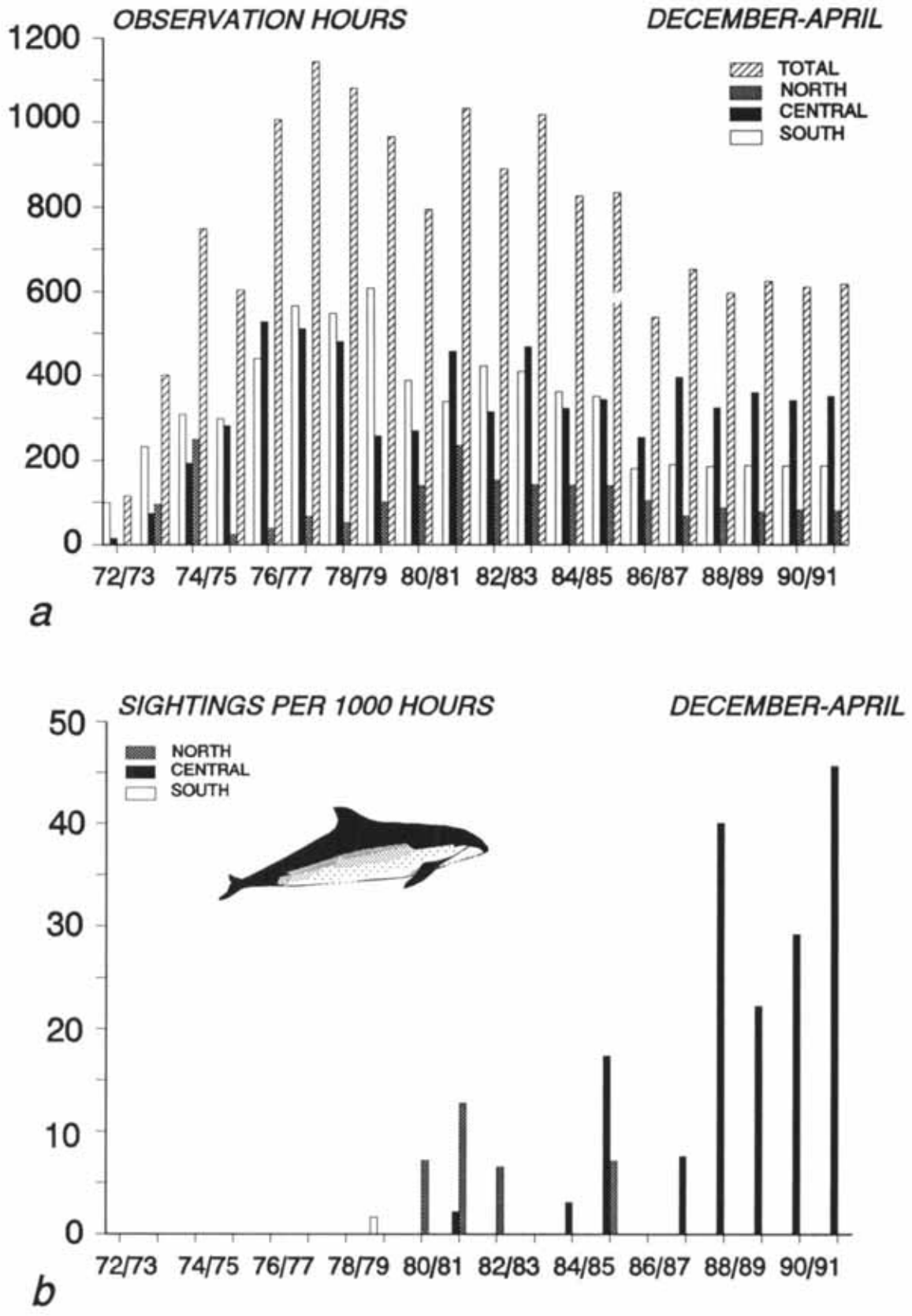


Fig. 2. (a) Observer effort during December-April, 1972/73-1991/92 and (b) harbour porpoises per 1000 hours of observation at seawatching sites in sector North (n = 1786 hours, 6 sightings), Central (5321 hours, 58 sightings), and South (5867 hours, 1 sighting).

to April) rapidly increased during 1972-1979 (Camphuysen & Van Dijk, 1983), then stabilized at 800-1100 hours per winter during 1980-1985, and slightly declined thereafter (fig. 2a). For 1990-1992, observer effort was not yet completely known at the time of writing and thus had to be estimated, using preliminary reports of regularly manned sites (N.F. van der Ham, pers. comm.) and trends set in previous years. All sightings of porpoises during CvZ/NZG seawatches were forwarded to the authors by N.F. van der Ham.

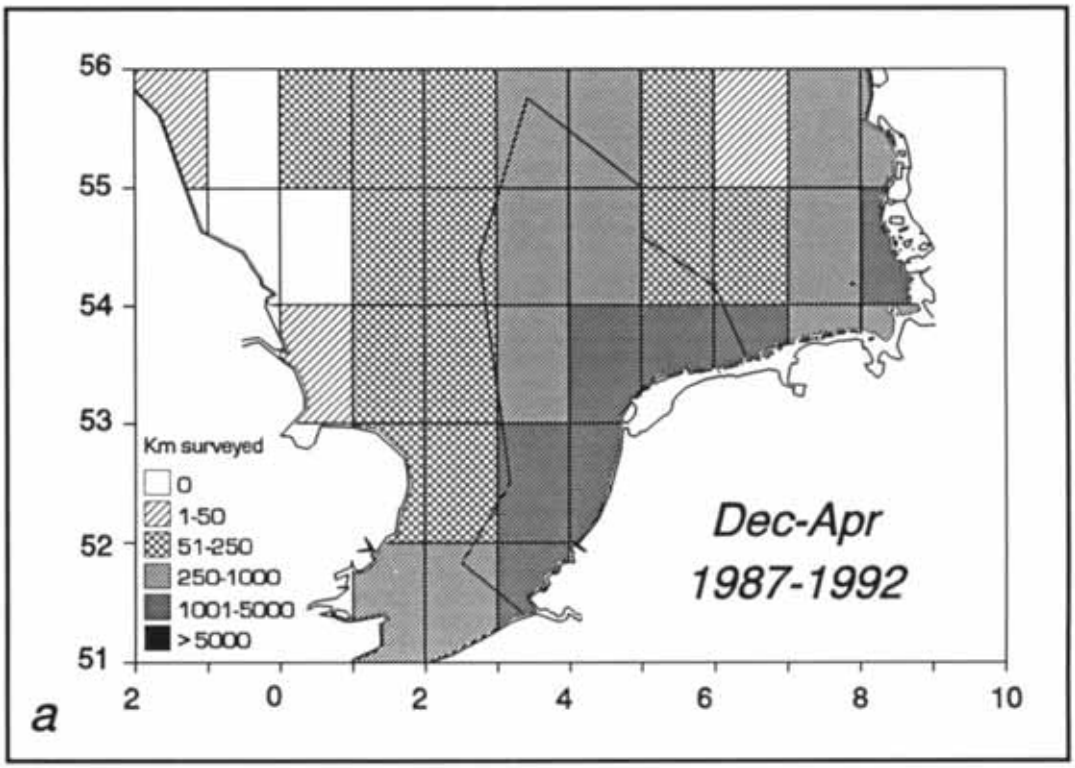
Observer effort of ship-based surveys is summed for all trips between February and June 1992 inclusive, per 1° × 1° rectangle, for winter (December-April; fig. 3a), summer (May-August; fig. 4a), and autumn (September-November; fig. 5a). In winter, most surveys were carried out in the Dutch coastal zone, the central southern North Sea and the German Bight, while very little information was collected off North-east England. In summer, besides the Dutch and German coastal zone, considerable attention was given to the Frisian Front area (see De Gee et al., 1991) and the southern half of the Dogger Bank. In July and August, the entire Dogger Bank area and waters off North-east England were surveyed. In autumn, two areas received most attention: the waters off East England (annually, but only in September) and the central part of the Dutch sector.

