

Review

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Cetacean strandings along the German North Sea coastline 1604–2017

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Abstract

The occurrence of 19 cetacean species along the German North Sea coastline as well as the lower reaches of the major rivers discharging into the German Bight is reviewed for the period 1604–2017 based on records of dead animals, either stranded dead or put to death. The harbour porpoise (*Phocoena phocoena*) is considered the most abundant and only native species in German coastal and riverine waters. Based on written sources its presence can be traced back to at least 1651, although with statistical data only available from 1990. Finds of further 18 species have been documented: white-beaked dolphin (*Lagenorhynchus albirostris*), bottlenose dolphin (*Tursiops truncatus*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), common dolphin (*Delphinus delphis*), striped dolphin (*Stenella coeruleoalba*), Risso's dolphin (*Grampus griseus*), long-finned pilot whale (*Globicephala melas*), killer whale (*Orcinus orca*), beluga whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*), Sowerby's beaked whale (*Mesoplodon bidens*), northern bottlenose whale (*Hyperoodon ampullatus*), sperm whale (*Physeter macrocephalus*), minke whale (*Balaenoptera acutorostrata*), sei whale (*Balaenoptera borealis*), fin whale (*Balaenoptera physalus*), blue whale (*Balaenoptera musculus*) and humpback whale (*Megaptera novaeangliae*). This review corrects several false species assignments earlier introduced in literature based on incorrect scientific or ambiguous German vernacular names and recovers lost records of beluga whale, northern bottlenose whale, sperm whale and fin whale.

Introduction

Modern scientific interest in cetacean diversity emerged in the mid-1700s all over Europe based on the examination and collection of specimens originating from animals found dead or killed on the beach or near shore – nowadays collectively known as 'stranding records'. Although being a heterogeneous dataset, they none the less constitute the only long-time series available for comparative studies into species diversity and changes therein (Lambert *et al.*, 2011).

For the entire North Sea coastline, cetacean stranding records date back to the 13th century, but systematically they have only been compiled and published for about a century with regular British stranding reports commencing in 1913 (Harmer, 1927). The first comprehensive Dutch compilation appeared in 1931 (van Deirse, 1931) with regular reports published since then. From the Danish coastline older records date back to 1575 and new records up till 2017 were compiled by Kinze and co-authors (Kinze, 1995; Kinze *et al.*, 1998, 2010, 2018).

While British, Dutch and Danish strandings are reported on a regular basis, similar overviews covering the entire German North Sea coastline so far have been unavailable, despite earlier attempts to launch a systematic reporting scheme for cetacean strandings (Mohr, 1937; Kock, 1976). It was only in the mid 1980s that cetacean species found along the German North Sea coast became the subject of scientific investigations, with a stranding network being established only by 1990 after the first seal die-off (Benke *et al.*, 1998; Siebert *et al.*, 2006). However, Schultz (1970), in his review of North and Baltic Sea cetacean occurrences had already included some German North Sea records covering the period to 1969, mainly from the northern coasts, i.e. the German federal state of Schleswig Holstein (SH). Goethe (1983), Meyer (1994) and Stede (1994) reviewed finds from the coast of the federal state of Niedersachsen (NI) until 1992 while Borkenhagen (2011) added and corrected records for the SH coast to 2010.

The harbour porpoise (*Phocoena phocoena*) is the most common cetacean species in the North Sea (Hammond *et al.*, 2002) and comprehensive studies during recent decades have re-established its status as an abundant native species in the German Bight (Siebert *et al.*, 2006) and the lower reaches of all major German rivers (Wenger & Koschinski, 2012).

Kinze *et al.* (1997) summarized records from the entire German North Sea coastline of white-beaked (*Lagenorhynchus albirostris*) and Atlantic white-sided dolphins (*Lagenorhynchus acutus*) for the years 1983–1992, while Ijsseldijk *et al.* (2018a) included the most recent records of the white-beaked dolphin along the German North Sea coasts in

Table 1. Non-phocoenid cetacean record for the German North Sea coastal area in total and subdivided into four 50 years periods and finds older than 1818

	1968–2017	1918–1967	1868–1917	1818–1867	<1818	Total
White-beaked dolphin	60	4	0	0	0	64
Bottlenose dolphin	7	10	8	5	0	30
White-sided dolphin	7	0	0	0	0	7
Common dolphin	11	1	0	0	0	12
Striped dolphin	1	0	0	0	0	1
Risso's dolphin	0	0	2	0	0	2
Long-finned pilot whale	7	1	0	0	0	8
Killer whale	2	5	0	2	0	9
Beluga whale	1	0	1	0	0	2
Narwhal	0	0	0	0	2	2
Sowerby's beaked whale	3	1	0	0	0	4
Northern bottlenose whale	2	1	2	0	2	7
Sperm whale	16	0	0	0	8	24
Minke whale	12	1	0	2	1	16
Sei whale	1	1	0	0	0	2
Fin whale	7	5	7	4	0	23
Blue whale	0	0	1	0	0	1
Humpback whale	2	0	0	1	0	3
	139	30	21	14	13	217

their study. The 2016 sperm whale mass strandings all over the North Sea prompted a detailed investigation (Unger *et al.*, 2016; Ijsseldijk *et al.*, 2018b).

Here we provide the first full review of all cetacean species records from the German North Sea coast and lower reaches of the larger rivers based on archival data, earlier publications, newspaper records and hitherto unpublished data. Due to the large number of stranding records for the harbour porpoise, below we only summarize available data while for all other less frequently occurring cetaceans we provide full details.

Finally, we offer a zoogeographic interpretation of these local cetacean occurrences.

Materials and methods

The data sets used for the present analysis comprise cetacean stranding records, here defined as any whale corpse encountered at a certain locality along a stretch of coast or riverbank at a given date within the German North Sea coastline. Although circumstances may vary, these records are considered to provide the most reliable faunistic signal over time. Cetacean corpses discovered in advanced and final stages of decomposition and finds of skeletal remains were excluded from the analysis in order not to weaken the signal due to possible drift-ins from other waters hereby causing temporal imprecisions.

Records were compiled from archive sources, published information (newspaper reports and popular and scientific reviews and papers) and databases held at the Institute for Terrestrial and Aquatic Wildlife Research, the Lower Saxony State Office for Consumer Protection and Food Safety, the Seal Nursery and National Park Center Norddeich, the Wadden Sea National Park Authority of Lower Saxony, natural history museum collections in Oldenburg, Wilhelmshaven, Bremerhaven, Hamburg, Kiel, Frankfurt, Stuttgart and Berlin and critically reviewed and assigned to a cetacean species using standard determination

procedures. False species identifications and double counts were corrected.

Subdivision of the coastal and riverine areas

Geographically, the German North Sea coastline is of considerable length (1155 km Table 1) as it includes both the shores of the mainland and that of several chains of islands. A major part of the Wadden Sea is found in German coastal areas and ecologically they are governed by its tidal regime. Further, the German coastal waters are influenced by the combined freshwater discharge of four larger rivers into the German Bight: the Ems, the Weser, the Elbe and the Eider, second only to the Rhine estuary output which also affects the adjacent German North Sea coastline (Radach, 1992). As such, the German Bight forms a biologically relevant sub-entity of the larger North Sea.

Administratively, the major portions of the coastline of the German North Sea belong to the federal states of Niedersachsen (NI) and Schleswig-Holstein (SH), respectively, while two tiny portions are part of the federal states of Hamburg (HH) and Bremen (HB), respectively. The River Elbe for about 110 km forms the border between SH and NI and also includes the major part of the HH coastline (Figure 1). Here we subdivide the German North Sea coastlines into a south-western component (Ems estuary to the mouth of Elbe; SW (NI) or SW (HH) for the island of Neuwerk), a north-eastern component (mouth of Elbe to Danish border; NE (SH)), and four riverine components (lower courses of the rivers Ems, Weser, Elbe and Eider; R Ems, R Weser, R Elbe and R Eider, respectively).

Validation of species assignments and deletion of double counts

Since the onset of zoological nomenclature with the 10th edition of *Linnæus Systema Naturae* in 1758 the number of cetacean

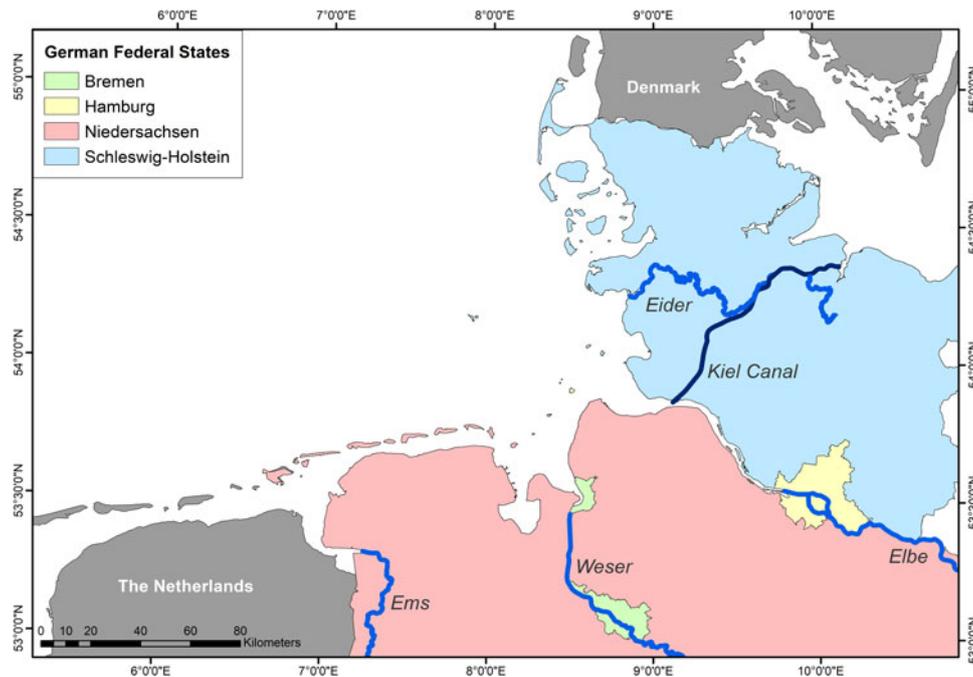


Fig. 1. The German North Sea coastline showing federal states and major rivers.

species has increased from originally eight to about 40 extant North Atlantic cetacean species (Jefferson *et al.*, 2015). While the identification of a species relies on specific diagnostic features either depicted on an illustration or description in words, the scientific name of the species may have changed over time. Therefore, sometimes incorrect species assignments survived till the present day although the record originally was based on correct contemporaneous literature available. For our taxonomic review we follow Jefferson *et al.* (2015) and our validation is based on collection specimens, depictions and descriptions from literature including newspaper records.

