Phocoena phocoena (Linnaeus, 1758)

English: Harbour porpoise
German: Schweinswal
Spanish: Marsopa común
French: Marsouin commun

Family: Phocoenidae

1. Description

Harbour porpoises have a short, stocky body resulting in a rotund shape, which enables them to limit heat loss in cold northern climes. Adult females reach a mean body length of 160cm and males only 145cm. Mean mass is 60 kg and 50 kg, respectively (Bjorge and Tolley, 2009). In some parts of the range, however, animals are much smaller: in the Black Sea mean body length of adult females and males is only 133 and 123 cm, respectively, making these the smallest representatives of the species (Gol'din, 2004).

The dorsal side is dark grey, while the belly is a contrasting light grey to white which sweeps up to the midflanks in a mottled pattern. There is a dark stripe from the mouth to the flippers. The small triangular dorsal fin and the characteristic swimming pattern of several short, rapid surfacings followed by an extended dive of several minutes are characteristic for this species. Whereas early morphological studies suggested a close relationship of the harbour porpoise with *P. sinus* and *P. spinipinnis*, recent genetic information suggests that the closest relative of the harbour porpoise is in fact Dall's porpoise, *Phocoenoides dalli* (Bjorge and Tolley, 2009). There is molecular and morphological evidence of frequent hybridization between free-ranging Dall's and harbour porpoises (Willis et al. 2004).

2. Distribution

http://www.iucnredlist.org/apps/redlist/details/17027/0/rangemap

Distribution of the four subspecies of Phocoena phocoena*: cold temperate and subarctic waters of the Northern Hemisphere (Hammond et al. 2008a; IUCN).*

Harbour porpoises are found in cool temperate and subpolar waters of the Northern Hemisphere (Jefferson et al. 1993). Significant differences in the skulls of *P. phocoena* from the North Atlantic, the western North Pacific, and the eastern North Pacific have been found and two subspecies are recognised, one in the Atlantic and one in the Pacific. However, western Pacific animals differ sufficiently from those in the eastern Pacific to warrant subspecific separation, although no species-group name has been based on a western Pacific specimen (Rice, 1998 and refs. therein).

P. p. phocoena is distributed in the North Atlantic Ocean and ranges on the western side from Cumberland Sound on the east coast of Baffin Island, south-east along the eastern coast of Labrador to Newfoundland and the Gulf of St. Lawrence, thence south-west to about 34°N on the coast of North Carolina; it is also found in southern Greenland, north to Upernavik on the west coast and Angmagssalik on the east coast. In the eastern Atlantic, its range includes the coasts around Iceland; the Faroes; and the coasts of Europe from Mys Kanin and the White Sea in northern Russia, west and south as far as Cabo de Espichel, Portugal (38°24'N), including parts of the Baltic Sea and the British Isles. An apparently isolated population ranges along the coast of West Africa from Agadir (30°30'N), Morocco, south to Joal-Fadiouth (14°09'N), Senegal (Van Waerebeek *et al.*, 2000); its members appear to attain a greater body length than European individuals. (Rice, 1998 and refs. therein). In the Gulf of Bothnia and the Gulf of Finland, both in the Baltic Sea, the species is no longer observed (Koschinski, 2002). *P. p. phocoena* is vagrant along the arctic coast east to Novaya Zemlya and Mys Bolvanskiy (Rice, 1998). It has also been observed in Svalbard (Joergensen, 2007). The species is mostly absent from the Mediterranean, except for former, or sporadic, occurrences in the western part (Strait of Gibraltar, Islas Baleares, Barcelona, and Tunisia; Rice, 1998).

Genetic analysis shows that movements of harbour porpoises across the Atlantic appear to occur at a low level (Rosel et al. 1999) and harbour porpoises from West Greenland, the Norwegian West coast, Ireland, the British North Sea, the Danish North Sea and the inland waters of Denmark (IDW) are all genetically distinguishable from each other (Andersen et al. 2001). In a more recent review, Evans et al (2009) suggest subdivision of the North Atlantic into the following stocks or subpopulations: 1) Gulf of Maine & Bay of Fundy; 2) Gulf of St Lawrence; 3) Newfoundland; 4) West Greenland; 5) Iceland; 6) Faroe Islands; 7) Northwest/Centralwest Norway & Barents Sea; 8) Northeastern North Sea & Skagerrak; 9) Southwestern North Sea & Eastern Channel; 10) Inner Danish Waters; 11) Baltic Sea; 12) Celtic Sea (plus South-west Ireland, Irish Sea & Western Channel); 13) North-west Ireland & West Scotland; 14) Bay of Biscay (West France); 15) IBNA (NW Spain, Portugal & NW Africa).