4. Results

4.1. Sightings from seawatching sites, 1972-1992

In total, 125 harbour porpoises were seen during systematic seawatches (72 sightings). In the 1970s, harbour porpoises were extremely rare (two sightings). A group of four was observed at Terschelling (sector North) on 26 September 1979, and a solitary animal was seen at Scheveningen (sector South) on 3 October 1979. During 1980-1985, 13 porpoises were seen (ten sightings). Most animals were seen at Texel (sector North, six individuals) and Scheveningen (sector South, five individuals). Starting in 1986, harbour porpoises appeared at the Dutch coast in considerably larger numbers (60 sightings 1986-92; 107 individuals). Virtually all records (58) were from Camperduin, Bergen aan Zee, and Egmond aan Zee (all sector Central, $n = 60$), with the majority (57) recorded between December and April in these years. Of the twelve sightings before 1986, eight were reported in December-April, but only two in sector Central. The frequency of winter sightings (fig. 2b) significantly increased only in sector Central: 0 sightings per 1000 hours of observation during 1972/73-1978/79, 0.5 sightings per 1000 hours during 1979/80-1984/85, and 23.1 sightings per 1000 hours during 1985/86-1991/92 (1972/73-1991/92, $r_s = 0.66$; $p < 0.02$ [2-tailed]; $n = 20$). Porpoises were virtually absent in sector South, while in sector North most porpoises were recorded from Texel in the early 1980s by one observer who left the island in autumn 1987. There were no porpoises reported in this sector since then, while observations have continued on most other islands (fig. 2).

The majority of the harbour porpoises observed were in transit. In some exceptional cases an individual or group stayed in one area for a while. Breaching has not been reported, and sun-bathing (floating without movement, dorsal fin exposed; cf. Camphuysen, 1987; Hoek, 1992) only occasionally. There was no behaviour reported which



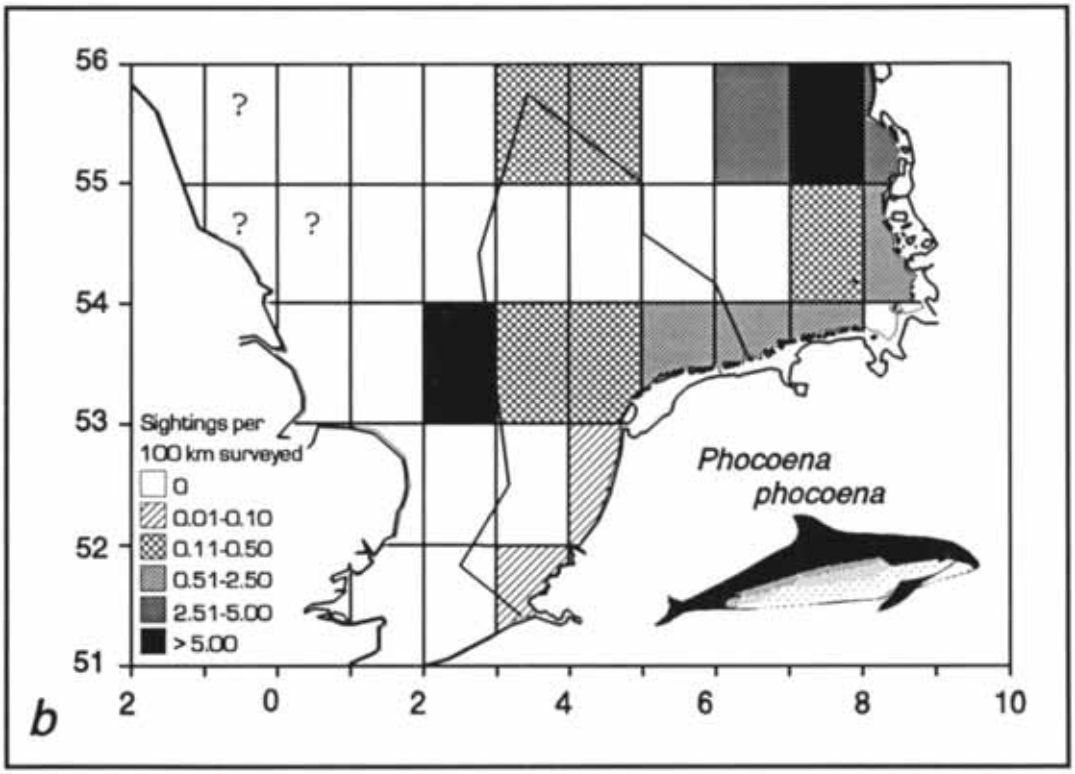


Fig. 3. (a) Observer effort during December-April, 1987-1992 for ship-based surveys in the southern North Sea, and (b) harbour porpoise abundance (number per 100 km of survey).

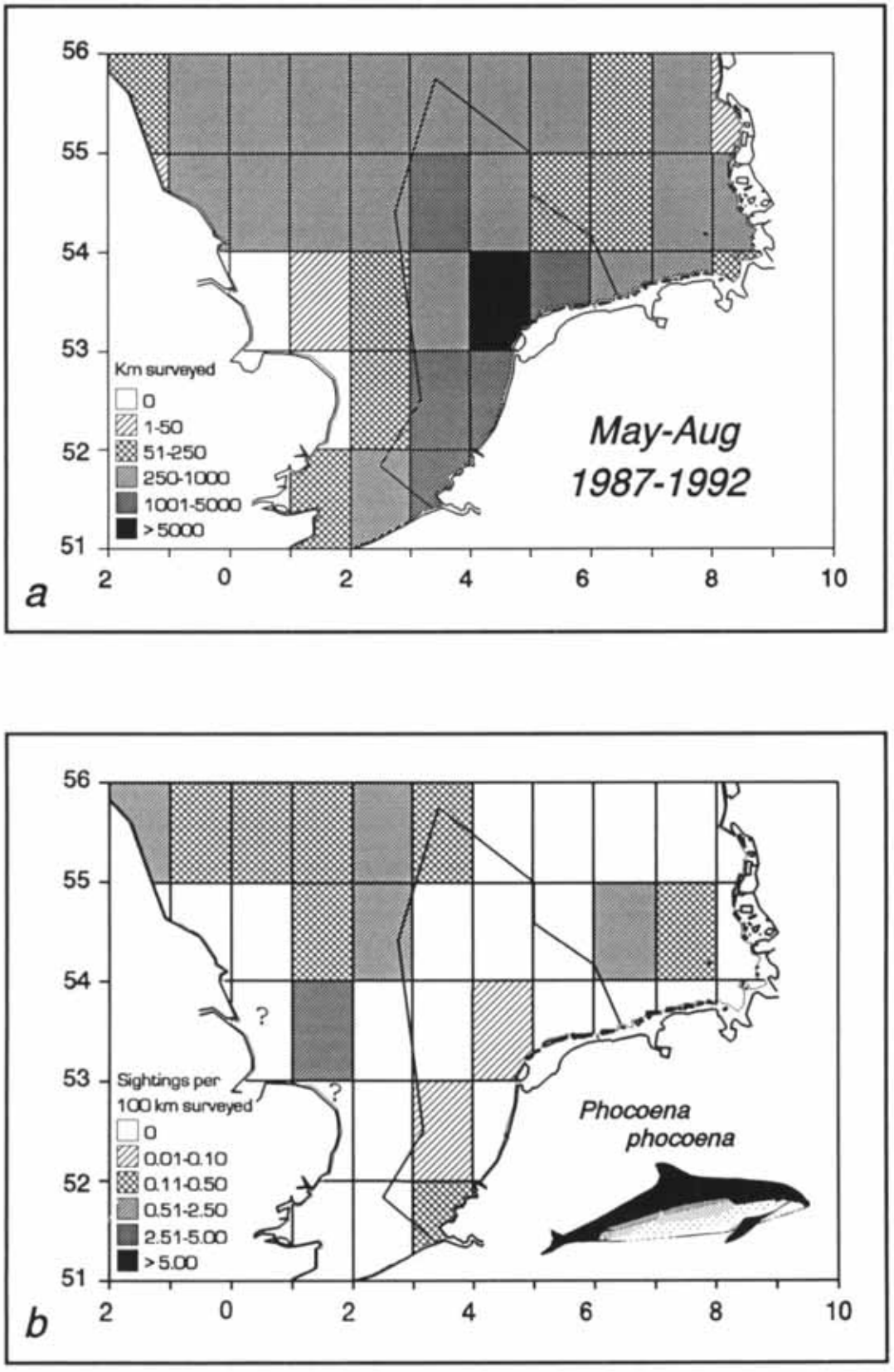


Fig. 4. (a) Observer effort during May-August, 1987-1992 for ship-based surveys in the southern North Sea, and (b) harbour porpoise abundance (number per 100 km of survey).