In northern European waters traditionally two small cetacean species have been recognized: a smaller (i.e. the harbour porpoise *Phocoena phocoena*) and a larger 'porpoise' species (i.e. an 'umbrella species' containing present-day bottlenose dolphin *Tursiops truncatus* and other similar sized delphinids). This conception can be traced back in time to at least the early 18th century. Both species were referred to as 'Tümmler' in the German language and without further specification the two species probably from time to time were confused with one another. Until 1975, the harbour porpoise and the bottlenose dolphin indeed were the most common species along the Dutch coast (Kompanje, 2001).

Also, bottlenose and white-beaked dolphins have been confused with one another as already pointed out by van Bree (1970). Among the rorqual species as well several misidentifications have been revealed with minke whales being reported twice – erroneously as blue whale calves and correctly as minke whale adults from the same locality and almost the same date (Goethe, 1983).

The drift of cetacean carcasses is influenced by the dynamics of the hydrographic regime of the North Sea, and along the German North Sea coast in particular the shifting tides of the Wadden Sea. Therefore, as a source of error the same individual when not collected may have been reported several times from different localities and over time in different stages of decomposition.

Results

Including the harbour porpoise, 19 cetacean species have been recorded along the German North Sea coastline, the lower reaches and tributaries of the Ems, Weser, Elbe and Eider rivers.

In total, 239 individuals of non-phocoenid cetaceans (i.e. species other than the harbour porpoise) comprising 18 species were compiled and validated. The earliest record documented concerns a multiple sperm whale stranding on the island of Pellworm (SH) in 1604. Rare occurrences comprise the narwhal (1669 and 1736 only), Risso's dolphin (twice in 1873 only), and the blue whale (1881 only). Records for the latest 50 years (1968–2017) hence comprise 16 species only. More than half of these records ($N = 122$) originate from the period 1990–2017 comprising 13 species in addition to the harbour porpoise for which during the same period the number amounted to 3734 (see below) (Table 1).

Harbour porpoise (*Phocoena phocoena* (Linnæus, 1758))

The harbour porpoise throughout time has been recognized as the only native species in the German Bight.

For the NE (SH) coast Mohr (1962) reported on the species providing qualitative data whilst Goethe (1983) and Meyer (1994) compiled similar records for the period 1840–1989 for the NI (SW) coastline.

The species, now supported by quantitative data, is regarded as an indigenous inhabitant of the entire North Sea. Quantitatively, this status within the German part of the North Sea only became well-established by the late 1980s when annual stranding numbers became available in conjunction with the set-up of dedicated stranding networks in the various federal states.

The total number of stranding records for the years 1990–2017 was 3764. While the numbers for SW (NI) exhibit an increase over time, indicative of a shift in distribution to the south, the NE (SH) figures fluctuate. Figure 2 provides an overview of the annual number of harbour porpoise strandings for NI and SH, respectively, for the period 1990–2017.

The harbour porpoise used to be seasonally abundant in the lower reaches of all major rivers discharging into the German Bight, but due to increased pollution occurrences probably ceased totally in the mid-1990s.

For German rivers historical records are known from the River Elbe at least since 30 December 1651 (newspaper report in *Extra Ordinari Mittwochs Postzeitungen* CCCIV, 8 January 1652) and the River Weser as early as 2 April 1670 (Pope, 1882).

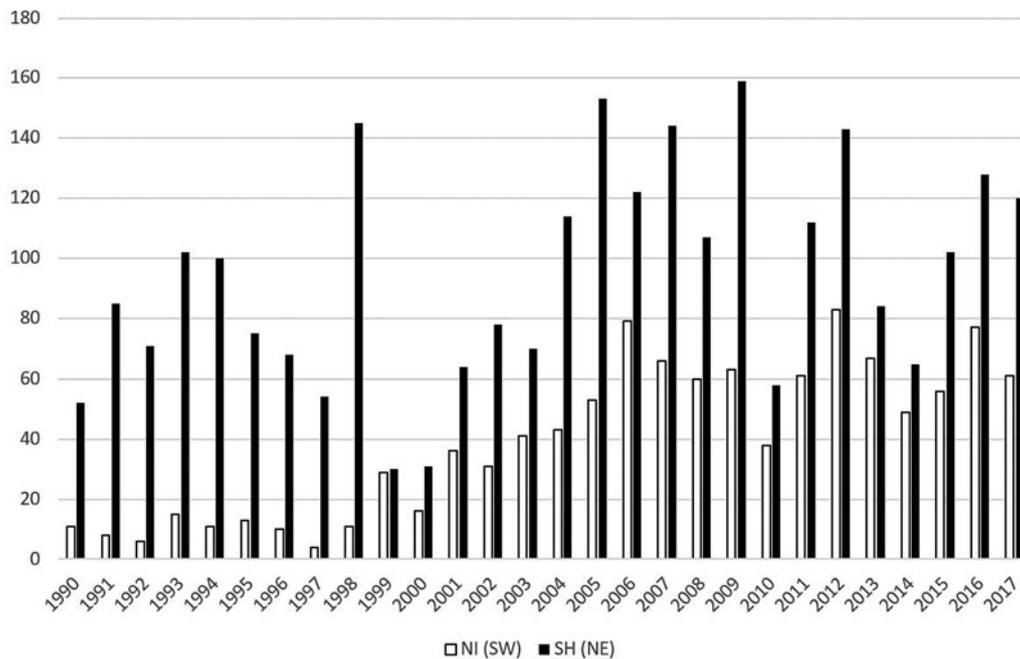


Fig. 2. Number of harbour porpoise strandings 1990–2017. NI (SW) = federal state of Niedersachsen (south-western component), SH (NE) = federal state of Schleswig-Holstein (north-eastern component).

Subsequent occurrences also include the River Rhine (1885, city of Emmerich (le Roi & von Schweppenburg, 1909), River Ems (de Fries & Focken, 1881), and the River Eider (August 1863, city of Tönning; newspaper report *Vestslesvigsk Tidende*, 10 August 1863).

A recolonization of the Elbe and the Weser rivers by the species has occurred, most likely caused by the significant habitat improvements of recent decades (Wenger & Koschinski, 2012), while re-entrances to the lower River Eider may have been hampered though not entirely blocked by the construction of the Eider Barrage in 1973.

White-beaked dolphin (*Lagenorhynchus albirostris* Gray 1846)

The white-beaked dolphin is the second most frequent cetacean species encountered along the German North Sea coastline with altogether 64 strandings since 1920 (Appendix 1). While peaking in the 1990s, fewer strandings have been recorded during the last two decades (Figure 3).

Occurrences prior to 1980 only account for six records exhibiting several decadal gaps and therefore may be under-represented due to confusion with the bottlenose dolphin. There are specimens of *Lagenorhynchus albirostris* most likely originating from the German North Sea coastline in the collections of several European museums (e.g. the Vienna Natural History Museum) purchased as ‘*Tursiops tursio*’. The first definite German North Sea record of this species is from Büsum (NE (SH)) and in the year 1921 but was, however, not recognized as such until 1970 when van Bree (1970) corrected Mohr’s (1935) original species assignment ‘*Tursiops tursio*’ i.e. bottlenose dolphin. For the NE segment, Dahl (1894, 1906) listed both the common dolphin (Island of Amrum without year specified) and the bottlenose dolphin (without details). Since for both these species quotations no diagnostic details were provided, it cannot be ruled out that they may have been finds of white-beaked dolphins instead. *Tursiops tursio* in sensu Mohr (1935) hence is to be regarded synonymous with the white-beaked dolphin. Therefore, doubt must be cast on several other records of *Tursiops tursio* listed in her work. Pohle (1941) considered *Tursiops tursio* (i.e. in sensu Mohr = *Lagenorhynchus albirostris*) as ‘the other native species’ in German North Sea waters (see Appendix 1).

Bottlenose dolphin (*Tursiops truncatus* (Montagu, 1821))

Altogether there are 31 records of *T. truncatus* documented between 1836 and 1998 (Figure 4). Until the 1920s, river occurrences predominated while the most recent occurrences solely have originated from the south-western component of the German North Sea coast (SW (NI)).

The occurrence of the bottlenose dolphin, as pointed out above, may have been blurred due to the confusion with both the white-beaked dolphin (van Bree, 1970) and the harbour porpoise (Wiepken & Greve, 1876).

The bottlenose dolphin possesses the highest riverine affinity second only to the harbour porpoise and has been documented for all major German riverine systems.

River Eider: In early March 1843, a school of 10–12 dolphins was sighted at Friedrichstadt at the confluence of the River Treene with the River Eider (NE (SH)). The estimated lengths (8–10 Danish feet; 2.5–3.1 m), the general behaviour and the school size fit both the white-beaked and the bottlenose dolphins, while the riverine and in-land locality only makes the latter species plausible (Danish newspaper *Berlingske Tidende*, 14 March 1843).

River Elbe: During the 19th century the species was documented for the year 1852 near Winsen (NI) (Poppe, 1882), 1860 near Glückstadt (SH) (Mohr, 1935), 1867 from an unspecified Lower Elbe locality (based on a specimen in the Copenhagen Zoological Museum), between 1875 and 1876 near Wittenberge (federal state of Brandenburg) (Erhardt, 1937), in May 1879 at the confluence of the River Stör with the Elbe (SH) (Häpke, 1880; concerning a female and her newborn calf) and in 1924 from almost the same locality yet another animal (Wegener, 1924).

River Weser: In December 1836, an individual was caught at Drielake, Oldenburg (NI) (Wiepken & Greve 1876, 1897) while a ‘large dolphin’ was reported by Häpke from the town of Celle (NI) in the River Aller tributary to the Weser. Poppe (1882) reported on an animal taken in 1852 in the Hunte, a tributary of the Weser.

Coastal records include a stranding near Wilhelmshaven (NI (SW)) in 1872 (Möbius, 1888). Schultz (1970) listed two records

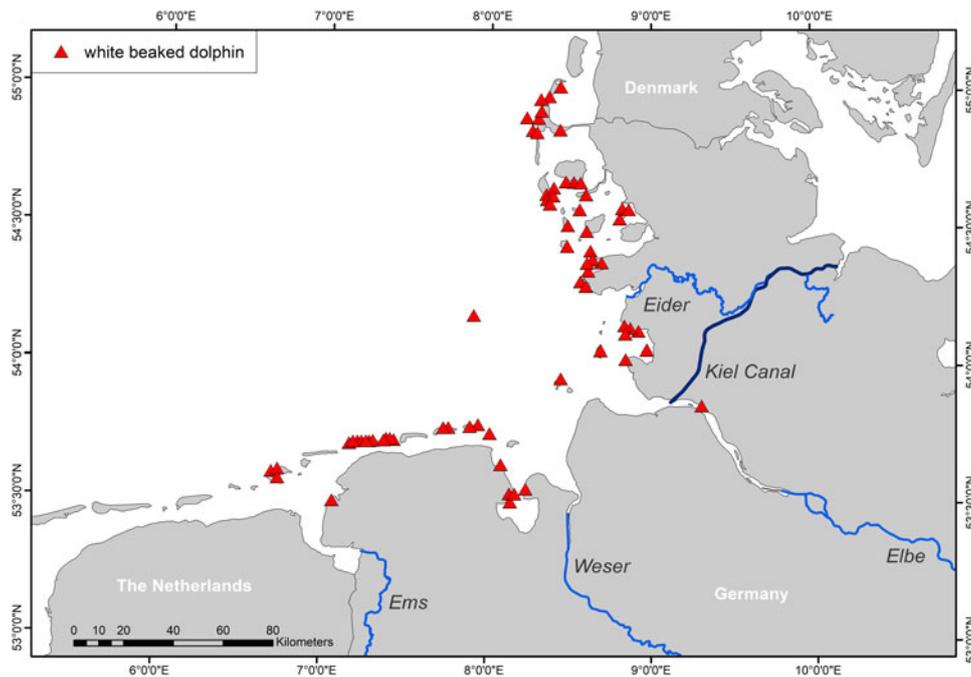


Fig. 3. Records of white-beaked dolphins.