P. p. relicta is another geographically disjunct population which inhabits the Black Sea, the Sea of Azov, the Bosporus, and the Sea of Marmara (Rice, 1998), with at least four individuals reported in the northern Aegean Sea (Rosel et al. 2003). Analyses of geographic variation in mitochondrial DNA (mtDNA) support the existence of this subspecies (Read, 1999). Viaud-Martinez et al.(2007) found that the morphologically different Black Sea population has been genetically separated from eastern Atlantic populations for thousands of years, warranting its classification as a subspecies.

P. p. subsp. occurs in the Western North Pacific Ocean. It ranges from Olyutorskiy Zaliv south along the east coast of Kamchatka, including Komandorskiye Ostrova and the Near Islands in the western Aleutian Islands, throughout the Ostrova Kuril'skiye, and all around the shores of the Sea of Okhotsk, including Zaliv Shelikhova, Hokkaido, and Honshu as far as Nishiyama on the west coast and Taiji on the east. A distributional gap in the Aleutian Islands between Shemya and Unimak separates this race from the next. *P. p. subsp*. is vagrant north through Bering Strait as far as Ostrov Vrangelya (Rice, 1998).

P. p. vomerina Gill, 1865 is distributed in the Eastern North Pacific Ocean and ranges from the Pribilof Islands, Unimak Island, and the south-eastern shore of Bristol Bay south to San Luis Obispo Bay, California. *P. p. vomerina* is vagrant north to Point Barrow in Alaska, and the mouth of the Mackenzie River in the Northwest Territories of Canada, and south to San Pedro in Southern California. (Rice, 1998).

3. Population size

There are no synoptic surveys covering the entire range within ocean basins, but abundance has been estimated for selected portions of the range. Taken together, these numbers indicate that the global abundance of the harbour porpoise is at least about 700,000 individuals (Hammond et al. 2008).

Note that all abundance estimates have to be taken with a grain of salt: According to Read (1999) there was an 80% discrepancy between abundance estimates for the Gulf of Maine in 1991 and 1992 (37,500 as opposed to 67,500, respectively). Similarly, aerial surveys conducted in 1995 and 1996 in the German North Sea revealed a mean abundance of 4,288 in 1995 and 7,356 harbour porpoises in 1996 (Siebert et al. 2006). In the south-western Baltic Sea, abundance estimates varied between 457 (CV 0.97, March 2003) and 1,726 (CV=0.39, June 2003) (Scheidat et al. 2008).

The factors responsible for this variation may be related to migratory behaviour in response to changes in water temperature or prey availability on a regional scale, but are not fully understood. Methodology also plays a role: Carretta et al. (2001) estimated the abundance of harbour porpoises in northern California at 5,686 from a November 1995 ship survey. However, this abundance estimate was significantly different from an aerial survey estimate obtained 1 to 2 months earlier in the same region, where abundance was estimated at 13,145. A possible explanation was insufficient transect effort during the ship survey, or underestimates of the fraction of porpoise groups missed on the trackline due to large swells.

Pacific Ocean:
From North to South: The estimated corrected abundance estimate for the Bering Sea harbor porpoise stock from a 1999 aerial survey is 48,215 (CV = 0.223). No fishery-related harbour porpoise mortalities were observed during the 2002-2006 period (Angliss and Allen 2008a).

For the Gulf of Alaska the estimated corrected abundance estimate from a 1998 aerial survey is 31,046 (CV = 0.214) (Angliss and Allen 2008b). Fishery related mortalities extrapolate to an estimated mortality level of 35.8 animals per year (Manly 2007).

The Southeast Alaska estimated corrected abundance based on a 1997 aerial survey is 11,146 (CV = 0.242). No incidental fishery-related mortalities were reported (Angliss and Allen, 2008c).

Between the British Columbia (BC)-Washington and the BC-Alaska borders, surveys conducted in 2004 and 2005 yield an abundance estimate of 9,120 (95% CI = 4,210-19,760) (Williams and Thomas, 2007).

For the inside waters of Washington and southern British Columbia, aerial surveys conducted during August of 2002 and 2003 led to an estimate of 10,682 (CV=0.38) animals. For coastal Oregon (north of Cape Blanco) and Washington waters the corrected estimate of abundance, based on a 2002 aerial survey from shore to 200 m depth is 37,745 (CV=0.38). The mean estimated mortality for the gillnet fishery in 1999-2003 is 0.6 harbour porpoise per year.(Carretta et al. 2009).

The northern California/southern Oregon stock was estimated from pooled 1997-99 aerial survey data including data from both inshore and offshore areas, yielding an abundance estimate of 17,763 (CV=0.39). The Monterey Bay and the Morro Bay stock were estimated from 1999 and 2002 aerial surveys at 1,613 (CV = 0.42)and 1,656 (CV = 0,39) animals, respectively (Carretta and Forney, 2004).