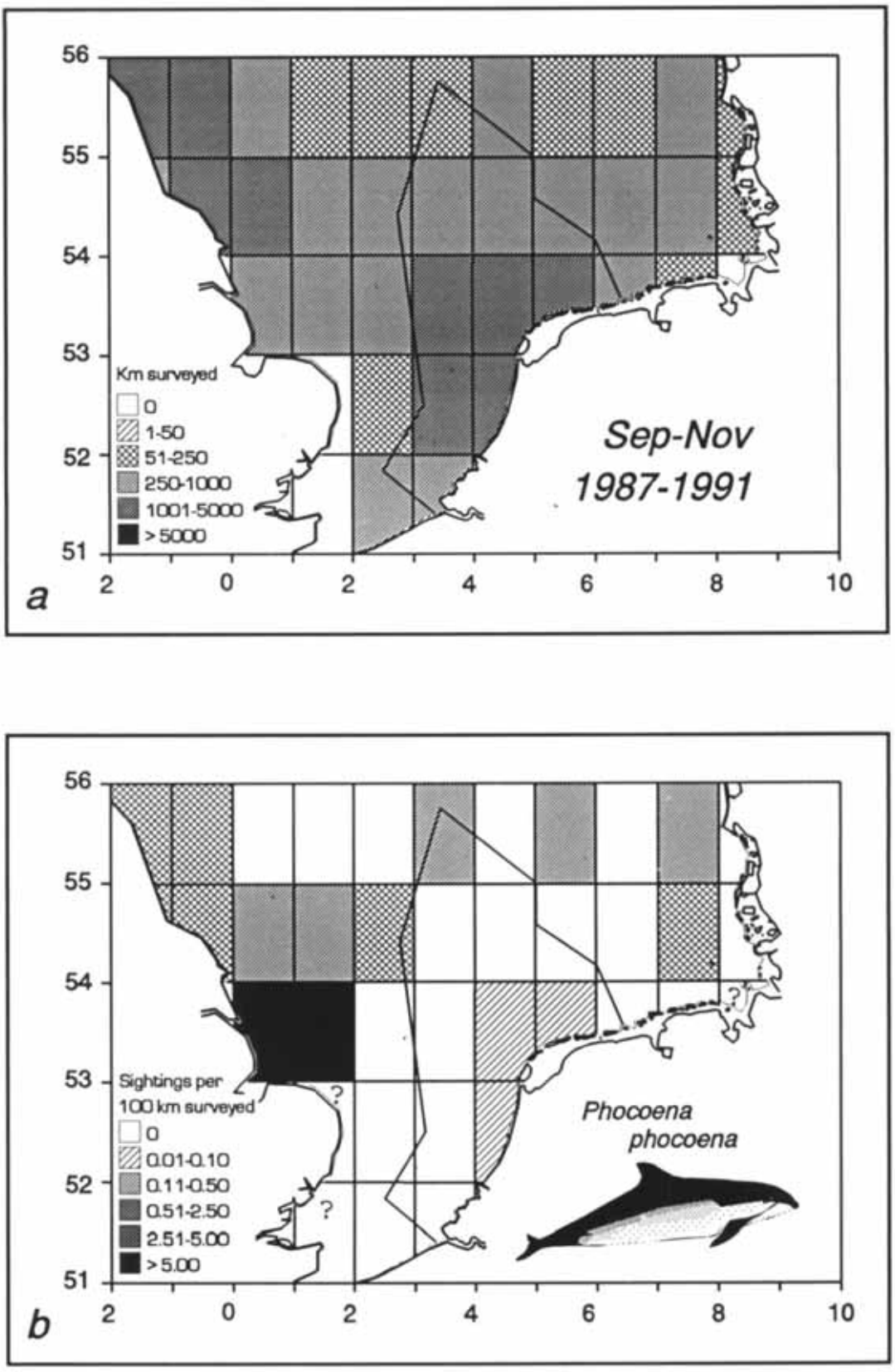


Fig. 5. (a) Observer effort during September-November 1987-1991 for ship-based surveys in the southern North Sea, and (b) harbour porpoise abundance (number per 100 km of survey).

could be interpreted as foraging. No clearly predominating direction of movement was observed (Dec.-Apr. 1986-92: 32% to the left, 59% to the right, 9% stationary, n = 44 sightings; $\chi^2 = 3.6$; df = 1; $p > 0.05$). Apparently, the animals "enter" Dutch coastal waters in winter to stay there for a while (similar to the movements up and down the coast of certain wintering birds like divers [Gaviidae], grebes [Podicipedidae], and scoters *Melanitta* spp.; Camphuysen & Van Dijk, 1983). It is therefore assumed that we are dealing with a population wintering in our waters, rather than a population migrating through our waters from one place to another.

4.2. Sightings during systematic ship-based surveys, 1987-1992

Between February 1987 and June 1992, 309 sightings of harbour porpoises (739 individuals) were collected. In winter, harbour porpoises were most abundant in coastal waters of the German Bight, most notably off Blåvandshuk (fig. 3b). Low densities were recorded further offshore, and the species was rarely encountered in the Channel area and the Southern Bight (51°-53° N). In summer, sightings were more widespread, but porpoises were most abundant in the north-western part of the study area, including the Dogger Bank. The coastal zone of the German Bight appeared deserted (fig. 4b). In fact, harbour porpoises were not seen within 40 km off the coast of The Netherlands' mainland and the Wadden Sea islands (fig. 7). In autumn, the coastal zone of the German Bight was re-populated by small numbers of porpoises. Further north, porpoises were encountered well offshore, but most commonly in an area off North-east and East England (fig. 5b). Major concentrations were found off Spurn Head and Flamborough Head, NE England (but note that this area was insufficiently surveyed in the summer, see fig. 4a). Harbour porpoises entered Dutch coastal waters occasionally in autumn (fig. 8).

The ship-surveys support the seawatching data, in that porpoises are mainly present in the Dutch coastal waters from December to April (fig. 6), and virtually absent in summer and autumn (fig. 7, 8). However, the species was not particularly common off (seawatching) sector Central, but appeared to be concentrated in the coastal zone of the Wadden Sea islands. This zone extended from Texel, the westernmost Frisian island, along the northern Dutch coast and the German coast onto Blåvandshuk in southern Denmark at the edge of our study area, with numbers increasing from south to north along the coast. Off the Dutch coast (52°30' N - 54°30' N), most winter sightings from ships were within 10 km from the shore (41.9% 0-5 km, 35.5% 5-10 km, 22.6% > 10 km, n = 62, fig. 9).

Harbour porpoises, which generally seem wary of approaching motorvessels, were often seen rushing away from the ship. "Escaping" porpoises once or a few times rushed at the surface, often altered course rather suddenly, and subsequently disappeared. The "splash", or "rooster-tail" caused by escaping porpoises is a characteristic feature that experienced observers use to detect porpoises in more windy conditions (Camphuysen, 1991a). In flat calm conditions, and at larger distances from the ship, porpoises were usually seen slowly "wheeling" or basking, without taking any notice of the ship. Breaching (clear of the water) was seen once (9 April 1990, M.F. Leopold, Terschellinger Bank). Diving times and surfacing frequency could not be measured from a (moving) ship. It has been seen, however, that young calves sur-