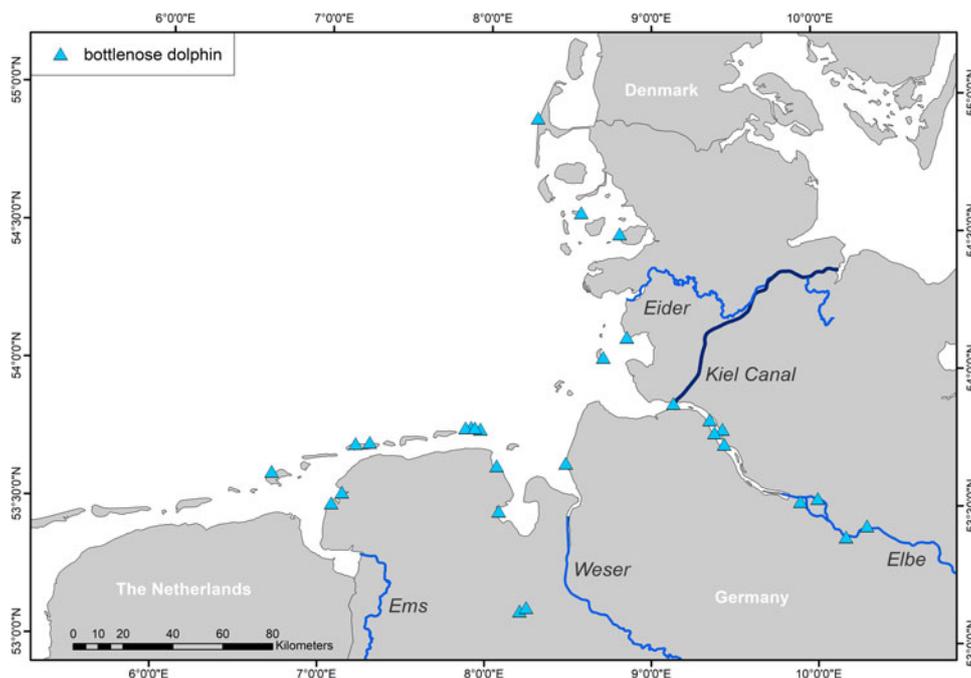


Fig. 4. Records of bottlenose dolphins.

of *Tursiops* from the NE (SH) Wadden Sea area (erroneously with reference to Mohr (1935) but apparently based on photographic evidence in the Hamburg Mohr archive). Both records are from September 1935 and the Islands of Hooge (SH) and Nordstrand (SH), respectively. Mohr (1961) under 'false cover' provided evidence on yet another specimen stranded on the island of Trischen (SH) without specified date.

Kompanje (2001) gave a comprehensive summary of Dutch strandings and found a marked decline in occurrence. By about 1975, the species here was reduced to the status of straggler. To the north, along the adjacent Danish coastline there has been an absence of the species since 1968 (Kinze, 1995). Our findings agree well with the general riverine and southern warmer-water

distribution known for the species and possibly the bottlenose dolphins formerly occurring along the German North Sea coast thence formed part of the Dutch Zuiderzee population (Kompanje, 2001).

Atlantic white-sided dolphin (Lagenorhynchus acutus (Gray, 1828))

The Atlantic white-sided dolphin was recorded seven times from the German North Sea, the first time in 1968, a single find from the island of Schillig, SW(NI) (Goethe, 1983), while of the remaining six records five originate from the south-western (NI) coastline (all but one from the month of April) and a single

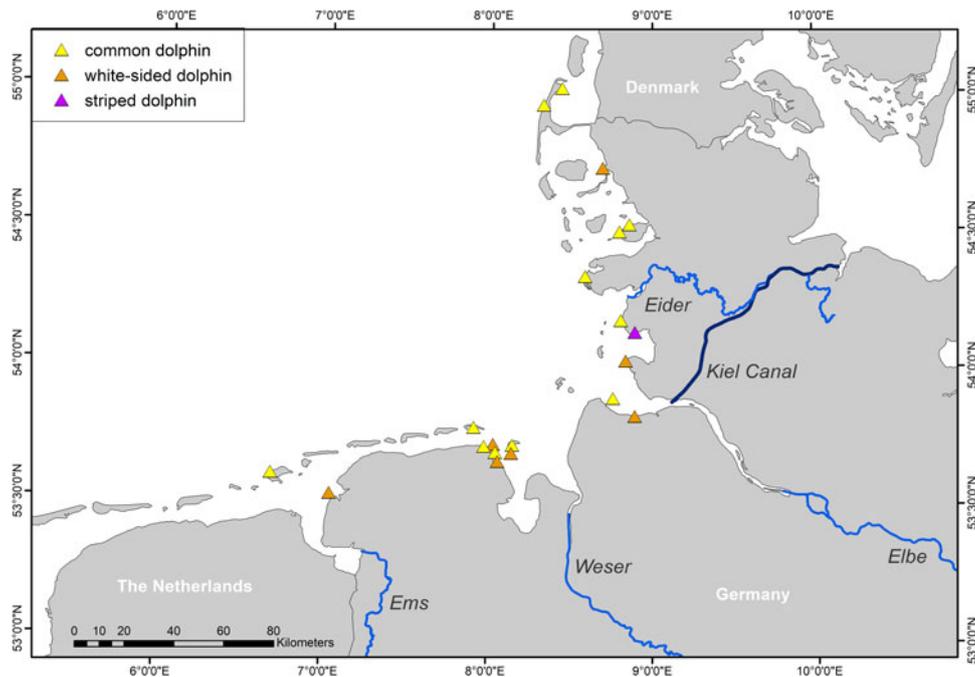


Fig. 5. Records of white-sided, common and striped dolphins.

from the north-eastern (SH) coastline from the month of September (Figure 5).

Common dolphin (*Delphinus delphis* Linnæus, 1758)

The application of the name ‘*Delphinus delphis*’ also in the German literature has been a matter of great confusion. A species under this heading was ubiquitously listed for German waters, but with no specific records ever provided. Without certainty, whether the present-day species was meant, these records must remain dubious. Dahl (1894, 1906) reported ‘*Delphinus delphis*’ from the island of Amrum, a record doubted by Mohr (1935) who believed most German records of ‘*Delphinus delphis*’ instead to be bottlenose dolphins. However, as van Bree (1970) established, she confused bottlenose dolphins with yet another species: the white-beaked dolphin. Poppe (1882) listed ‘*Delphinus delphis*’ from the SW coast with reference to Heineken (1837) who, however, also listed the species without any supportive evidence.

The first genuine record of the common dolphin originates from the SW coast and the year 1958 (Goethe, 1983) with 12 subsequent records (Figure 5).

The common dolphin during certain periods enters the southern North Sea, presumed to be indicative of an influx of warmer water. Fraser (1937) reported such an earlier occurrence during the 1930s while Kompanje (2005) and recently Smeenk & Camphuysen (2016a) reviewed the trends in occurrence along the Dutch coast.

Striped dolphin (*Stenella coeruleoalba* (Meyen, 1833))

The striped dolphin was documented for the first time in 2006 near Büsum (NE (SH)), a single record adding a new species to the list of cetaceans recorded from German North Sea waters (Figure 5). The natural distribution area of the striped dolphin is both further south and further offshore than German coastal waters. Two Danish North Sea records were presented by Kinze *et al.* (2000) and Kinze *et al.* (2018), respectively, while adjacent Dutch records were reviewed by Kompanje (2005) and Smeenk & Camphuysen (2016b).

Already in 1910, however, Trouessart (1910) had reported ‘*Prodelphinus euphrosyne*’ from near the mouth of the River Elbe. The source of his record is unfortunately unknown. Mohr (1931) doubted this occurrence, quoting Brohmer (1914), as did Schultz (1970) although citing Tomelin (1967) for this information. A misinterpretation of Möbius (1873) so-called ‘*Gestreifter Delphin*’ (literally = striped dolphin), referring to two finds of Risso’s dolphin near Büsum in 1873, seems evident.

Risso’s dolphin (*Grampus griseus* (Cuvier, 1812))

The first and hitherto only record from the German North Sea coast originates from the year 1873 (Figure 6).

Two individuals of this species were found in February within two days of each other near the town of Büsum NE (SH) (Möbius, 1873). The literal translation of the German vernacular name ‘*Gestreifter Delphin*’ is striped dolphin and may have caused a confusion with *Stenella coeruleoalba*.

Long-finned pilot whale (*Globicephala melas* (Traill, 1809))

The long-finned pilot whale was documented eight times (Figure 6). The first reported record of the species originates from the year 1965 and the island of Sylt (Gewalt, 1971). Three finds were registered for the SW coast (1976, 1988 and 2017) and five for the NE coast (1965, 1974, 1995, 1999, 2001), respectively.

The long-finned pilot whale is an oceanic teuthophageous species and therefore probably poorly adapted to the coastal habitat and in particular to the Wadden Sea coast – alike sperm whales. Unlike these, they are much smaller and therefore may have escaped detection in earlier decades.