Based on pooled 1995-99 aerial survey data, an updated estimate of abundance for the central California harbour porpoise stock is 7,579 harbour porpoises (CV=0.38; NMFS, K. Forney, unpublished data; Carretta et al. 2009).

Abundance estimates are lacking for the western Pacific Ocean (Hammond et al. 2008).

Atlantic Ocean:
The best current abundance estimate of the Gulf of Maine/Bay of Fundy harbour porpoise stock is 89,054 (CV=0.47), based on the 2006 survey results (Waring et al. 2009).

In Greenlandic waters the harbour porpoise has been observed around in the south from Ammassalik on the east coast to Avanersuaq in northwest Greenland. The main distribution lies between Sisimiut and Paamiut in central west Greenland (Teilmann and Dietz, 1998). There are no available abundance estimates for the Greenland harbour porpoise stock (NAMMCO, 2009).

A survey conducted in the eastern North Atlantic in July 2005 (SCANS II), covering continental shelf seas from SW Norway, south to Atlantic Portugal, gave an estimate of 385,600 (CV = 0.20) (Hammond et al., 2008), with regional estimates: North Sea (c. 231,000), Baltic (23,000 in Kattegat/Skagerrak/Belt Seas/Western Baltic Sea), Channel (40,900), and Celtic Shelf (58,400). From line transect surveys in July 1994 (Hammond et al., 2002), with a somewhat different coverage, population was estimated at 341,000 porpoises (CV=0.14; 95% CI: 260,000-449,000): North Sea (c. 250,000), Baltic region (36,600 in Kattegat/Skagerrak/Belt Seas/Western Baltic Sea), Channel (0), and Celtic Shelf (36,300). Comparing the two surveys, although the overall number estimated for the North Sea, Channel and Celtic Sea was comparable (341,000 in 1994, and 335,000 in 2005), numbers in the northern North Sea and Danish waters had declined from 239,000 to 120,000, whereas in the central and southern North Sea, Channel and Celtic Shelf, they had increased from 102,000 to 215,000. This is thought to represent a southwards range shift rather than actual changes in population size (Winship, 2009), at least for the month of July. This is consistent with recent studies using stranding data and observations from seabird surveys indicating a comeback of the species along the Dutch and Belgian coast (Laczny and Piper, 2006; Haelters and Camphuysen, 2009).

Baltic Sea:
In the Skagerrak / Kattegat region between the Baltic and the North Seas, 36,046 (CV = 0,34); 5,262 (CV = 0,25) were estimated (Hammond et al. 2002). Teilmann et al. (2003) used satellite transmitters on animals in Skagerrak/North Sea and in Inner Danish Waters. Throughout the year there was no overlap in the home range of adult porpoises tagged in the two areas, respectively. The authors suggest a population boundary in the northern Kattegat across the Danish island of Læsø. This population structure is confirmed by genetic studies of all ages during the summer season (Teilmann et al., 2003; 2008).

Harbour porpoises were also once numerous in the Baltic Sea south and east of the Belt region but today the population is estimated in the low thousands. Scheidat et al. (2008) give combined estimates for the German EEZ south in Kiel Bight, Mecklenburg Bight and the German waters of the Baltic proper ranging between 457 (March 2003; CV = 0.97) and 4610

(May 2005; CV = 0.35). The abundance in Kiel Bight was estimated at 588 (CV= 0,48) from 1994 data, with a density of 0.101 ind/km² (Hammond et al. 2002), of which about 50% or 300 would likely be mature (Taylor *et al.* 2007). Recent density estimates are somewhat higher, with 0.13 ind/km² in July 2004 (Scheidat et al. 2008).

Between Kiel and Mecklenburg Bights the relative abundance of porpoises decreases continuously (Gillespie et al. 2003), from 16.2 acoustic detections/100-km in the northern Kiel Bight, 9.2/100km in the southern Kiel Bight, and 2.8/100km in the Mecklenburg Bight to only 0.1/100km in the Baltic proper. During visual surveys, porpoises were only sighted in Kiel Bight. These results are consistent with Scheidat et al. (2008) who found similar densities in Kiel Bight: 0.13 ind/km² (95% CI = 0.02 – 0.38) and Mecklenburg Bight: 0.178 ind/km² (95% CI = 0.007 – 0.41) in July 2004, but only 0.008 ind/km² (95% CI = 0-0.03) in the Pomeranian Bight further east. The latter confirms earlier estimates of 599 individuals for an area around the Island of Bornholm determined in 1995 by L. Hiby and P. Lovell (pers. comm. to Scheidat et al. 2008), corresponding also to a density of roughly 0.09 ind/km². A survey of Polish coastal waters conducted in 2001 using the same acoustic equipment, which found 0.05 detections/100km (Gillespie et al. 2003).