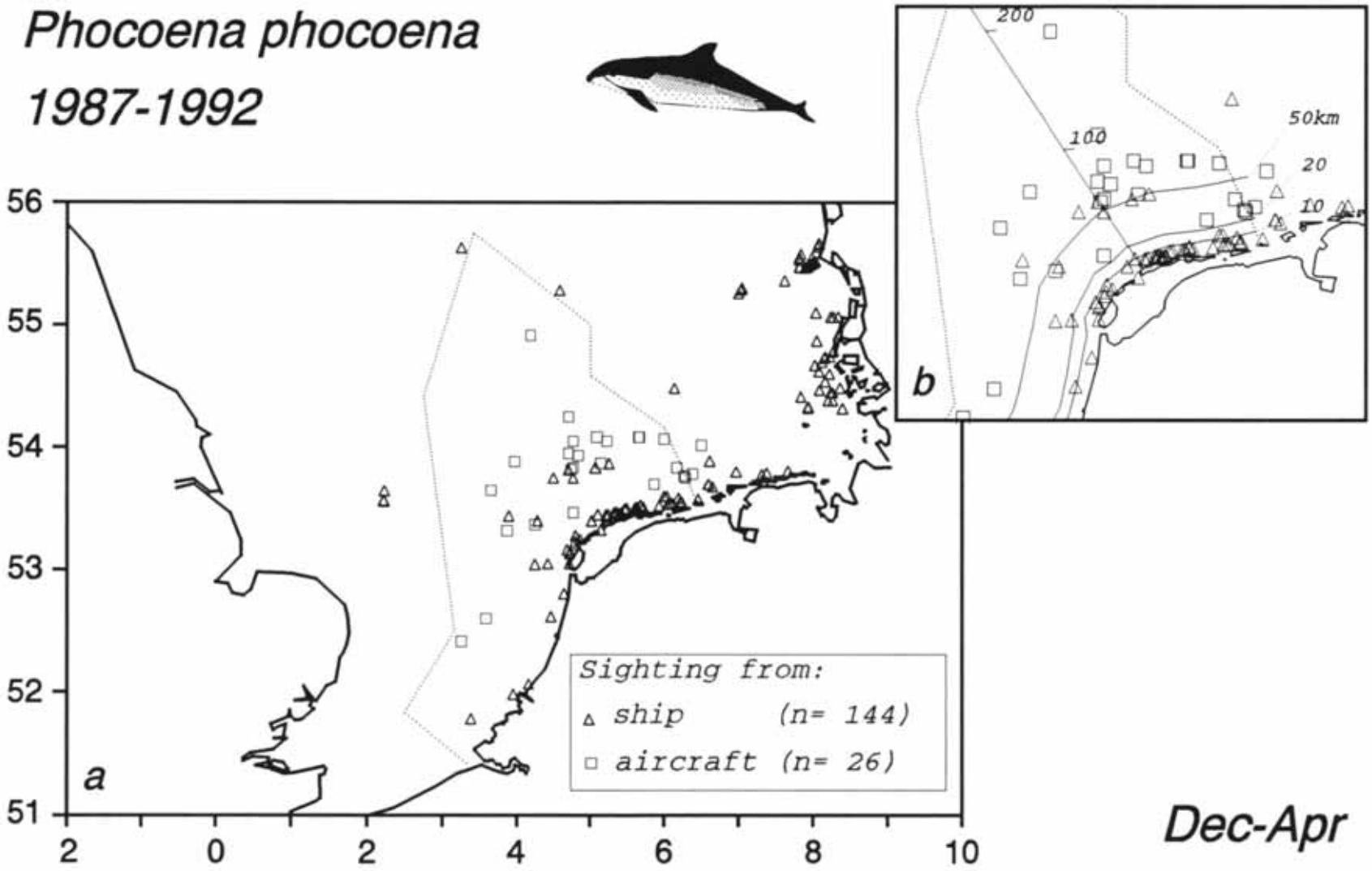


Fig. 6. (a) Sightings of harbour porpoises in the southern North Sea during December-April 1987-1992 from systematic ship-based surveys (triangles) and aerial surveys (squares), and (b) distance zones and sightings in the area where porpoises were most abundant off The Netherlands.

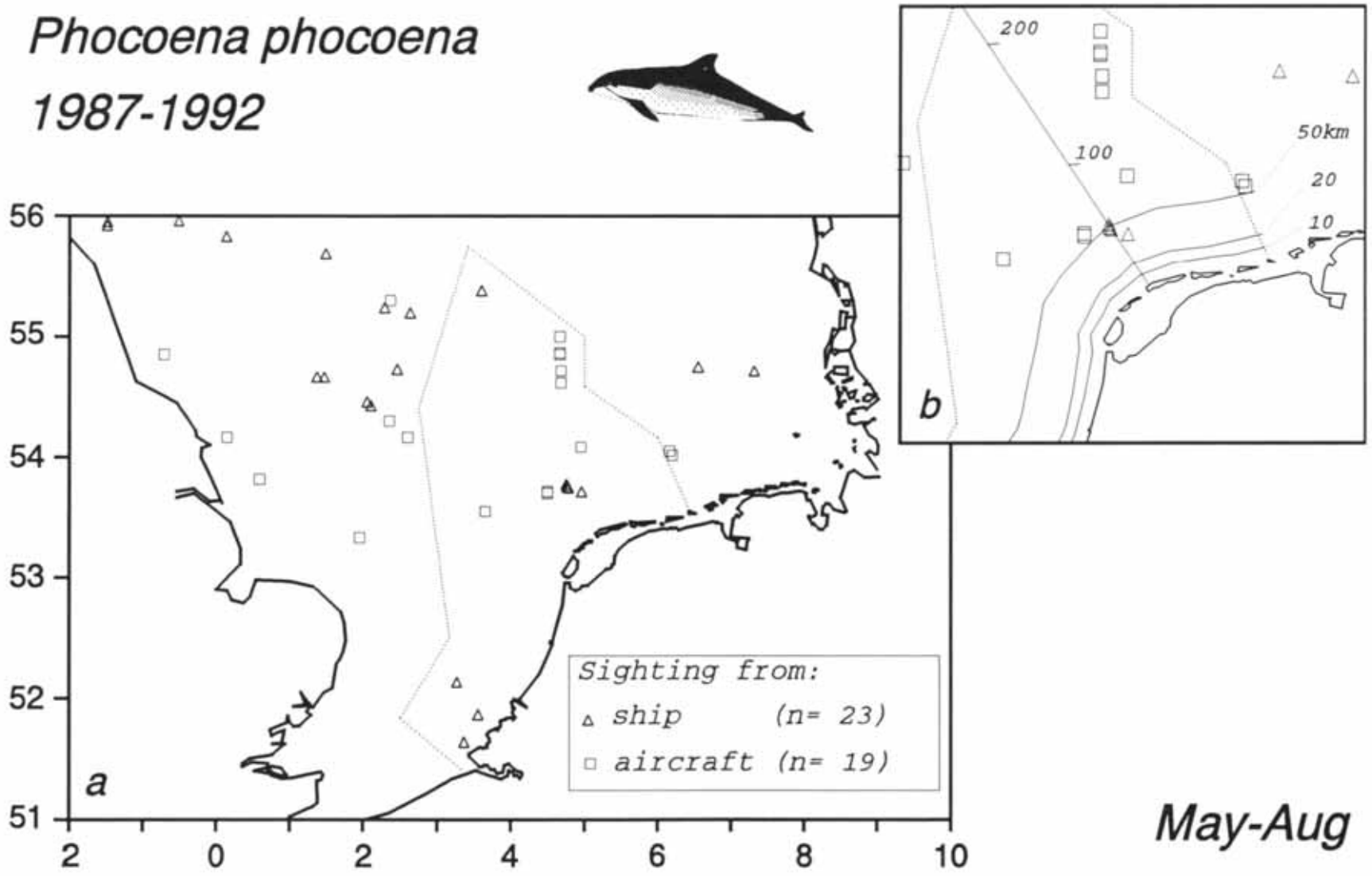


Fig. 7. (a) Sightings of harbour porpoises in the southern North Sea during May-August 1987-1992 from systematic ship-based surveys (triangles) and aerial surveys (squares), and (b) distance zones and sightings in the area where porpoises were most abundant off The Netherlands.