Killer whale (*Orcinus orca* (Linnæus, 1758))

Between 1841 and 2016 nine strandings of killer whale have been documented (Figure 6). Dahl (1894, 1906) and Mohr (1931, 1935) listed the earliest documented find (1841) from the island of Sylt (NE (SH)). Other older records of the species include an

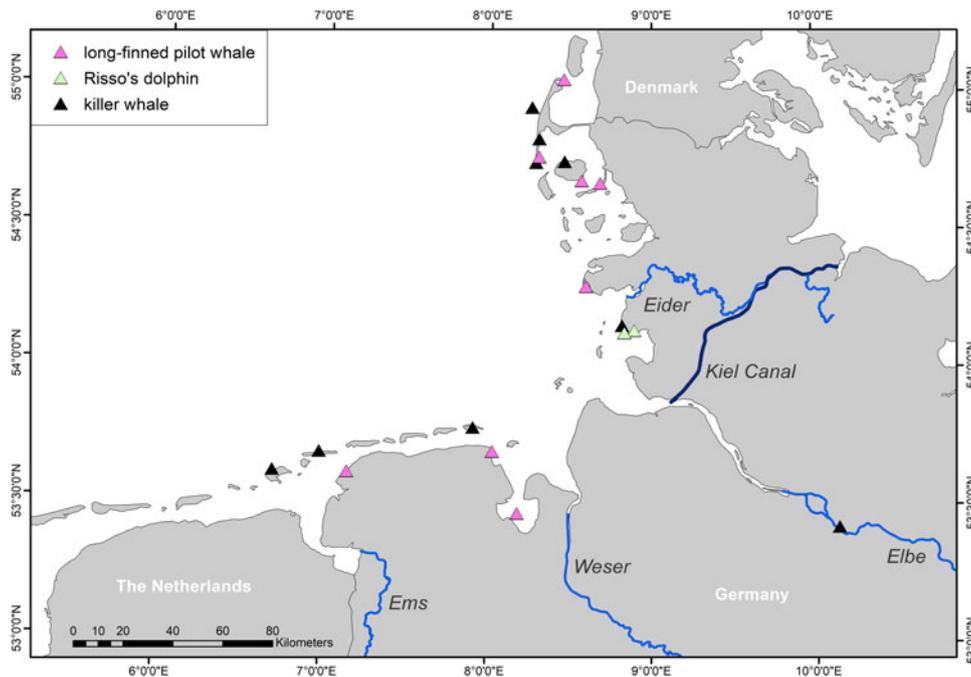


Fig. 6. Records of Risso's dolphins, long-finned pilot whales and killer whales.

individual stranded on the shores of the island of Juist NI around World War I (Schultz, 1970) and another killed upstream in the Elbe at Fliegenberg (NI) in 1921 (Hentschel, 1921).

The species was further encountered both for the SW coast (Juist 1943; Wangerooge 1956; Borkum 1967) and the NE coast (Sylt 1965, 2016; Föhr 1988), respectively. It is noteworthy that the 1943 killer whale was reported as a 'Nordkaper', a German vernacular name confusingly also in use for the fin whale and the North Atlantic right whale

Beluga whale (Delphinapterus leucas (Pallas, 1770))

Records of stranded dead belugas are rare due to the pronounced coastal adaptability of the species. Individuals often enter rivers and migrate upstream. Accordingly, the only German North Sea stranding hitherto reported was of a beluga whale found dead on the Island Rhinplatte in the vicinity of the town of Glückstadt (SH), i.e. some 100 km upstream in the River Elbe in 1993. Here, we include another record recovered from an unequivocal newspaper report: a 5 m individual found on the island of Föhr (SH) in 1905 (*Neue Hamburger Nachrichten*, 17 August 1905) (Figure 7).

Although the beluga whale is an arctic coastal species, during certain periods invasions seem to take place into more southern coastal waters, namely also the North Sea. In 1984 an individual swam up the River Elbe near Hamburg, and subsequently appeared in the Jadebusen and Dollart at the mouth of the River Ems (Jensen *et al.*, 1987; Goethe, 1996). Already in 1967, another beluga had swum 400 km up the Rhine to Bad Honef (Gewalt, 1976).

There is a very doubtful old record of the species from the River Elbe near Hamburg for the year 1736. The only source here seems to be Mohr (1935) who quoted Japha (1919 sic!; a reference not contained in her reference list) to have quoted Klein (1741) for this record, but Klein reported on a 1736 narwhal only. Schultz (1970) as well lists a beluga for this year with reference to another Mohr paper (1962) which, however, again only refers to a narwhal. This record therefore has been deleted from the list.

Narwhal (Monodon monoceros Linnæus, 1758)

There are two historical records of the narwhal, one from the Dollart in 1669 (SW, NI; Hartmann 1930) and another from 1736 and the mouth of the River Oste, a tributary to the Elbe (R Elbe, NI; Klein, 1741. Mohr, 1931, 1962) (Figure 7).

Mohr (1931) at first believed that two individuals had been taken during 1736, but in 1935 she considered only a single occurrence of a male in early February of this year. Donndorff (1792) on the other hand provided a different month (December) and Tomelin (1967) reported the specimen to be female. Recently, Haelters *et al.* (2018) reviewed extralimital occurrences of the species in the North Sea.

Sowerby's beaked whale (Mesoplodon bidens (Sowerby, 1800))

Records of this species have been extremely rare with only four finds from the German North Sea coast (Figure 7). The two earliest finds are both from the island of Sylt: 1962 Rantum and 1970 Morsum (Schultz, 1970; Kühlemann, 1983). In 2009, there were two reports of the species from two adjacent localities, but in different federal states. Careful analysis of photographs documents them as two independent records. Also, during 2009 there were two North Sea live strandings: first 13 August on the English coast near Blakeney Point on the northern shores of Norfolk (which subsequently was found dead), then later 4 October 2009 on the Dutch coast near Masvlaake. The latter specimen was not re-encountered and may be identical with one of the German North Sea strandings.

Northern bottlenose whale (Hyperoodon ampullatus Forster, 1770)

This large beaked whale was recorded seven times (Figure 7) comprising nine individuals in total. For the year 1659, Mohr (1935) reported on the earliest bottlenose whale find from Blankenese on the banks of the River Elbe to the west of Hamburg. To this we add from the island of Föhr (SH) a catch of two individuals during the summer of 1780 (Danish newspaper report *Kiøbenhavn*

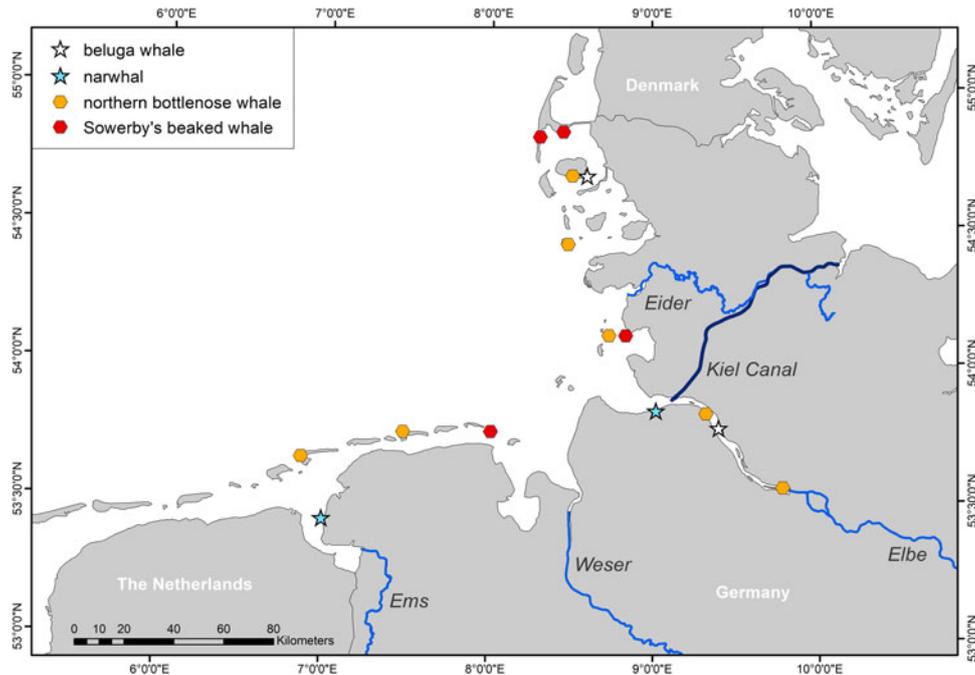


Fig. 7. Records of beluga whales, narwhals, Sowerby's beaked whales and northern bottlenose whales.

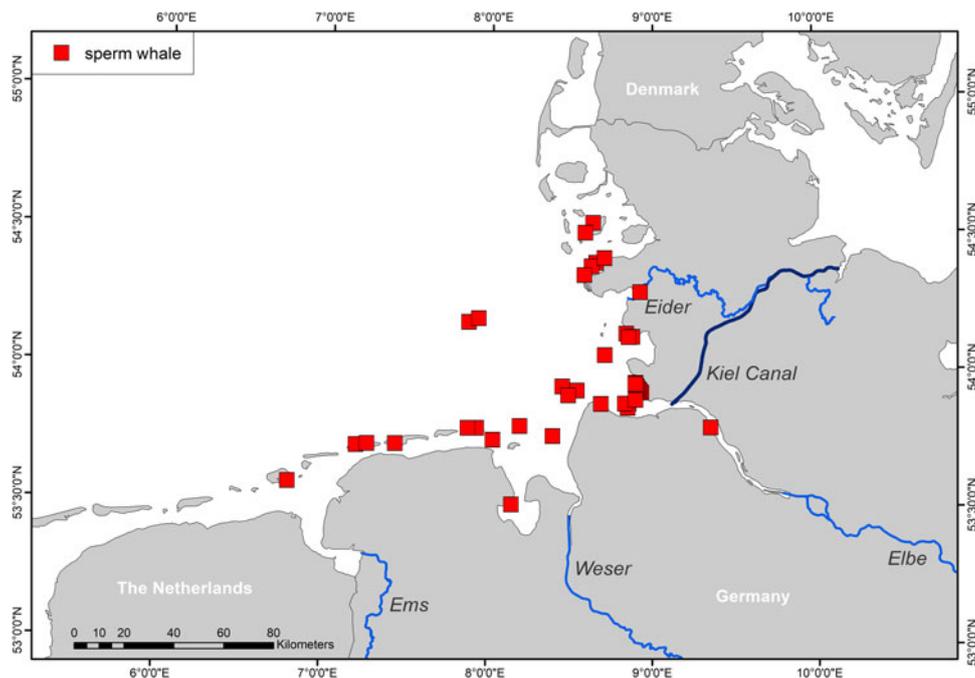


Fig. 8. Records of sperm whales.

Kongelig alene privilegerede Adresse-Contoirs Efterretninger, 9 August 1780). The species identity of the latter record rests on the vernacular Danish, German and Dutch names applied, the size of the two individuals, the season of the catch and the obvious reference to the bottlenose whale account delivered by Chemnitz (1779).

Marshall (1896) listed it as one of the more commonly occurring species and mentioned several contemporaneous finds (i.e. the 1890s) exhibited in public, but unfortunately without providing any details. Recently, an additional find from the early 20th century has been identified from a photograph and newspaper reports of an individual stranded on Langeoog (NI) in 1902 (Schmidt, 2014, *Neue Hamburgische Zeitung*, 28 August 1902).

For the year 1913 a well-known find from Freiburg (upon Elbe, NI) hitherto erroneously was considered a stranding of a single male. Correctly the incident, however, instead involved a mother-calf pair (*Neue Hamburger Zeitung* 13 September 1913). A single record is known from Memmert (NI) in 1938 (Goethe, 1983). In 1976 there was a stranding near Büsum (SH) and another in 1981 from Süderoogsand (SH) (Borkenhagen, 2011).