Kilian et al. (2003) support these findings using autonomous click detectors (PODs): Around the island of Fehmarn, harbour porpoise click trains were recorded almost every day, whereas along the east coast of the island of Rügen, only few porpoise encounters were collected. Nevertheless, for most areas investigated, porpoises were present regularly. Verfuss et al. (2007) also noted a significant decrease from west to east in the percentage of days with POD porpoise detections. There were more days of porpoise detections in summer than in winter, suggesting that the German Baltic Sea is an important breeding and mating area for these animals. Scheidat et al. (2003) report that on the Oderbank east of Rügen, Baltic harbour porpoise concentrations between May and August 2002 were very high with 0.086 animals per km aerial transect, as opposed to 0.014 and 0.024 in nearby Mecklenburg and Kiel Bights, respectively. The reason for this high density in the area of the Oderbank could be foraging behaviour (S. Koschinski, 2010, pers. comm.).

Black Sea

The results of several surveys conducted between 2001 and 2005 in the Black Sea suggest that present total population size is at least several thousands and possibly in the low tens of thousands (Hammond et al. 2008): 2,922 (95% CI = 1,333 – 6,403) in the Azov Sea (Birkun et al. 2002); 1,215 (95% CI = 492-3,002) in the northern, north-eastern and north-western Black Sea (Birkun et al. 2004), 3,565 (95% CI = 2,071-6,137) in the south-eastern Black sea (Birkun et al. 2006) and 8,240 (95% CI = 1,714 – 39,605) in the central Black Sea (Krivokhizhin et al. 2007).

4. Biology and Behaviour

Habitat: Throughout its range, *P. phocoena* is limited to the waters of the continental shelf by its demersal foraging behaviour and diving capacity (see below). In northern California significantly more porpoises than expected occurred at depths of 20 to 60m as opposed to depths beyond 60 m (Carretta et al. 2001). Harbour porpoises are seldom found in waters with an annual average temperature above 17°C, preferring cool waters, where aggregations of prey are concentrated (Read, 1999 and refs. therein).

In the Horns Reef area, eastern North Sea, small-scale changes in local currents reflecting upwelling driven by the interaction of the semi- diurnal tidal currents with the steep slopes of the bank are the main habitat driver of harbour porpoises. The distribution of harbour porpoises alternates between 2 upwelling cells less than 10 km large, depending on the direction of tidal currents (Skov and Thomsen, 2008). Similarly, at Morte Point in North Devon, UK porpoises are found to aggregate in an area of high tidal flow, where prey items are likely to be abundant (Goodwin, 2008).

Fine-scale distribution in the Bay of Fundy was influenced by tides and prey availability. Whereas over the course of a month individuals ranged across large areas (7,738 to 11,289 km^2), they also concentrated their movements in small focal regions (August-September mean = 250 - 300 km^2) close to islands, headlands, or restricted channels, where density was significantly larger during flood than ebb tide and associated to prey aggregations along localized fronts (Johnston et al. 2005).

Behaviour: The harbour porpoise is difficult to observe. It shows little of itself at the surface, so a brief glimpse is the most common sighting. On calm days it may be possible to approach a basking animal, but it is generally wary of boats and rarely bow-rides. It can sometimes be detected by the blow which, although rarely seen, makes a sharp, puffing sound rather like a sneeze (Carwardine, 1995). Observations from cliffs above calm fjords yield the best results (Culik et al. 2001).

Schooling: Most harbour porpoise groups are small, consisting of fewer than 8 individuals (pers. obs.). They do, at times, aggregate into large, loose groups of 50 to several hundred animals, mostly for feeding or migration (Jefferson et al. 1993). Harbour porpoises are not generally found in close association with other species of cetaceans and instead are observed to avoid bottlenose dolphins (*Tursiops truncatus*) due to aggressive and lethal interactions (Read, 1999).

Reproduction: Most calves are born from spring through mid-summer (Jefferson et al. 1993). The majority of female harbour porpoises in Denmark and the Bay of Fundy become pregnant each year and are simultaneously lactating and pregnant for much of their adult lives. In contrast, female porpoises in California do not appear to reproduce each year (Read, 1999 and refs. therein). In Aberdeenshire, North Sea, Scotland most porpoise calves and juveniles were recorded between June and September, when 35% of harbour porpoise groups contained immature animals. The proportion of calves amongst porpoise sightings was higher during June than any other month (Weir et al. 2007). Sexual maturity is reached at the age of 3 years and gestation lasts approximately 10.5 months. The life span is on average 8 to 10 years, the oldest documented individual was 23 years old (Bjorge and Tolley, 2009).