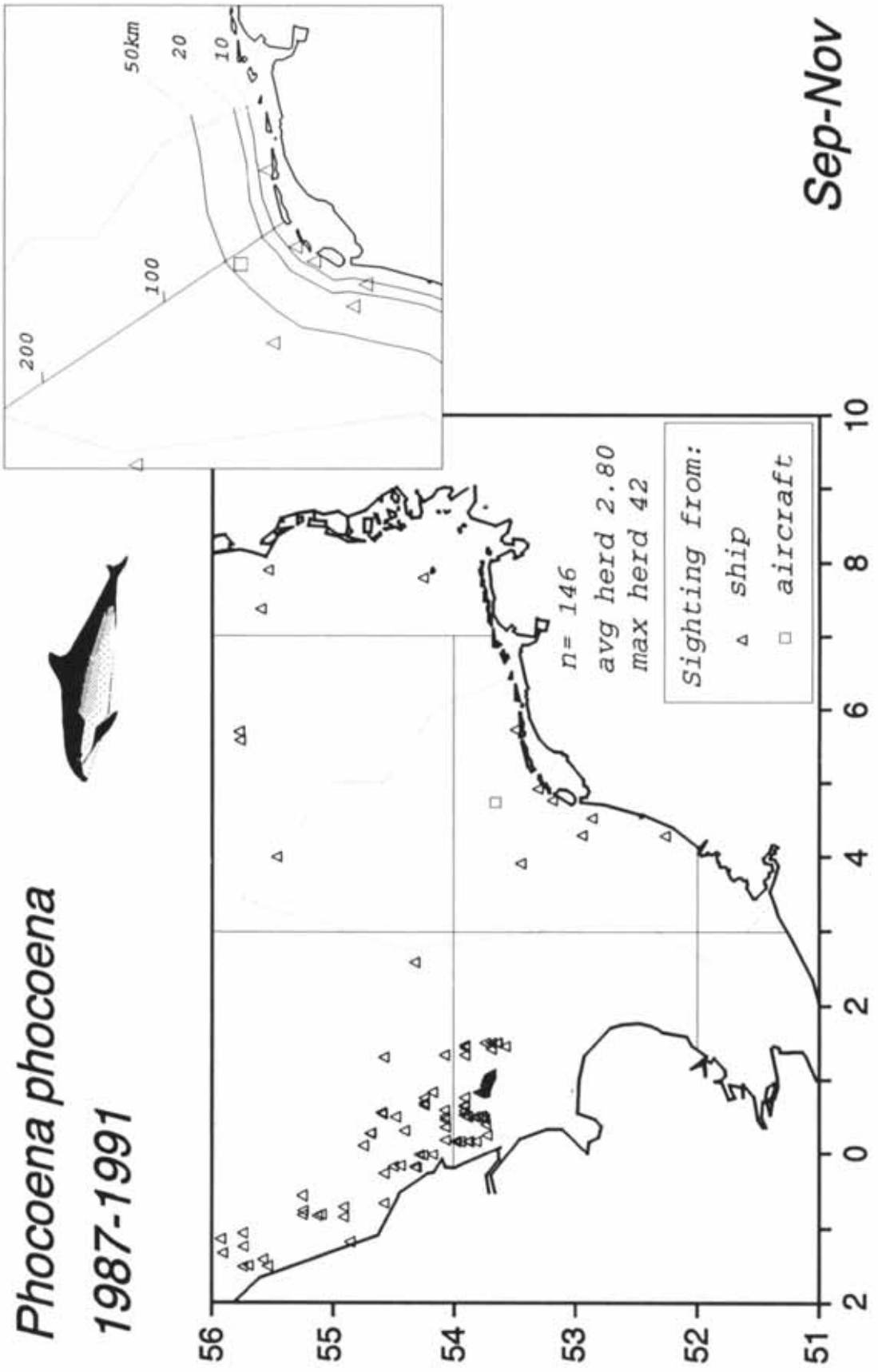


Fig. 8. (a) Sightings of harbour porpoises in the southern North Sea during September-November 1987-1991 from systematic ship-based surveys (triangles) and aerial surveys (squares), and (b) distance zones and sightings in the area where porpoises were most abundant off The Netherlands.

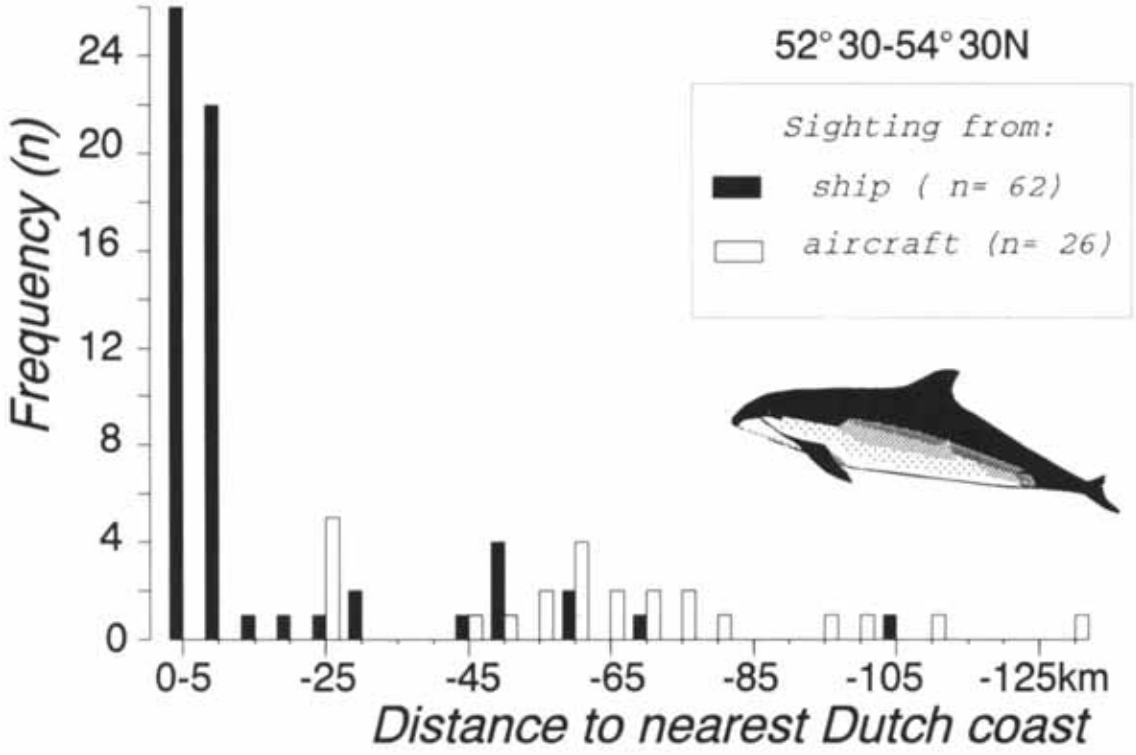


Fig. 9. Frequency distribution of sightings in December-April in relation to distance to the nearest Dutch coast within 52°30'-54°30' N, 3°-7° E, for ship-based surveys (n = 62, black) and aerial surveys (n = 26, white).

faced slightly more frequently than accompanying adults (approximately 4:3; pers. obs. C.J. Camphuysen).

Calves were seen rather frequently off East England and Scotland in August and September 1987-1990. Very small calves were encountered in the Central North Sea in June 1991 (pers. obs. C.J. Camphuysen). In the Dutch sector, there were no well-documented sightings of calves.

4.3. Group size and co-occurrence with other species

Most seawatching records involved solitary animals (68.1% of all sightings, n = 72) or couples (22.2%). Three groups of four, two of six and one exceptional group of 17 individuals were observed. The last group mentioned was in fact an aggregation of smaller groups (Lagerveld, 1988). Excluding this last group, the average group size (mean ± SD) was 1.5 ± 1.0 individuals.

The overall average group size of harbour porpoises seen during the ship-based surveys was 2.4 ± 3.5 (range 1-42, n = 309). The bulk of all sightings were of solitary animals (48.2%) and couples (28.5%, n = 309). Locally and temporarily, the average group size deviated from these figures. In an area along the east coast of England, September 1989, the groups averaged 3.8 ± 3.0 (range 1-10, n = 21; Camphuysen & Wolf, 1989). However, in a wider area off the English north-east coast in September, the average group size was 2.7 ± 3.4 (1-34, n = 134). Winter concentrations in Dutch

coastal waters (53°-54° N, 3°-7° E) had an average group size of 2.0 ± 1.4 (range 1-8, n = 60), while the average group size in winter off Germany and South-west Denmark (east of 7° E) was only 1.4 ± 0.7 (range 1-4, n = 72). Average group size was largest in summer, when the animals were most dispersed: 3.7 ± 3.9 (range 1-16, n = 23). The largest, compact herds seen during ship-based surveys (≥ 10 individuals) comprised:

11	2 June 1987, Dogger Bank (L. Camps)
12	2 June 1987, Dogger Bank (L. Camps)
10	7 September 1989, off E England (H. Offringa)
10	13 September 1989, off E England (H. Offringa)
16	28 August 1990, German Bight (M.F. Leopold)
34	10 September 1990, off NE England (M.F. Leopold)
11	12 September 1990, off E England (P.A. Wolf)
42	17 October 1990, off Blåvandshuk, Denmark (C.J. Camphuysen)

In some areas large aggregations of small groups were seen. On 12 September 1990, off the east coast of England, M.F. Leopold and P.A. Wolf counted 143 porpoises in one afternoon (average group size 2.1 ± 1.5; range 1-9; n = 67). A similar concentration had been noted the previous year further north of Flamborough Head (Camphuysen & Wolf, 1989). Small groups (of 1, 1, 2, 2, 3, 4, 4, 4, 6, 6, and 8 individuals) seen off the Dutch Wadden Sea islands on 12 March 1991 formed in fact relatively large aggregations of 29 and 12 individuals, respectively (H. Offringa). Off Blåvandshuk, Denmark, on 23 April 1992, 61 porpoises were seen (average group size 1.7 ± 0.8, range 1-4, n = 36; M.F. Leopold and H. Skov).