Sperm whale (Physeter macrocephalus L. 1758)

Due to the immense size of this toothed whale, sperm whale strandings can be traced back in time further than any other large cetacean. The earliest known German North Sea sperm

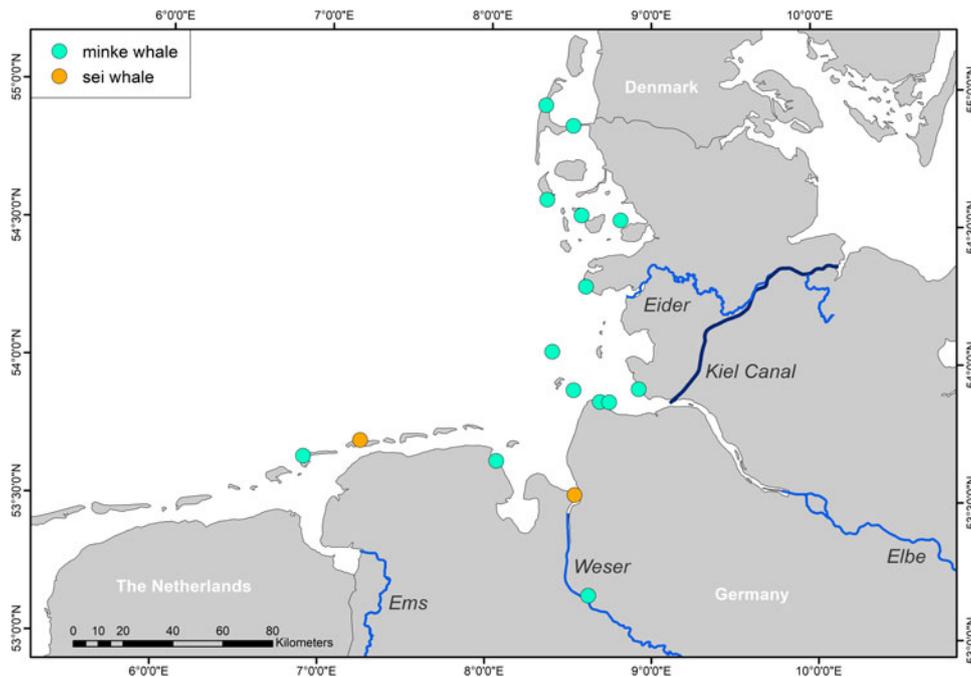


Fig. 9. Records of minke and sei whales.

whale stranding dates back to 1604. In total, 21 strandings of at least 59 individuals have been documented (Figure 8). Here we include a hitherto overlooked sperm whale stranding from the Eider estuary from early 1695. Subsequent strandings have occurred in the 18th century in 1721, 1723 (18 animals), 1738 (3 animals), 1751 (3 animals, scattered), 1759 (2 animals) and 1762 (≥ 2 animals). From the 19th century there are no safe records. A presumed sperm whale stranding from 1848 on the island of Borkum (Vanselow & Ricklefs, 2005) did not meet the criteria for an unequivocal species identification and was not included in the list compiled by Smeenk & Evans (2018).

The gap in records between 1762 and 1969 for the German North Sea strandings is in accordance with findings from the entire North coastline. Smeenk & Evans (2018) reviewed sperm whale stranding for the entire North Sea area while Pierce *et al.* (2007) proposed a relationship between strandings and fluctuations in sea temperature.

Minke whale (*Balaenoptera acutorostrata* Lacepede, 1804)

The minke whale was documented 16 times in total between 1669 and 2017 (Figure 9). For the period 1990–2017 it ranked the most commonly encountered baleen whale with an overwhelming preponderance for the NE (SH) coastline. Records from the SW (NI) coastline include Beichle *et al.* (2005).

The species was originally known as the *Balaena rostrata* of Fabricius, 1780, but has frequently been confused with its homonym *Balaena rostrata*, Müller, 1776, a junior synonym of the northern bottlenose whale. Therefore, Poppe (1882) erroneously listed an undisputable minke whale of 1669 (a life-size oil painting in the town hall of Bremen; Goethe, 1983) as a bottlenose whale.

Prior to 1971, the only German record known for this species originated from Leesum, the River Weser and the year 1669 (Goethe, 1983). Here, a record from Hooksiel and the 1830s originally considered a fin whale (Wiepken & Greve 1876), we re-assign to minke whale. Mohr (1935) reported a 'fin whale suckling' on exhibit in Hamburg in early 1932. This animal stranded near Cuxhaven at the mouth of the River Elbe and was reported to be 7–8 m in length. Based on newspaper

photographs (e.g. in *Der gerade Weg*, 3 April 1932) we re-identify it as a minke whale.

Sei whale (*Balaenoptera borealis* Lesson, 1828)

Only two records of this species were documented from the German North Sea coastline: in 1955 on the island of Norderney (NI) (Goethe, 1983) and recently in 2016 near Blexen (NI) at the mouth of the River Weser (Figure 9).

Due to its pelagic habitat the sei whale is a very rare visitor to the shallow parts of the North Sea. However, further sei whale specimens may be found among collectedrorqual specimens 7–10 m in length that were entered to scientific collections under an incorrect species heading. The 2016 Blexen specimen was identified morphologically (baleen colour) and molecularly (DNA analysis) to sei whale (Ralph Tiedemann, pers. com.).

Fin whale (*Balaenoptera physalus* (Linnaeus, 1758))

Twenty-one fin whale records have been documented, spanning from 1827–2012 (Figure 10) indicating a preponderance in occurrence on the Sylt coasts (SH) ($N = 8$) and among these finds for the List Deep between the islands of Sylt and Rømø (Denmark).

Unfortunately, the fin whale was known by both the German vernacular names 'Nordkaper' and 'Grönländischer Wal', also being in use for the North Atlantic right whale (*Eubalaena glacialis*) and the Greenland right whale or bowhead whale (*Balaena mysticetus*), and even the killer whale (*Orcinus orca*) thereby causing a lot of confusion (see above). In the 18th century fin whales were listed under the species heading *Balaenoptera musculus* (Companyo 1830) therefore in later reviews (e.g. Schultz, 1970) erroneously were considered records of blue whale.

Here, we establish the correct species assignment of a 75-foot female 'Walfisch' from the island of Helgoland found in November 1849 to be a fin whale (archival evidence: Claudius in lit., 28 August 1857 to J. H. Blasius; Appendix 1). This stranding was erroneously considered a record of *Balaena mysticetus*, the Greenland right whale by von Dalla Tore (1889) based on Oetker (1855). Mohr (1931) after Dahl (1894, 1906) gave the

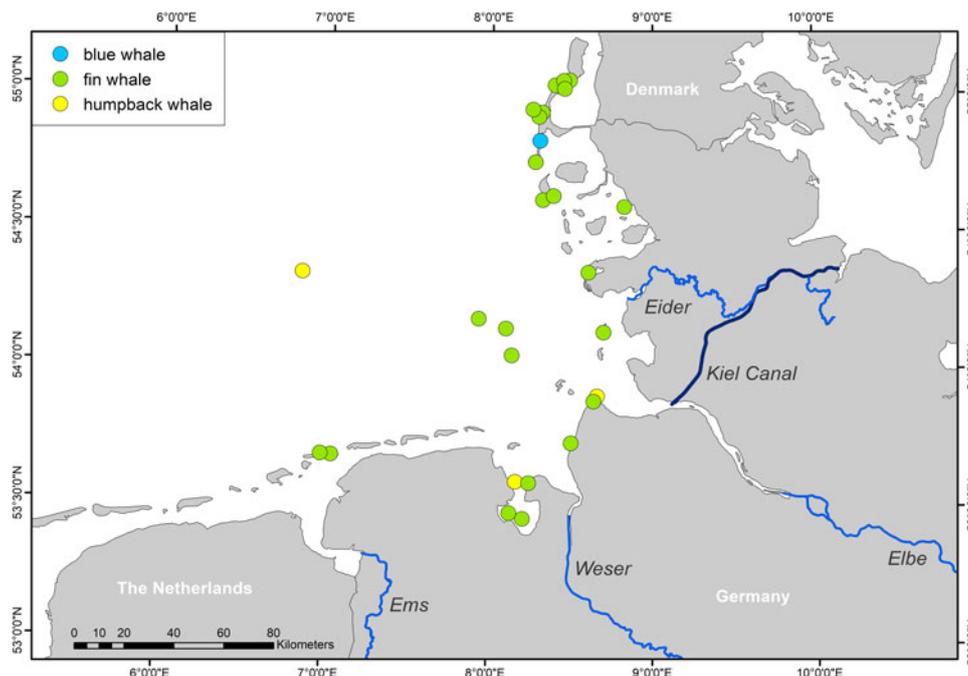


Fig. 10. Records of fin, blue and humpback whales.

year as 1805 (an obvious printing error for 1850) for the same incident.

Of Wiepken & Greve's (1876) two records of fin whale (Hooksiel 1830s, Wilhelmshaven 1870), only the latter record could be validated as belonging to the species while the Hooksiel record has been re-identified as minke whale. Newspaper reports revealed a further two fin whale strandings near Cuxhaven for the year 1882, and the species has also been documented from the island of Sylt in 1911 by Mohr (1931).

Both World War I and II unfortunately produced fin whale casualties due to collisions with sea mines. During August 1915, another two large baleen whales, possibly fin whales, washed ashore on the west coast of Amrum (SH) and the island of Pellworm (SH), respectively. A possible third fin whale stranding occurred in July 1943 as a 'headless' rorqual was found on the Juister Riff (NI).

Blue whale (*Balaenoptera musculus* (Linnæus, 1758))

For the German North Sea coastline, the blue whale still only has been encountered once in 1881 on the island of Sylt (SH) (Möbius, 1885) (Figure 10).

While the fin whale during the latter half of the 19th century unfortunately was known as *Balaenoptera musculus* (Companyo 1830) a homonym of the present day scientific name of the blue whale (*Balaenoptera musculus* (Linnæus, 1758)), the blue whale during the same period carried a variety of scientific names including *Sibbaldius borealis* Gray 1864 and *Pterobalaena gigas* Van Beneden 1861. Some 19th century records of 'Balaenoptera musculus' in literature therefore refer to fin whales instead and sometimes even are listed twice, both correctly as fin whales and incorrectly as blue whales (e.g. Schultz, 1970).

Further, Meyer (1994) erroneously reported a minke whale as 'blue whale'. This stranding supposedly occurred on the island of Neuwerk on 12 December 1984, but indeed it is identical with a find the previous day on exactly the same location of a minke whale.

From the adjacent North Sea there are just three additional validated records: a Belgian (1827) and a Dutch (1840) one (Smeenk & Camphuysen, 2016c) and a single 1907 record from the Danish North Sea coast (Kinze, 2007).