Food: Harbour porpoises eat a wide variety of fish and cephalopods, and the main prey items appear to vary on regional and seasonal scales (Jefferson et al. 1993). In the North Atlantic, harbour porpoises feed primarily on clupeoids and gadoids, while in the North Pacific they prey largely on engraulids and scorpaenids. Squids and benthic invertebrates have also been recorded, the latter considered as secondarily introduced (Reyes, 1991 and refs. therein). Individual prey are generally less than 40cm in length and typically range from 10cm to 30cm in length (Read, 1999).

Many prey items are probably taken on, or very close to, the sea bed. Even though a wide range of species has been recorded in the diet, porpoises in any one area tend to feed primarily on two to four main species (e.g. whiting *Merlangius merlangus* and sandeels (Ammodytidae) in Scottish waters). The literature on porpoise diets in the northeast Atlantic suggests that there has been a longterm shift from predation on clupeid fish (mainly herring *Clupea harengus*) to predation on sandeels and gadoid fish, possibly related to the decline in herring stocks since the mid-1960s. Evidence from studies on seals suggest that such a shift could have adverse health consequences. Food consumption brings porpoises into contact with two important threats - persistent organic contaminants and fishing nets, both of which have potentially serious impacts (Santos et al. 2003; Santos et al. 2004).

In the Kattegat and Skagerrak stomach contents of juvenile and adult harbour porpoises contained mostly Atlantic herring (*Clupea harengus*) while Atlantic hagfish (*Myxine glutinosa*) was also important for adults (Boerjesson et al., 2003). In another study on animals stranded and by-caught in Denmark, cod (Gadidae), viviparous blenny (Zoarcidae) and whiting (Gadidae) made up most of the stomach contents while in the Netherlands whiting was the main prey, making up around 34 % of the total reconstructed prey weight (Santos et al. 2005).

In Danish waters, maximum dive depth generally does not exceed 50m, corresponding to the depth of the Belt seas and Kattegat. Maximum dive depth recorded was 132 m from animals moving north into Skagerrak. Dives were frequently recorded in the category 10-15 min, and harbour porpoises dive continuously both day and night, with peak activity during daylight hours (Teilmann et al. 2007). Dives to at least 226 m have been recorded via telemetry in other areas (Westgate et al. 1995).

5. Migration

According to Read (1999) porpoises in each of the Bay of Fundy-Gulf of Maine, Gulf of St. Lawrence, Newfoundland and Labrador, and Greenland populations move into coastal waters during summer. In some areas, harbour porpoises move offshore to avoid advancing ice cover during winter. According to Gaskin et al. (1993) seasonal harbour porpoise migrations, especially in and out of the Sea of Okhotsk, must occur because of extensive ice coverage in winter, but in Japanese waters there are confirmed records of porpoises as far north as the northern tip of Hokkaido Island in January.

In the western North Atlantic, harbour porpoises arrive in the Bay of Fundy area in July, staying there until approximately late September. There is little evidence that the region may be significant either as a mating area or a calving ground. The arrival of females with calves coinciding with the arrival of juvenile herring is more suggestive of a feeding ground (Reyes, 1991 and refs. therein). Trippel et al. (1999) noted in a by-catch study in the lower Bay of Fundy that during years of low herring abundance, low harbour porpoise entanglement rates are observed. This suggests harbour porpoise movements matched the migratory behaviour of one of their preferred prey species. Long-term studies using satellite-linked radio telemetry indicate that porpoises are extremely mobile and are capable of covering large distances in relatively short periods, with mean daily distance travelled varying between 14 – 58 km. Animals move throughout the Bay of Fundy and Gulf of Maine, utilising home ranges that encompass tens of thousands of km² and suggesting that they form a single population at risk of entanglement in both Canadian and US fisheries (Read and Westgate, 1997).

Observations gathered from surveys off New Hampshire suggest this may be part of the wintering areas for the Bay of Fundy population, which may have a north-south (and inshore-offshore) seasonal migration limited to the continental shelf in the eastern seaboard (Reyes, 1991 and refs. therein). Stranding data from the North Carolina coast confirm that harbour porpoises typically strand during the winter and spring months during migrations (Webster et al. 1995).

For the Baltic Sea, Koschinski (2002) summarised that 1) there might be a tendency of animals from the Kattegat to migrate into the North Sea during winter months; 2) a proportion of animals may stay in the western Baltic during the winter or even in the Baltic proper; 3) there might be a difference in migratory tendency between putative subpopulations; and finally 4) migration patterns might depend on winter severity. Verfuss et al. (2007) identified the Kadet Trench and Fehmarn Belt as important migration corridors.