Concentrations of porpoises were usually seen in waters with high densities of piscivorous seabirds. Off East England, during August and September 1987-1990, most porpoises were observed in areas containing high densities of auks (Alcidae). Guillemots *Uria aalge* also occurred in comparatively high densities in an area off Denmark in October 1990, where 42 harbour porpoises were seen in a single herd (C.J. Camphuysen). Similarly, concentrations of harbour porpoises and guillemots occurred together in the German Bight in August 1990 (M.F. Leopold, M.H. Laks, Sula 4: 119), whilst in April 1992 high densities of porpoises and divers *Gavia* spp. occurred together off Blåvandshuk, Denmark (Sula 6: 79; cf. Danielsen et al., in prep.). Some 34 porpoises were apparently feeding in association with eleven minke whales *Balaenoptera acutorostrata*, 50 gannets *Sula bassana* and two great black-backed gulls *Larus marinus* off East England in September 1990 (M.F. Leopold, P.A. Wolf; Sula 4: 158). Single groups of porpoises were seen together with seabirds on several other occasions. Off Zuid-Holland, The Netherlands, a porpoise was seen in a feeding concentration of large gulls (100 herring gulls *Larus argentatus*, 20 common gulls *L. canus*, and 20 great black-backed gulls; C.J. Camphuysen). Fulmars *Fulmarus glacialis*, gannets, great black-backed gulls and kittiwakes *Rissa tridactyla* were often seen closely following fast-moving groups of porpoises, or showed interest in places where the animals had just surfaced. On the other hand, porpoises were encountered in distinctly different areas to those where another common species, the white-beaked dolphin *Lagenorhynchus albirostris*, occurred (Camphuysen & Wolf, 1989; Camphuysen, 1991b).

4.4. Sightings from other sources

During aerial surveys, 46 sightings (66 individuals) were published for the period February 1985 to August 1991 (Baptist, 1987 and Sula, Recent reports 1987-92). The aerial surveys were designed to cover the Dutch sector of the southern North Sea each month or every two months (Baptist, 1987). One exception was a trip over waters off East England in August 1991. In general, the results were similar to those obtained by ship-based surveys. However, in winter, when porpoises were most abundant in the Dutch sector, there is a discrepancy between sightings in the two schemes. From ship-based surveys it was clear that porpoises were quite numerous in the shallow coastal waters off the Frisian Islands, whereas observers from the aircraft did not report a single individual within a strip of 20 km from the shore (cf. figs. 6 and 9). The lack of aerial sightings in the coastal zone may be explained by the difficulty to detect these small mammals from an airplane in turbid water. This should be kept in mind when drawing the conclusion that few harbour porpoises occur in coastal waters (see Baptist, 1987; Heide-Jørgensen et al., 1992).

Seawatching has been conducted from the platform "Meetpost Noordwijk", 10 km off Noordwijk (sector South), in spring and autumn 1978-1982 (Van der Ham, 1988). During c. 1300 hours of observation, only two solitary porpoises were seen (in October 1978 and October 1981). In winter 1984/85, seabirds were counted from gas production platforms (approx. 53°30' N, 03°20' E), using slightly different methods (birds and mammals were detected by eye, without use of binoculars; Platteeuw et al., 1985). During 200 hours of observation, 14 harbour porpoises were seen (seven sightings). During the 1970s and early 1980s, very few porpoises were reported, but since 1985 several occasional sightings of porpoises in Dutch waters have come to our knowledge. This possible increase may reflect the increased interest in marine mammals of people in the area, but it is in agreement with the trend found during seawatching.

5. Discussion

5.1. Decline and return of the harbour porpoise in Dutch coastal waters

Smeenk (1987) discussed the decline of the harbour porpoise in The Netherlands from stranding data from the early 1950s to the early 1980s. The first reports of a suspected decline in the Dutch coastal population of the harbour porpoise were published already in the 1950s, based on sightings. Several independent observers claimed that following the Second World War, numbers seen in coastal waters and estuaries had become very small (Appelman, Kristensen, Monsees, Van der Veen, Verwey and Viergever, cited in Van Deinse, 1952, 1957, 1958, 1960; appendix 1). Verwey (1975), convinced that the harbour porpoise had declined, was unable to confirm the trend from his own observations in the Marsdiep area (1935-1948; appendix 2). Since only qualitative statements are available, it is difficult to compare the present situation with the past. However, it is obvious that either the harbour porpoise had declined in the southern North Sea, or that it was avoiding shallow coastal waters (cf. Reijnders, 1992). From seawatching data, it can be shown that harbour porpoises were virtually absent in Dutch coastal waters in the 1970s, very rare in the early 1980s, and increased

in our waters in the late 1980s. However, contrary to the 1940s and 1950s, an occasional visit to the beach in recent years would not produce a sighting of a harbour porpoise, whereas this was a common event early this century (Thijsse, 1927: 22). Unconvinced that a decline had occurred, Klinowska (1987) suggested that one should perform bicycle rides along the dike in Den Helder, as did Verwey, in order to check whether or not the harbour porpoise actually had declined. However, she appears to have overlooked the fact that Verwey was one of the very few naturalists in his days, whereas the beaches and dikes in The Netherlands are nowadays frequented by numerous "nature-minded" people, and harbour porpoises are hardly ever seen. Observations prior to the Second World War, even though of a qualitative nature only, clearly indicate that harbour porpoises used to be present in Dutch coastal waters in considerably larger numbers than today (Verwey, 1975), and in this context the present increase seems still rather insignificant. Nevertheless, the data derived from seawatching during 1972-1992 show that the harbour porpoise is now back in our waters in some numbers, and these data may be used as a baseline for future trends.

5.2. The present status of the harbour porpoise in the southern North Sea

The harbour porpoise was once considered a summer visitor in The Netherlands (IJsseling & Scheygrond, 1943). Frequencies of both sightings and strandings increased in spring, peaked in August, and declined rapidly from September onwards (e.g. Van Deinse, 1931). Today, most sightings from coastal sites are in winter (95.0% Dec.-Apr., n = 60), and ship-based surveys have confirmed that porpoises return to our coastal waters in late autumn, and are most numerous between December and April. Recent strandings of harbour porpoises in The Netherlands show a very similar pattern, with peak numbers in autumn and winter (Addink & Smeenk, 1989; Smeenk, 1992.) Hence, the species is now regarded as being mainly a winter visitor in Dutch waters. Evans et al. (1986) concluded that harbour porpoises in British waters move offshore in winter. In the southern North Sea, however, quite the opposite seems true, with a comparatively large number of offshore sightings in summer and concentrations in coastal waters in SE England, The Netherlands, Germany and Denmark in winter. Kremer et al. (1990) report on "a surprising" 103 sightings of harbour porpoises (242 individuals) off Sylt, German Bight, in November-January 1989-1990. Their data are well in line with the results discussed here: a winter visitor in coastal waters and rather larger numbers than we have found off The Netherlands. Near Sylt, most harbour porpoises were seen during rising tide (Kremer et al., 1990). In The Netherlands, however, such a correlation was not found. The actual phase of the tide was calculated for all sightings from seawatching sites between 1986 and 1992, using tide-tables. Of 58 sightings, 17 were around high water, 19 at falling, 14 around low, and 8 at rising water. This distribution is not significantly different from random ($G_{adj} = 2.64$; $df = 3$; $p > 0.05$).

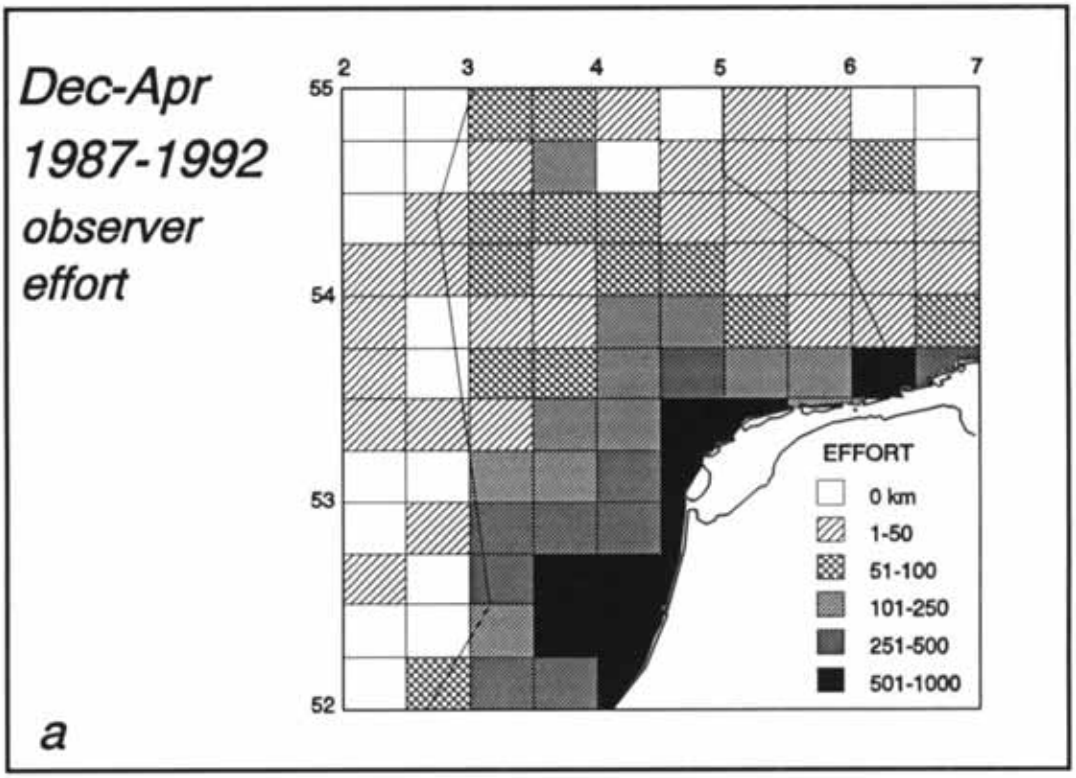
Sightings from coastal sites concentrate along the mainland coast of the province of Noord-Holland (96.7% in sector Central, n = 60, 1986-92). This pattern is obviously biased because of a scarcity of data from Texel in the appropriate period (winter, 1987-92), but it demonstrates the rarity of harbour porpoises south of 52°30' N where