Humpback whale (*Megaptera novaeangliae* (Borowski, 1791))

The humpback whale was reported thrice only, in 1824 at the mouth of River Elbe (Mohr, 1935) and a single specimen, 1991 in the Jade inlet, and in 1994 an individual floating in the German Bight (Stede *et al.*, 1996) (Figure 10).

Discussion

As compared with adjacent coastlines, the lower cetacean diversity (Table 2) encountered in the German Bight may be explained by the hydrographic conditions possibly favouring species with coastal affinity and adaptability. The riverine habitat has been exploited by both the harbour porpoise and the bottlenose dolphin, but with increasing riverine pollution throughout the 20th century these visits ceased. However, the successful return of the harbour porpoise to these rivers also may be a precursor to the reappearance of the bottlenose dolphin. So far records of bottlenose dolphin are documented for the southernmost part of the German North Sea coast and may be an inclusive part of the Dutch distributional scenario with stragglers occurring only. Along the northern English North Sea coastline bottlenose dolphins from Scotland have recently expanded their range further south (Stockin *et al.*, 2006; Evans & Waggitt, 2020).

Historically, all cetaceans encountered in the German part of the North Sea other than the harbour porpoise over-simplified were lumped into a single category of presumed erratic species. However, they constitute a rather heterogeneous group of species with very different potentials to adapt to the hydrographic regime of the larger German Bight. So-called 'neighbourhood species' include frequently reported white-beaked dolphins and minke whales while sperm whales and other pelagic cetaceans are purely erratic species (Gosselck & Kinze, 2011). Hence, coastal and shelf species from southern and northern areas may adapt to environmental conditions and altered sources of food. On the other hand, oceanic or pelagic species are challenged by their lack of resilience to the coastal habitat and may even face shortcomings of their orientation and navigation capacities.

Table 2. Strandings of non-phocoenid cetaceans (number of individuals) along the Dutch, German and Danish North Sea coasts for the period 1990–2017

Species	NL	D	DK
White-beaked dolphin <i>Lagenorhynchus albirostris</i>	126	46	117
White-sided dolphin <i>Leucopleurus acutus</i>	7	7	9
Common dolphin <i>Delphinus delphis</i>	4	7	4
Striped dolphin <i>Stenella coeruleoalba</i>	9	1	1
Bottlenose dolphin <i>Tursiops truncatus</i>	13	6	0
Long-finned pilot whale <i>Globicephala melas</i>	3	6	12
Killer whale <i>Orcinus orca</i>	3	1	2
Beluga whale <i>Delphinapterus leucas</i>	0	1	0
Sowerby's beaked whale <i>Mesoplodon bidens</i>	11	2	1
Blainville's beaked whale <i>Mesoplodon densirostris</i>	1	0	0
Bottlenose whale <i>Hyperoodon ampullatus</i>	2	0	0
Sperm whale <i>Physeter microcephalus</i>	26	27	42
Minke whale <i>Balaenoptera acutorostrata</i>	18	9	22
Sei whale <i>Balaenoptera borealis</i>	1	1	0
Fin whale <i>Balaenoptera physalus</i>	12	5	1
Humpback whale <i>Megaptera novaeangliae</i>	7	2	1
Total	215	120	213
Length of coast (km)	451	1155	606
Finds per 100 km	47.7	10.4	35.3
Species number	15	14	11

Sources: NL: Smeenk, 1995, 2003, Camphuysen *et al.*, 2008, Keijl *et al.*, 2016 and www.walvistrandingen.nl. DK: Kinze, 1995, Kinze *et al.*, 1998, 2010 and 2018.

Historical context

Several German scholars of the late 18th and early 19th century have pointed out the lack of knowledge on cetaceans occurring along the German coasts in particular and the North Sea coastline in general (Blasius, 1857). These treatises therefore in many ways provided a generalized picture drawn from adjacent, in many cases Dutch, waters – thereby listing cetacean species assumed to occur or expected to appear in German waters. The literature containing information on historical cetacean strandings is rather scattered, reflecting the historical administrative division of present-day Germany into then several independent states. The species assignment sometimes relied on inadequate literature and was in several cases found incorrect. Even the most recent reviews by Schultz (1970) and Goethe (1983) contain misinterpretations and double counts (see above).

The present federal state Schleswig-Holstein until 1864 was part of the Danish monarchy which is why several older reports on cetacean strandings are written in the Danish language. After a transition period, SH became a province of Prussia in 1867. Subsequent literature on 19th century cetacean records from the North Sea coast comprise the works of Möbius (1873, 1885) and Dahl (1894, 1906) while Mohr (1931, 1935) provided the first comprehensive compilation but also introduced several errors, as did Schultz (1970). Borkenhagen (2011) listed and corrected records to the year 2010. Also, certain 'border cases' were removed from the list since they took place on the present-day Danish coast and already have been treated elsewhere (Kinze, 1995).

The present Federal State of Niedersachsen was only formed in 1945, merging the coastal areas of the Prussian province of Hannover and the Grand Duchy of Oldenburg into a single entity and hence older literature on cetaceans covered only certain portions of the present coastline.

For the present-day Federal States of Hamburg and Bremen information on cetacean records are found in Itzerodt (1904) and Heineken (1837), respectively.

Harbour porpoise

The period 1990–2017 in adjacent Dutch waters (Smeenk 1995, 2003; Camphuysen *et al.*, 2008; Keijl *et al.*, 2016) yielded 8444 specimens. The Dutch figures do indicate a very high reporting effort along with a marked increase in occurrence resembling the SW (NI) German figures while the NE (SH) figures seem to fluctuate with no clear trend.

Other species

For the entire German North Sea coastline and the period 1990–2017, 120 specimens of 14 non-phocoenid species were documented while the Dutch coast yielded 215 specimens of 15 and the Danish coast 213 of 11 species. The German coastline exhibited the lowest number of specimens as well as the lowest encounter rate with about 10 finds per 100 km coastline while for the Dutch and Danish coasts a much higher encounter rate could be noted with nearly 48 finds per 100 km and 35 finds per 100 km, respectively and each above 200 specimens. (Table 2). The white-beaked dolphin was the most frequently encountered species along all three coastlines with 38.3%, 54.9% and 58.6% of the finds from the German, Danish and Dutch coasts, respectively. Sperm whales accounted for 22.5%, 19.7% and 12.1%, respectively. Figures for the minke whale were 7.5%, 10.4% and 8.4%, respectively (Table 2). White-beaked dolphins predominate in the northern parts of the North Sea while common dolphins range into its southern parts (MacLeod *et al.*, 2005). So far

along the German North Sea coast, the white-beaked dolphin has kept position as the most common delphinid, but due to evident climate changes shifts in species frequency are to be expected and rising sea temperatures could push white-beaked dolphins further north and away from the German North coastline and instead attract more common dolphins, although these two species do not share the same ecological preference (Evans & Waggitt, 2020). Common dolphins, being indicative for a warmer climate, have also occurred in earlier periods in the southern North Sea (Fraser, 1937).

Striped dolphins are both pelagic and southern indicators. Their occurrence along the German North Sea coast has been recorded just once so far. There have been several finds along the English and Dutch coasts, generally in increasing numbers since 1967 (Ijsseldijk et al., 2018a, 2018b).

The killer whale is a rare visitor to the German North Sea coastline with no clear trend in occurrence. Within the northern sectors of the North Sea killer whales have continuously been present for decades (Evans & Waggitt, 2020). The white-sided dolphin had its first appearance on the SW (NI) coast already in 1968 and may be considered a northern pelagic intrusion. Possibly the freshwater output within the German Bight has led to finds only outside the river mouths, i.e. further to the west and to the north.

The beluga whale is a coastal Arctic species with a high riverine affinity. As in adjacent waters this species exhibits a low stranding mortality with much more frequent sightings and live strandings than finds of dead specimens. In 1983 for instance, the entire German North Sea coastline for weeks was visited by a single beluga whale (Jensen et al., 1987; Goethe 1996) without a lethal stranding incident. During periods, e.g. 1903–1908 (Schultz, 1970) there have been extralimital intrusions of beluga whales into temperate waters. The rediscovered find from the island Föhr and the year 1905 falls into the same period while the find from the River Elbe is supportive for the riverine affinity of the species. The narwhal is a high Arctic pelagic species for which there are only historic records. From Dutch, English and Belgian North Sea waters more recent finds are known (Weber, 1912; Fraser, 1949; Haelters et al., 2018).

Genuine oceanic species such as the teuthophageous sperm whale, northern bottlenose whale and Sowerby's beaked whale may find little food along the German North Sea coast. In addition, their navigation capacities may run short. None the less, ziphiid species are known to enter rivers and venture upstream. For the Thames estuary and river at least six such occurrences of northern bottlenose whales have been documented (Crouch, 1891; Deaville & Jepson, 2007) that may mirror the occurrences in the River Elbe (1659, 1913).

Among the baleen whales there is a high preponderance of fish-eating species (minke, fin and humpback). The minke whale is a rather stable fauna component in the northern and central North Sea but has also become the most frequent rorqual in the German North Sea stranding record. The species may have benefited from the intense exploitation of the larger piscivorous baleen whales such as the fin whale and the humpback whale. The fin whale seems to have been a foraging visitor along the NE (SH) coast, with occurrences in the deeps between the islands. The humpback populations of the North Atlantic experienced a heavy exploitation in the 19th and 20th century but now seem to have undergone a full recovery with few but regular sightings off the Dutch coast (Leopold et al., 2018) and accordingly again records from the German North Sea coast.

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Schleswig-Holstein data directly was made available by US.

The holdings of the collections in Frankfurt (Senckenberg Museum), and Stuttgart (Staatliches Museum für Naturkunde Stuttgart) were accessed over their websites (CCK). Details of specimens held in the scientific collections of the museums in Oldenburg were provided to RC.

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Authors contribution. CCK Conducted the overall compilation and analysis, drafted the manuscript, provided historical records from literature and archives. RC provided recent records from Niedersachsen and photographic documentation. HH designed the distribution maps. US initiated the work and provided recent records from Schleswig-Holstein and photographic documentation. All authors read and approved the final manuscript.

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Appendix 1

Record details. Date given in format YYYY-MM-DD. Sex M, male; F, female; U, sex unknown; TL, total length; TW, total weight; PR, pregnant.