Satellite telemetry revealed that in a few cases subadult porpoises tagged in the inner Danish waters moved into the Skaggerak/North Sea while only one of the tagged porpoises moved into the Baltic proper for a short visit (Teilmann et al. 2003). Teilmann et al. (2008) satellite-tagged 24 porpoises on the border between Skagerrak and Kattegat on the northern tip of Denmark (Skagen, Jylland) and 39 in Kattegat, Little Belt, Great Belt or Western Baltic (Inner Danish Waters, IDW) from 1997 to 2007. All animals from the northern group stayed in the northern Kattegat or in the Skagerrak and North Sea (including the EEZ of Norway and Sweden). Porpoises tagged in IDW stayed south of this area (including the EEZ of Germany, Sweden and Poland) except for five animals. Three of these stayed the majority of time in IDW and the other two animals moved immediately after tagging into the Skagerrak and North Sea and stayed there for the entire contact period. Based on these data, Teilmann et al. (2008) propose that the Danish waters be divided into four management areas for harbour porpoises 1) southern North Sea, 2) northern North Sea and Skagerrak, 3) Inner Danish Waters and Kattegat and 4) The Baltic Sea proper.

The Black Sea population is isolated, but there are a few records of *P. p. relicta* from the Aegaean Sea, showing that at least some parts of the population may migrate (Rosel et al. 2003).

6. Threats

Direct catch: Directed fisheries have occurred in Puget Sound, the Bay of Fundy, Gulf of St. Lawrence, Labrador, Newfoundland, Greenland, Iceland, Black Sea, and the Baltic Sea. Many of these fisheries are now closed, but hunting of harbour porpoises still occurs in a few areas. Greenland and the Black Sea are the only areas where large direct catches have been reported within the last 20 years (Jefferson et al. 1993). According to Reyes (1991) around 1,000 porpoises were taken annually in West Greenland using rifles and hand-thrown harpoons. Harbour porpoises are mainly caught between April and November, with a peak during June to October (Teilmann and Dietz, 1998). In 2003 the reported catch had increased to 2,320 (NAMMCO 2005); reported takes were 3,100 in 2005 and 2,563 in 2006; without any abundance estimates on population size or potential biological removal levels, these numbers are a matter of concern (NAMMCO 2009). Hunting on a small scale also still occurs in Japan, Canada and the Faroe Islands.

In the Baltic Sea, historical catch levels averaged about 1,000 porpoises per year during most of the nineteenth century, increasing to 2,000 at the end of the century with a subsequent declining trend during the twentieth century until catches increased again in the 1940s. Historical directed catches in the Baltic proper might have been higher than the catches in the Danish Straits (Kinze, 1995). Due to the resulting low abundance, the current bycatch, known to be at least 7 porpoises per year, is thought to be unsustainable, and Baltic porpoises may become extinct in the near future unless actions are taken to prevent future anthropogenic mortality (ASCOBANS 2000).

In the Black Sea, unregulated hunting was the primary threat until 1983, (IWC 1992, 2004). Very large numbers of harbour porpoises, as well as other cetaceans, were taken during the 20th century by all Black Sea countries for a variety of industrial uses. In 1996, the Ministers of Environment of Black Sea countries adopted cetacean conservation and research measures within the framework of the Strategic Action Plan for the Rehabilitation and Protection of the Black Sea (Birkun and Frantzis, 2008).

Incidental catch: Due to their habitat in productive coastal waters, harbour porpoises are captured incidentally in commercial fisheries throughout their range. Porpoises are taken in a variety of gear types including weirs, pound nets, cod traps, purse seine nets and surface gill nets, but the vast majority of this mortality occurs in bottom-set gill nets.

In Newfoundland gillnet fisheries, incidental catches of small cetaceans were estimated to be 862 in 2001, 1,428 in 2002 and 2,228 in 2003, virtually all of which were harbour porpoises. Most by-catches were reported in the nearshore cod fishery, although there were also numerous reports of catches in fisheries for lumpfish, herring and Greenland halibut and in offshore fisheries for monkfish, white hake and Greenland halibut. Most incidental catch events occurred during July-September along the south coast (Benjamins et al. 2007).

In the gillnet fishery of the Estuary and Gulf of St. Lawrence, Canada, a questionnaire survey provided bycatch estimates of 2,215 (95% CI 1,151-3.662) and 2,394 (95% CI 1,440-3,348) porpoises in 2000 and 2001, respectively. Although these numbers are very high, they indicate a 24-63% reduction in bycatch since the late 1980s (Lesage et al. 2006).

Bycatches in herring weirs in the Bay of Fundy, Canada varied between eight in 1996 to 312 in 2001 (Neimans et al. 2004).

In Icelandic waters, harbour porpoise by-catches numbered 120 in 2006 and 147 in 2007 (NAMMCO, 2009).