several sites were extensively manned throughout 1972-92. This pattern is in accordance with recent stranding data (Addink & Smeenk, 1989). From ship-based surveys it appears that harbour porpoises are most abundant in shallow waters off the Frisian Islands, with considerably smaller numbers along the mainland coast of Noord-Holland and even smaller numbers further south. Apparently, off the Frisian Islands, porpoises occur at a distance beyond which seawatchers are able to detect them.

From ship-based data, it is theoretically possible to estimate the total number of porpoises in an area (Leopold et al., 1992). However, the data considered here were collected under all but the worst weather conditions (10% at windforce ≤ 1 Beaufort; 80% at 2-5 Beaufort; 10% at 6-9 Beaufort) and the sightings were not recorded following line-transect techniques (cf. Burnham et al., 1980; Hiby & Hammond, 1987). Therefore, the effective strip-width is unknown, but this has varied between c. 1000 m under flat calm conditions (cf. Leopold et al., 1992) to virtually zero in stormy weather. Since the bulk of our data was collected under moderately favourable circumstances, we assume that a considerable number of harbour porpoises must have been overlooked. Adopting an effective strip-width of 175 m as calculated for harbour porpoises during minke whale surveys in the northern North Sea (cf. Bjørge & Øien, 1990), we arrive at an estimate of around 20,000 harbour porpoises in the southern North Sea. Following the same assumptions, the winter concentration off The Netherlands would number only 750 porpoises (area shown in fig. 10). However, our estimates are very crude and more accurate assessments of the number of harbour porpoises in the (southern) North Sea will be feasible only after a dedicated survey, under good conditions and simultaneously covering the entire area.

5.3. Reasons for the increase in Dutch coastal waters

Two explanations may be offered for the recent increase of the harbour porpoise in Dutch coastal waters. Firstly, the increase may be a reflection of a more widespread increase in the North Sea at large. There is little evidence for such an increase (Klinowska, 1991; Reijnders, 1992; but see Evans, 1992). Alternatively, the porpoises may have come back to Dutch waters because of altered food conditions, either because more food has become available here, or because food resources have deteriorated elsewhere. Unfortunately, the diet of the harbour porpoise in the North Sea is poorly known. Harbour porpoises were particularly abundant in The Netherlands in the winter of 1957/58 (Van Deinse, 1959; Dudok van Heel, 1960), when sprat *Sprattus sprattus* (cf. Verwey, 1975) or immature herring *Clupea harengus* catches (Dudok van Heel, 1960) in Dutch coastal waters were very large. Evans (1990) shows that porpoises around the British Isles are often concentrated in areas where herring is abundant. Herring is found to be an important food species for porpoises in the North Sea and adjoining seas (Lindroth, 1962; Rae, 1965, 1973; Bjørge et al., 1991). It should be noted, however, that investigations of stomach contents of stranded harbour porpoises in the south-eastern North Sea do not indicate clupeids as the major food species. M.J. Addink (pers. comm.) has found large numbers of gobies *Pomatoschistus* spp. in porpoises beached in The Netherlands, and in Germany, Lick (1991) found gadoids, gobies and flatfish (most notably sole *Solea solea*) to be important in stranded and by-caught porpoises.



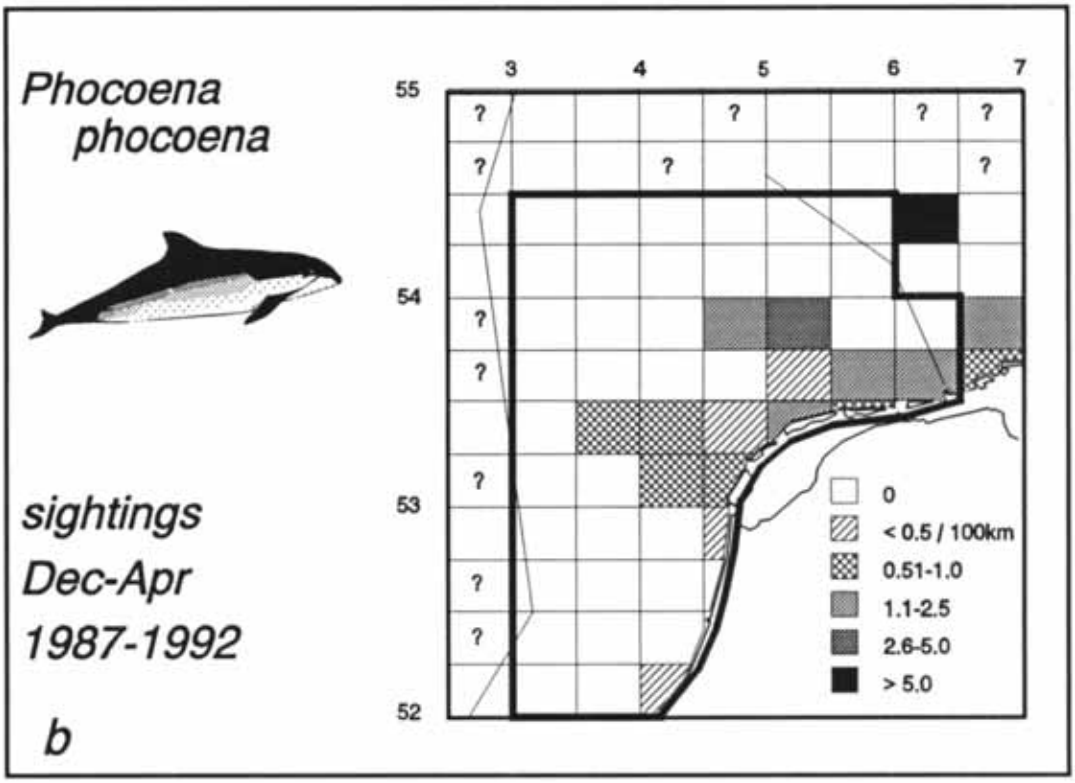


Fig. 10. (a) Observer effort during December-April 1987-1992 for ship-based surveys off the Dutch coast (52°-55° N, 2°30'-7° E), and (b) harbour porpoise abundance in Dutch coastal waters (number per 100 km of survey). The sightings in the area within the bold line were used to estimate total numbers in Dutch waters in winter.

North Sea herring stocks have fluctuated enormously, with a total collapse in the late 1970s, and a recovery since the early 1980s (Corten, 1986, 1990). Sprat stocks increased from the mid-1960s to the mid-1970s, but this was followed by a collapse in sprat fisheries in the northern North Sea in the early 1980s (Johnson, 1984; McKay, 1984; Corten, 1990). Since 1977, the sprat stock declined significantly (r_s -0.92; $n = 10$; $p < 0.05$; Camphuysen, 1990), especially in the northern North Sea, but new fisheries developed further to the south, indicating a shift in sprat occurrence in the North Sea from north to south (Johnson, 1982, 1983, 1985; Kunzlik, 1989; Anon., 1989a). Certain piscivorous seabirds, which probably use the same food species as porpoises, have clearly increased as winter visitors in the southern North Sea since 1980 whilst decreasing in the northern parts, apparently mainly in response to changes in sprat availability in winter in the northern North Sea (Camphuysen, 1989, 1990). Herring stocks in the (southern) North Sea have recovered in most areas, while in winter North Sea sprat is still mainly found in the shallow waters of the south-eastern North Sea (Anon., 1989b). Hence, there are indications that foraging conditions in the southern North Sea have recently improved, both absolutely and compared to other areas in the North Sea. It may thus be speculated that harbour porpoises, like several seabirds, have shifted their winter distribution to the south in the last ten years, in response to changes in fish stocks.