White-beaked dolphin (*Lagenorhynchus albirostris* Gray, 1846)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1921-07	Büsum	NE (SH)	F adult U Calf	Mohr, 1935
2	1952-02-15	Wangerooge	SW (NI)	U 275 cm	Goethe (1983)
3	1962-01-15	Düne, Helgoland	NE (SH)	F 262 cm	Goethe (1983)
4	1962-01-23	Wangerooge	SW (NI)	U 2 m	Goethe (1983)
5	1973-12-04	Baltrum	SW (NI)	M	Specimen kept in Kiel
6	1982-06	Scharhörn	SW (NI)	F 270 cm	Goethe (1983)
7	1982-09-11	Hooksiel	SW (NI)	F 256 cm 191 kg	Goethe, 1983
8	1982-11-04	Wittdün, Amrum	NE (SH)	F 314 cm* 320 kg	Specimen kept Kiel
9	1982-11-04	Wittdün, Amrum	NE (SH)	F 320 kg	Specimen kept Kiel
10	1982-11-04	Nordstrandischmoor	NE (SH)	F 258 cm 275 kg	Specimen kept inKiel
11	1983-02-02	Baltrum	SW (NI)	U 2 m	Goethe (1983)
12	1983-04-26	Süderoogsand	NE (SH)	M 290 cm	Specimen kept in Kiel
13	1983-05-06	Norderoogsand	NE (SH)	U	Specimen kept in Kiel
14	1984-02-10	Föhr	NE (SH)	F 226 cm 226 kg	Specimen kept in Kiel
15	1984-07-14	Sylt	NE (SH)	M 281 cm	Specimen kept in Kiel
16	1986-05-30	Langeness	NE (SH)	U 257 cm 252 kg	Specimen kept in Kiel
17	1986-11-07	Spiekeroog, west coast	SW (NI)	F 234 cm 100 kg	Specimen kept in Oldenburg
18	1989	Föhr	NE (SH)	U	Specimen kept in Hamburg
19	1989-11-10	Campen, light house 53.405717, 7.015593	SW (NI)	F 252 cm 200 kg	Specimen kept in Oldenburg
20	1990-01-12	Sylt	NE (SH)	F 275 cm 235 kg	Specimen kept in Kiel
21	1990-12-28	Oststrand List, Sylt	NE (SH)	M 197 cm	Specimen kept in Kiel
22	1991-03-01	St. Peter Ording	NE (SH)	M 232 cm 174.5 kg	Specimen kept in Kiel
23	1991-05-29	Norderney	SW (NI)	U	Specimen kept in Oldenburg
24	1992-01-12	Tammwerft, Pellworm	NE (SH)	F 176 cm 78 kg	Specimen kept in Kiel
25	1992-11-26	Norderney	SW (NI)	F 223 cm 145.5 kg	Meyer (1994), Stede (1994) **
26	1992-12-10	Norderney	SW (NI)	M 255 cm	Specimen kept in Oldenburg

(Continued)

Appendix 1. (Continued.)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
27	14-12-1992	Brokdorf, Elbe	NE (SH)	F 285 cm 230 kg	Specimen kept in Kiel
28	06-04-1993	Baltrum	SW (NI)	U 2 m	Specimen kept in Oldenburg
29	05-05-1993	Eiderstedt (Stuffhusen)	NE (SH)	F 245 cm	Specimen kept in Kiel
30	29-05-1993	Büsum	NE (SH)	F 263 cm 245 kg	Specimen kept in Kiel
31	29-05-1993	Helmsand (Friedrichskoog)	NE (SH)	F 244.5 cm	Specimen kept in Kiel
32	29-05-1993	Friedrichskoog, Spitze	NE (SH)	F 275 cm	Specimen kept in Kiel
33	11-07-1993	St. Peter Ording, Strand	NE (SH)	F 262 cm 275 kg	Specimen kept in Kiel
34	17-07-1993	Westerhever-Sand	NE (SH)	F 136 cm	Specimen kept in Kiel
35	07-09-1993	Heverstrom, Nordsee	NE (SH)	F 243 cm 178 kg	Specimen kept in Kiel
36	07-09-1993	Westerhever Sand	NE (SH)	M 250 cm 191 kg	Specimen kept in Kiel
37	07-11-1993	Spiekeroog	SW (NI)	U 240 cm	Specimen kept in Kiel
38	09-11-1993	Beitringharder Koog, nerr Lüttmoorsiel	NE (SH)	F 241 cm 178 kg PR 355 mm 760 g	Specimen kept in Kiel
39	09-03-1994	Amrum	NE (SH)	M 205 cm	Specimen kept in Kiel
40	27-06-1994	Trischen	NE (SH)	U	This paper
41	11-09-1994	Büsum	NE (SH)	F 177 cm	Specimen kept in Kiel
44	16-01-1995	Borkum	SW (NI)	F 254 cm 180 kg	Specimen kept in Oldenburg
45	17-01-1995	Borkum	SW (NI)	F 253 cm 200 kg	Specimen kept in Oldenburg
46	1997-05-15	Wittdün Amrum	NE (SH)	F 230 cm	Specimen kept in Kiel
48	09-08-1998	Westerhever Sandbank	NE (SH)	M 230 cm	Specimen kept in Kiel
49	18-10-1998	Nieblum, Foehr	NE (SH)	F 245 cm 230 kg	Specimen kept in Kiel
50	07-11-2000	Wilhelmshaven	SW (NI)	F 245 cm 225 kg	Specimen kept in Oldenburg
51	08-11-2000	Wilhelmshaven	SW (NI)	F 235 cm 250 kg	Specimen kept in Oldenburg
52	08-11-2000	Wilhelmshaven	SW (NI)	F 245 cm 250 kg	Specimen kept in Oldenburg
53	02-07-2001	Hooge	NE (SH)	U 150 cm	Specimen kept in Kiel
54	18-06-2002	Leysiel	SW (NI)	F 245 cm	Specimen kept in Kiel
55	27-06-2002	Sylt, Morsum Weststrand, Höhe Haupttreppe	NE (SH)	F 237 cm	Specimen kept in Kiel
56	10-02-2003	Sylt, Rantum, Nord, Camping	NE (SH)	F 252 cm 214 kg	Specimen kept in Kiel
57	31-12-2003	Borkum	SW (NI)	F 260 cm 230 kg	Specimen kept in Kiel
58	22-01-2005	Baltrum	SW (NI)	F 235 cm	Specimen kept in Oldenburg
59	09-12-2006	Amrum	NE (SH)	M 260 cm	Specimen kept in Kiel
60	04-09-2007	Klappholtal Sylt	NE (SH)	M 190 cm	Specimen kept in Kiel
61	2007-06-30	Minsener Oog	SW (NI)	U 248 cm	This paper
62	04-01-2010	Sylt, List, Klappholtal	NE (SH)	F	Specimen kept in Kiel
63	21-03-2010	Sylt, Wenningstedt, Kliffkieker	NE (SH)	F	Specimen kept in Kiel
64	23-12-2015	Norderney	SW (NI)	U 260 cm	Specimen kept in Oldenburg

* Zoological length; ** type errors in Stede: Date 26-01, TW 232 kg; 1992 Dissection report date 27-11. Kiel refers to Zoological Museum University of Kiel, Oldenburg to Natural History Museum Oldenburg.

Bottlenose dolphin (*Tursiops truncatus* (Montagu, 1821))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1836-12-22	Drielake, Oldenburg	R Weser	U 276 cm	Wiepken & Greve (1876)
2	1850 spring	Celle (River Aller)	R Weser	Large dolphin	Häpke (1880)
3	1852 summer	Winsen	R Elbe	U	Poppe (1882)
4	1860	Glückstadt	R Elbe	U	Mohr (1935)
5	1867 summer	Lower Elbe	R Elbe	M	Specimen kept in Copenhagen

(Continued)

Appendix 1. (Continued.)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
6	1872	Wilhelmshaven	SW (NI)	U	Möbius (1888)
7	1876-03	Garbe River Wittenberg Sachsen-Anhalt	R Elbe	U	Erhardt (1937)
8	1879	Glückstadt	River Elbe	F 300 cm 450 kg Calf 100 cm	Häpke (1880)
9	1887-07-17	Hooksiel	SW (NI)	M 300	Wiepken & Greve (1897)
10	1887-10	Fedderwerder	SW (NI)	M 363 cm	Wiepken & Greve (1897)
11	1900-04	Hamburg harbour	R Elbe	U	Schultz (1970)
12	1901-02-28	Hamburg harbour	R Elbe	U	Schultz (1970)
13	1903	Büsum	NE (SH)	Juvenile	Specimen kept in Berlin
14	1909-07	Oldenburg	R Weser	U > 300	Schütte & Huntemann (1913)
15	1924-06-10	Mouth of River Stör	R Elbe	U 370 cm 288 kg	Wegener (1924)
16	1929-10-10	Brunsbüttel*	R Elbe	M 365 cm	Mohr (1935)
17	1935-09-17	Hooge	NE (SH)	U	Mohr Archive Hamburg
18	1935-09-19	Nordstrand	NE (SH)	U	Mohr Archive Hamburg
19	1940	Kampen, Sylt	NE (SH)	U 315 cm 350 kg	Schultz (1970)
20	1954-04-17	Wangerooge	SW (NI)	U 315 cm	Goethe (1983)
21	1958-10	Westerland, Sylt	NE (SH)	U	Schultz (1970)
22	1960	Trischen	NE (SH)	U	Mohr (1962)
23	1963-06-07	Wangerooge	SW (NI)	F	Goethe (1983)
24	1964-08	Cuxhaven	SW (NI)	U	Specimen kept in Stuttgart
25	1971-07-01	Borkum	SW (NI)	U	Specimen kept in Kiel
26	1989-04-22	Norderney	SW (NI)	M 260 cm	SAS 8/21
27	1990-03-30	Norderney	SW (NI)	U 155 cm	SAS 8/21
28	1991-04-18	Leybucht	SW (NI)	M	Meyer (1994)
29	1993-02-21	Wangerooge	SW (NI)	F 227 cm 150 kg	Meyer (1994)
30	1993-03-18	Wangerooge	SW (NI)	M 210 cm	SAS 11/10
31	1996-07-17	Leysiel	SW (NI)	F 170 cm 80 kg	This paper SAS 15/15

White-sided dolphin (*Lagenorhynchus acutus* (Gray, 1828))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1968-04-26	Schillig	SW (NI)	U	Goethe (1983)
2	1990-04-25	Schillig	SW (NI)	F 200 cm 150 kg	Stede (1994)
3	1990-04-21	Westplate, Mellum	SW (NI)	U 208 cm	Meyer, (1994)
4	1996-04-09	Otterndorf	SW (NI)	M 243 cm 150 kg	Specimen List IFF Cuxhaven
5	2001-04-08	Leysiel	SW (NI)	F 235 cm 150 kg	Specimen kept in Oldenburg
6	2007-09-18	Dagebüll	NE (SH)	M 243 cm 191 kg	Specimen kept in Kiel
7	2011-12-31	Friedrichskoog	NE (SH)	M 255 cm 190 kg	Specimen kept in Kiel

Common dolphin (*Delphinus delphis* Linnæus, 1758)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1958-08-24	Wangerooge	SW (NI)	M 240 cm	Goethe (1983)
2	1971-01-14	Nordstrand	NE (SH)	M	Borkenhagen (2011)
3	1983-01-25	Cuxhaven	SW (NI)	U	Goethe (1983)
4	1989-05-03	Schillig	SW (NI)	F 148 cm 36 kg	Stede (1994)
5	1989-08-23	Schillig	SW (NI)	U	Meyer (1994)