The annual bycatch of harbour porpoise in the Danish North Sea bottom-set gillnet fisheries was estimated to have been in the range of 2,867-7,566 between 1987-2001, with a significant reduction in the most recent years due to a decrease in both effort and landings (Vinther and Larsen, 2004).

A distinct increase in the numbers of strandings of porpoises showing lesions indicative of bycatch along the Dutch and Belgian coastline has occurred in recent years, in parallel to the increasing number of porpoises sighted in the southern North Sea (Haelters and Camphuysen, 2008). By-catch and drowning were noted most frequent in winter and spring. By-catch and drowning rate was responsible for 7 – 19 % of deaths similar to the statistics in neighbouring countries (Osinga et al. 2008).

Kuklik and Skóra (2003) report that in Polish waters of the Baltic Sea, by-catch occurred mostly in so-called salmon “semi-driftnets” and cod bottom-set nets, amounting to 62 by-catch reports between 1990 and 1999. Berggren et al. (2002) estimated potential limits to anthropogenic mortality for harbour porpoises in the Baltic region and concluded that immediate management action is necessary to reduce the magnitude of by-catches to meet the conservation objectives of ASCOBANS, the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas. In German Baltic Sea waters low by-catch numbers are reported (8 individuals reported in 2008, IWC 2009). However, between the years 2000 and 2007, strandings have increased dramatically from 25 to 173. A large proportion of these animals has net marks or cuts indicating a vast majority of unreported cases (Herr et al. 2009; Koschinski and Pfander, 2009).

In northern Portuguese waters (Ferreira et al. 2003) confirmed bycatch was responsible for 34% of all strandings and up to 18% of the deaths were suspected to have been caused by interactions with artisanal fishing gear. This coastal area is used by harbour porpoises as an important feeding and breeding site, thus making bycatch a serious threat to the species. Up to 53% of all harbour porpoise strandings recorded involved animals caught in beach purse-seine nets. Despite limited monitoring effort, by-catches of harbour porpoises have also been documented in artisanal gillnet fisheries in Senegal (Van Waerebeek et al., 2000).

Baker et al. (2006) report on detecting by-caught harbour porpoises through molecular monitoring of 'whalemeat' markets in the Republic of (South) Korea, based on nine systematic surveys from February 2003 to February 2005.

There is some hope that acoustic deterrents may help to reduce by-catch rates in gillnets in certain fisheries, provided foraging harbour porpoises can find prey in pinger- as well as net-free areas (Culik et al. 2001). These devices are now mandatory in Danish gillnet-fisheries around wrecks (Finn Larsen, pers. comm.) as well as in the North and Celtic Seas, the German Baltic Sea between Warnemünde and the Polish border and in 2 areas in Swedish Baltic for gillnet vessels over 12 m length (EU Regulation 812/2004). Another solution may lie in using enticing sounds, i.e. of alerting porpoises to nets rather than attempting to deter them. Koschinski et al. (2003) and Eskesen et al. (2003) report that certain sounds trigger investigative behaviour, echolocation activity increasing by 70–130% to investigate the sound source. This may help in alerting them to otherwise "invisible" nets. However, a field study by Kindt-Larsen (2008) concluded that a pinger producing porpoise-alerting-sounds based on porpoise clicks did not reduce bycatch. The author does not exclude, however, the possibility that an alerting pinger which succeeds in stimulating porpoises to a higher click rate may achieve this.

Another possibility for the reduction of by-catch is the use of acoustically reflective nets. High-density iron-oxide (IO) gillnets proved to be effective in reducing by-catch while catches of target species (cod) were reduced by as much as 30%. However, both effects were attributed to the mechanical properties of the net material rather than to acoustic reflectivity (Larsen et al. 2007). However, Mooney et al (2004) and Koschinski et al. (2006) found that in an acoustically enhanced Barium-Sulfate net, acoustic target strength was higher at 150 kHz than in a standard nylon net. Koschinski et al. (2006) conclude that harbour porpoises can detect the enhanced net 4.4 m in advance of standard nylon nets. However, because porpoises were found to often swim without echolocating, the authors suggest using a combination of reflective nets and warning sounds.

The most promising means for elimination of by-catch is the closure of important areas for certain fisheries and a shift to porpoise friendly gear such as baited pots and jigging reels, in some cases also long-lines.

Overfishing: Large scale fisheries operating in the North Sea take are targeted at species which are important prey items for harbour porpoises. A similar situation occurs with the commercial fisheries for horse mackerel and anchovy in the Black Sea (Reyes, 1991 and refs. therein). Independent of fishery-related data, stable isotope analysis from harbour porpoises tissue collected prior to and after the 1960's in the North Sea indicates that lately they have been feeding at a lower trophic level than during the preceding century (Christensen et al. 2008) and this may also be reflected in the available recent stomach content analyses.