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SUMMARY

Two different long-term seabird studies in The Netherlands have provided, as a byproduct, quantitative data on the occurrence of the harbour porpoise *Phocoena phocoena* (L., 1758) in the southern North Sea. These porpoise data are presented here and compared to sources of information that were previously published by others. Sightings of harbour porpoises in coastal waters were systematically collected during an extensive seawatching scheme, carried out from 1972 until present from several sites scattered along the Dutch coast. At sea, porpoises were systematically recorded during ship-based strip-transect counts of seabirds, starting in 1987. The picture that emerges is that harbour porpoises may be found all over the southern North Sea, with highest densities off England (mainly in summer) and off the Frisian Islands in winter, and very low densities in the Southern Bight at all times of the year. In Dutch coastal waters the species appears to make a slight come-back, at least in the winter, after a serious decline in the period 1940-1980. This apparent increase in numbers of porpoises in Dutch waters is probably a reflection of improved local feeding conditions, particularly through the availability of clupeids (herring and sprat).

SAMENVATTING

De bruinvis *Phocoena phocoena* in de zuidelijke Noordzee, met name in de Nederlandse wateren

Van 1972 tot heden worden zeevogelverplaatsingen langs de Nederlandse kust onderzocht door middel van zeetrektellingen. Sinds 1987 wordt de zeevogelverspreiding op de zuidelijke Noordzee in kaart gebracht door vanaf schepen systematische waarnemingen te verrichten. Beide programma's, ofschoon gericht op de registratie van vogels, hebben een groot aantal gegevens over het voorkomen van walvisachtigen opgeleverd. In dit artikel wordt een overzicht gegeven van de bruinviswaarnemingen die tijdens het vogelonderzoek werden gedaan, en de gegevens worden vergeleken met onlangs gepubliceerde waarnemingen van tellingen vanuit een vliegtuig en met historisch materiaal. De veronderstelde afname van de bruinvis voor de Nederlandse kust kon tot dusverre niet worden ondersteund door veldwaarnemingen, vooral doordat er geen waarnemingsprogramma's bestonden waarbij ook de waarnemingsinspanning werd gemeten. Aan de hand van het nu beschreven materiaal, met inachtneming van de waarnemingsinspanning, is de verspreiding van de bruinvis in de zuidelijke Noordzee in kaart gebracht en is bovendien aangetoond dat de soort in recente jaren, als wintergast, weer toeneemt in onze kustwateren. In de winter (december-april) werden de grootste aantallen dicht onder de kust van de Waddeneilanden waargenomen, in de zomer (mei-augustus) waren de dieren verspreid over de gehele zuidelijke Noordzee, maar kwamen ze nergens dicht onder de kust, en in de herfst (september-november) werden concentraties bruinvissen gevonden binnen 100 km onder de kust van Noordoost-Engeland. Een voorzichtige schatting van het aantal bruinvissen in de zuidelijke Noordzee bedraagt ongeveer 20.000 exemplaren, waarvan (in de winter) 750 in de Nederlandse kustzone. In vergelijking met halverwege deze eeuw gepubliceerde waarnemingen is de recente toename in onze kustwateren niet groot en het gaat te ver om te spreken van een volledige terugkeer van de bruinvis in Nederland. De oorzaak van de toename is mogelijk een veranderd voedselaanbod, vooral in de winter. Verschillende piscivore zeevogels namen tegelijkertijd sterk toe als overwinteraars in de zuidelijke Noordzee. De hier gepresenteerde gegevens dienen als basis, op grond waarvan toekomstige statusveranderingen beter kunnen worden nagegaan.

APPENDIX 1

Sightings of harbour porpoises in The Netherlands, 1946-1964 (Van Deinse, 1946-1965 [in series])

1949	January:	IJmuiden "large herd" (29th; Th.A. van der Laan). Comment Van Deinse (1951): "this sighting is unusual, because in January most animals have left the North Sea".
1950	January:	West Kapelle 1 (14th; J. van Dalsum): uncertain record of porpoise fighting with seal.
1951	Remark on decline of harbour porpoise (at least around Den Helder and the western Wadden Sea) since the Second World War (J. Verwey, in litt.). Remark on decline in Oosterschelde ("in 1933 many more than nowadays").	
1955	Remark on decline of harbour porpoise (Zeeland, Scheveningen, around Den Helder and the western Wadden Sea) since the Second World War (pers. comm. F.J. Appelman, I. Kristensen, J. Viergever).	
1957	June-July:	Loosduinen 0 (45 visits; F.J. Appelman).
	Summer:	Texel (W. Wadden Sea) common (W.H. Dudok van Heel).
	Autumn:	Texel (W. Wadden Sea) common (W.H. Dudok van Heel).
	Remark on decline of harbour porpoise (Noord-Holland; pers. comm. R. Monsees).	
1958	January:	Texelstroom 40-50 (W.H. Dudok van Heel).
	February:	Harlingen "many" (T. Mol).
	June-July:	Kijkduin 10 (15 visits; F.J. Appelman).
1959	Summer:	Loosduinen 0 (60 visits; F.J. Appelman).
	Remark on decline of harbour porpoise (pers. comm. B. van der Veen, Friesland).	
1960	Remark on decline of harbour porpoise (Scheveningen; W.C. van Heurn, in litt.).	
1961	May:	Dokkumerdiep, Lauwerszee 1 (Leeuwarder Courant, 16 May 1961).
	Remark on frequent visits to the beach by F.J. Appelman in 1961: no sightings.	
1963	Remark on frequent visits to the beach by F.J. Appelman in 1961-1963: no sightings.	

APPENDIX 2

Sightings of harbour porpoises in the Marsdiep area: 1945-1973, Western Wadden Sea, west coast of Texel, Camperduin-Terschelling (Verwey, 1975)

1945	December:	Den Helder 14 individuals (24th-31st, 5 visits; no porpoises on 2 visits).
1946	January:	Den Helder 2 near the harbour (1st).
	March:	Den Helder 3 (5 visits; no porpoises on 2 visits).
	April:	Den Helder 3-4 (3 visits; no porpoises on 2 visits), De Koog, Texel 1.
	May:	Den Helder 4 (4 visits; no porpoises on 1 visit).
	June:	Texel ferry 10 (15th), 4 (16th).
	July:	Den Helder 1 in the harbour (19th).
	August:	Den Helder 1 (5th), 1 feeding (31st), Texel ferry 3 (5th).
	September:	Den Helder 1 (8th), Texel ferry 7 (28th).
	October:	Den Helder 2.
	November:	Den Helder 2 feeding (7th).
1947	January:	Den Helder 0 (5th), 2 (19th).
	March:	Den Helder 0 (12-22nd, 4 visits), 2 (23rd).
	April:	Texelstroom, Oudeschild, Texel 7 (16th), Texel ferry 0 (20th).
	May:	Den Helder 0 (26th), Texel ferry 2 (25th).
	June:	Den Helder 0 (8th, 14th).
	August:	Den Helder 0 (24th), 2 at harbour (27th), Noorderhaaks 2 (21st). Texelstroom 2 (27th)[1].
	September:	Texelstroom-Inschot* (Wadden Sea) 8 (3-4th), Texelstroom* 0 (6th).
	October:	Den Helder 0 (5th), Texelstroom* 2 (3rd), Texelstroom-Terschelling-Den Helder* (W. Wadden Sea) 0 (4th), Schulpengat* (North Sea) 3 (7th), off Texel* (North Sea) 11 (7th), Terschelling-Den Helder* (W. Wadden Sea) 0 (8th), Scheurrak, Omdraai, Oude Vlie* (W. Wadden Sea) 4 (13th), Inschot, Oude Vlie* (W. Wadden Sea) 0 (16th).
	November:	Zuidwal* 0 (12th).
1948	March:	Den Helder 2 at the harbour (15th, 16th).
1949	May:	Callantsoog 4 (4th).
1957	June:	Den Helder 1-2 (28th), Molengat 1 (18th).
1958	January:	Texelstroom 40-50 (Dudok van Heel, 1960; misdated as mid-Jan. 1960 in Verwey, 1975).
1959	December:	Westerslag, Texel 7 (6th).
1960	January:	Den Helder 1 at harbour (15th), Egmond aan Zee "quite a number" (15th).
1972	June:	Den Helder 1 at harbour (present during 3 weeks).

[1] The observations from Noorderhaaks and Texelstroom are from Den Helder Zoological Station's vessel. Further sightings (or non-sightings) from this vessel are indicated with an asterisk (*).

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