Climate change: One of the prey items of harbour porpoises in the Scottish North Sea, sandeels, are known to be negatively affected by climate change in a number of ways. When porpoise diet from spring 2002 and 2003 was compared to baseline data of 1993-2001, the diet was found to be substantially different, with a significant and substantially smaller proportion of sandeels being consumed in March and May. Whereas 33% of stranded (?) porpoises died of starvation in spring 2002 and 2003, only 5% did so during the baseline period, suggesting that the negative effects of climate change on sandeel availability may have serious negative effects on harbour porpoise populations (MacLeod et al. 2007).

Pollution: A considerable body of literature exists describing the levels of various pollutants in tissues of the harbour porpoise. Contaminant levels in harbour porpoises often vary geographically and may serve as useful markers in studies of population structure (Read, 1999 and ref. therein, Koschinski, 2002).
Pesticides, plasticisers, flame retardants (such as PBDEs BPA and HBCD) and trace metals are of special concern due to their bioaccumulative or endocrine disrupting potential.
In 48% of all samples, concentrations of polychlorinated biphenyls (PCBs) in blubber of female harbour porpoises from the Atlantic coast of Europe were above the threshold at which effects on reproduction could be expected. This rose to 74% for porpoises from the southern North Sea. The average pregnancy rate recorded in porpoises (42%) in the study area was lower than in the western Atlantic. Porpoises that died from disease or parasitic infection had higher concentrations of persistent organic pollutants (POPs) than animals dying from other causes (Pierce et al. 2008). Perfluorooctane sulfonate (PFOS) contamination in samples from the German Baltic Sea and from coastal areas near Denmark are comparable to levels found in Black Sea harbour porpoises and might pose a threat to these populations (Van de Vijver et al. 2007).

Furthermore, as opposed to a series of other local top-predators, harbour porpoises in Danish coastal waters contained the highest hepatic concentrations of butyltin, an antifouling agent in ship paint, with (134-2283 ng/g ww), indicating a strong degree of bio-magnification in the food chain (Strand et al. 2005).

Noise pollution: Harbour porpoises react very sensitively to anthropogenic noise. Consequently, shipping, marine exploration, construction and operation of noisy equipment such as sonar are likely to affect the behaviour and distribution of the species. Dense maritime traffic e.g. was correlated with reduced harbour porpoise density in the North Sea (Herr et al. 2005). Furthermore, there are many areas where ammunition was dumped at sea. Underwater detonations, e.g. from ammunition removal, mine diver training, ship shock trials, closure of drill holes and other military or civil applications can seriously harm harbour porpoises due to extremely strong pressure changes created by the shock wave (S. Koschinski, 2010, pers. comm..)

The planned construction of offshore wind turbines in the North and Baltic Seas involves the emission of high numbers of intense impulsive sounds when turbine foundations are driven into the ground by impact pile driving, evoking at least a temporary threshold shift (TTS) in the auditory system of harbour porpoises (Lucke et al. 2008). Cumulative effects of multiple pulses must be considered (Southall et al. 2007). During operation of the offshore turbines, available data indicate that the potential masking effect would be limited to short ranges in the open sea (Koschinski et al. 2003).

7. Remarks

Range states (Hammond et al. 2008) :
Belgium; Bulgaria; Canada; Cape Verde; China; Denmark; Estonia; Faroe Islands; Finland; France; Georgia; Germany; Gibraltar; Greenland; Iceland; Ireland; Japan; Latvia; Lithuania; Mauritania; Morocco; Netherlands; Norway; Poland; Portugal; Romania; Russian Federation; Senegal; Spain; Sweden; Tunisia; Turkey; Ukraine; United Kingdom; USA; Western Sahara.

The species is listed in Appendix II of CITES. The Baltic Sea and Black Sea, the western North Atlantic and the North West African populations are listed in Appendix II of CMS.

The IUCN considers the species as “Least Concern” with the exception of the Baltic Sea (Critically endangered) and Black Sea (Endangered) populations (Hammond et al. 2008a). This is justified by all individuals in the Baltic Sea population belonging to one subpopulation, which numbers fewer than 250 mature animals. A continued decline can be inferred based on the current information on bycatches (Hammond et al. 2008b).

In the Black Sea, large directed takes between 1976 and 1983, intensive mortality as by-catch in fisheries, large numbers of casualties attributed to the petrochemical industry, epidemics, and ice entrapments, and a general degradation of the environment have led to a reduction in population size of 70% over the past 30 years (Birkun and Frantzis, 2008).

There have been several reports of decline of harbour porpoise populations in various parts of the range. The low abundance of porpoises observed around Japan may be the result of overhunting or incidental catches in the past (Reyes, 1991 and refs. therein).

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8. Sources

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