(Continued)

Appendix 1. (Continued.)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
6	1990-03-27	Sylt	NE (SH)	F 193 cm 62 kg	Borkenhagen (2011)
7	1995-10-29	Hedwigenkoog	NE (SH)	M	Borkenhagen (2011)
8	2000-04-16	Nordstrand	NE (SH)	M 156 cm 39 kg	This paper
9	2005-05-31	St. Peter Ording	NE (SH)	M 174 cm 40 kg	This paper
10	2007-07-05	Mellum	SW (NI)	U 220 cm	This paper
11	2016-01-05	Borkum	SW (NI)	M 207 cm 90 kg	This paper
12	2016-12-23	List, Sylt	NE (SH)	U	This paper

Striped dolphin (*Stenella coeruleoalba* (Meyen, 1833))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	2006-02-22	Büsum	NE (SH)	F 161 cm 39 kg	Borkenhagen (2011)

Risso's dolphin (*Grampus griseus* (Cuvier, 1812))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1873-02-17	Büsum	NE (SH)	F 342 cm	Möbius (1873)
2	1873-02-19	Büsum	NE (SH)	M 370 cm 470 kg	Möbius (1873)

Longfinned pilot whale (*Globicephala melas* (Traill, 1809))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1965-06-26	Ellenbogen, Sylt	NE (SH)	U 5 m	Gewalt ⁵⁸
2	1974-01-24	Hörnum, Sylt	NE (SH)	F 467 cm 2t	Specimen kept in Kiel
3	1976-01-20	Schillig	SW (NI)	M 600 cm	Kock (1976)
4	1988-09-04	Jade	SW (NI)	M 540 cm 1340 kg	Meyer (1994)
5	1995-02-23	Wyk Föhr	NE (SH)	M 578 cm	Specimen kept in Kiel
6	1999-06-21	Oland	NE (SH)	F 352 cm 407 kg	Specimen kept in Kiel
7	2001-03-12	St. Peter Ording	NE (SH)	F 442 cm 917 kg	Specimen kept in Kiel
8	2017-12-09	Norddeich	SW (NI)	F 450 cm	Specimen kept in Kiel

Killer whale (*Orcinus orca* (Linnæus, 1758))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1841	Sylt	NE (SH)	U	Mohr (1931)
2	1864	Büsum	NE (SH)	U	Schultz (1970)
3	1921-11-11	Fliegenberg	River Elbe	F 550 cm 3 t	Hentschel (1921), Mohr (1931)
4	1943-07-27	Juist	SW (NI)	U 6 m 4 t	Goethe (1983)
5	1956-11-21	Wangerooge	SW (NI)	U	Goethe (1983)
6	1965-09-17	Rantum Sylt	NE (SH)	M 650 cm	Schultz (1970)
7	1967-06-26	Borkum	SW (NI)	M 550 cm	Goethe (1983)
8	1988-03-08	Föhr	NE (SH)	M 650 cm	Borkenhagen (2011)
9	2016-02-08	Rantum Sylt	NE (SH)	M 246 cm 181 cm	This paper

Beluga whale (*Delphinapterus leucas* (Pallas, 1770))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1905	Wyk Föhr	NE (SH)	U 5 m	This paper
2	1993-07-16	Rinplate, Elbe near Glückstadt	R (Elbe)	M 440 cm 1t	Specimen kept in Büsum

Narwhal (*Monodon monoceros* Linnæus, 1758)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1669-03	Bunderhamrich Dollart	SW (NI)	M 5.1 m (17')	Hartmann (1930)
2	1736-02	River Oste	R (Elbe)	M 5.4 m (18')	Mohr (1962)

Sowerby's beaked whale (*Mesoplodon bidens* (Sowerby, 1800))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1962-10-12	Morsum, Sylt	NE (SH)	U	Kuhlemann (1983)
2	1970-02-02	Rantum, Sylt	NE (SH)	U	Schultz (1970)
3	2009-09-01	Minsener Oog	SW (NI)	U 400 cm	This paper
4	2009-09-07	Büsum	NE (SH)	M	This paper

Northern bottlenose whale (*Hyperoodon ampullatus* Forster, 1770)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1659-09-10*	Blankenese	R Elbe (HH)	F 24' (8 m)	Mohr (1931, 1935)
2	1780-08	Wyk Föhr	NE (NH)	1) U est. 2t 2) U est 2 t	Newspaper report **
3	1902-08	Langeoog	SW (NI)	U 7.2 m	Schmidt (2014) This paper
4	1913-09-05	Freiburg	R (Elbe)	1) F 8 m 5027 kg 2) U 4, 5 m	This paper***
5	1938	Memmert	SW (NI)	Juvenile	Goethe (1983)
6	1976-03-01	Büsum	NE (SH)	M 570 cm	Borkenhagen (2011)
7	1981-08-03	Süderoogsand	NE (SH)	U	Borkenhagen (2011)

* Gregorian date, (Julian date 1659-08-31); ** Danish newspaper *De Aalborgske allene privilegerede Jydske Efterretninger* of 18 August 1780, two whales of the nebbeval kind were caught near Wyk harbour; *** *Neue Hamburger Zeitung*, 28 August 1913.

Sperm whale (*Physeter macrocephalus* L. 1758)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1604	Pellworm	NE (SH)	2 M	Smeenk & Evans (2018)
2	1695-03	Mouth of River Eider	NE (SH)	M 58' (2 M espaced)	This paper*
3	1720-12-31	Wischhafen	R Elbe (NI)	M 60-70'	Smeenk & Evans (2018)
4	1723-12-03	Neuwerk	SW (NI)	18 M 70-60'	Smeenk & Evans (2018)
5	1738-01-24	Süderhöft, Eiderstedt	NE (SH)	3 M (1 M 48')	Smeenk & Evans (2018) ¹
6	1751-03-14	Horumersiel; Jadebusen Minsener Oldeoog	SW (NI)	3 M (1 M 54'3")	Smeenk & Evans (2018)
7	1759-12	Eiderstedt	NE (SH)	M 58'	Smeenk & Evans (2018)
8	1762-01	Schahörn/Neuwerk	SW (SH)	>2 M	Smeenk & Evans (2018)
9	1969-04-03	Westerhever	NE (SH)	M 1610 cm	Smeenk & Evans (2018)
10	1984-11-22	Bremerhaven	SW (HB)	M 1750 cm	Meyer (1994)
11	1994-11-04	Baltrum	SW (NI)	M 1380 cm	Smeenk & Evans (2018)
12	1996-01-31	Norderney	SW (NI)	M 1600 cm	Smeenk & Evans (2018)
13	1997-12-04	Bremerhaven	R (Weser)	1 M	Smeenk & Evans (2018)
14	1997-12-04	Cuxhaven	SW (NI)	1 M 1300 cm	Smeenk & Evans (2018)
15	1998-01-23	Eiderstedt	NE (SH)	3 M (3 M escaped)	Smeenk & Evans (2018)
16	2002-01-15	Friedrichskoog	NE (SH)	3 M	Smeenk & Evans (2018)
17	2003-12-02	Norderney	SW (NI)	2 M	Smeenk & Evans (2018)
18	2011-11-14	Pellworm	NE (SH)	M 1500 cm	Smeenk & Evans (2018)

(Continued)

Appendix 1. (Continued.)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
19	2016-01-08	Wangerooge	SW (NI)	2 M (13.1 m; 11.8 m)	Ijseldijk <i>et al.</i> (2018a, 2018b)
20	2016-01-12	Helgoland	German Bight	M	Ijseldijk <i>et al.</i> (2018a, 2018b)
21	2016-01-12	Eversand	R (Weser)	M	Ijseldijk <i>et al.</i> (2018a, 2018b)
22	2016-01-13	Trischen	SW (NI)	M 10.7 m	Ijseldijk <i>et al.</i> (2018a, 2018b)
23	2016-01-31	Kaiser Wilhelmskoog	NE (SH)	8 M (10.2;10.5; 10.8; 11.0;11.2;11.3; 11.4;11.7)	Ijseldijk <i>et al.</i> (2018a, 2018b)
24	2016-02-03	Blauortsand Büsum	NE (SH)	2 M (11.4; 12.0)	Ijseldijk <i>et al.</i> (2018a, 2018b)

* The Danish monthly magazine *Maanedlig Relation om det Nyt som ere passeret oc fremkommet i May Maaned* for the month of May of the year 1695.

Minke whale (*Balaenoptera acutorostrata* Lacepede, 1804)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1669-05-15*	Lesum	R Weser	F 840 cm (29')	de Vries & Focken (1881) TL given in Goethe, 1983 (20') corrected
2	1830s	Hooksiel	SW (NI)	U 9 m	Wiepken & Greve (1876) Species corrected
3	1851-08	Nordstrandischmoor	NE (SH)	U 959 cm (30½')	This paper**
4	1932-03-25	Groden near Cuxhaven	SW (NI)	F 600 cm 6 t	Species in Mohr (1935) corrected
5	1971-05-10	German Bight	NE (SH)	F	Specimen in Kiel
6	1984-12-11	Neuwerk	SW (NI)	F 450 cm 3700 kg	Stede (1994)
7	1989-07-26	Bensersiel	SW (NI)	F 450 cm	Meyer (1994)
8	1992-08-18	Hallig Hooge	NE (SH)	U 870 cm	Specimen kept in Kiel
9	1995-04-19	German Bight	NE (SH)	M	Specimen kept in Kiel
10	1995-06-09	Amrum	NE (SH)	U	Specimen kept in Kiel
11	1996-07-15	St Peter Ording	NE (SH)	F	Specimen kept in Kiel
12	1996-12-21	Kaiser Wilhelmskoog	NE (SH)	F	Specimen kept in Kiel
13	2000-07-15	Kampen, Sylt	NE (SH)		Specimen kept in Kiel
14	2001-10-23	Juist	SW (SH)	F 920 cm 3360 kg	Beichle <i>et al.</i> (2005)
15	2012-08-07	Hindenburgdamm, Sylt	NE (SH)	F 6 m	This paper
16	2017-12-06	Cuxhaven	SW (NI)	M 700 cm 3000 kg	This paper

* Julian date 1669-05-08; ** *Neue Hamburger Zeitung*, 01-09-1915.

Sei whale (*Balaenoptera borealis* Lesson, 1828)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1955-03-25	Norderney	SW (NI)	U 7 m	Goethe (1983)
2	2016-12-27	Blexen	R (Weser)	M 750 cm	This paper

Fin whale (*Balaenoptera physalus* (Linnæus, 1758))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1827-10-31	List, Sylt	NE (SH)	U 21 m (70')	Borkenhagen (2011)
2	1829-01	List, Sylt	NE (SH)		Borkenhagen (2011)
3	1843-12-02	Lister Tief, Sylt	NE (SH)		Borkenhagen (2011)
4	1849-11	Helgoland	German Bight	F 22.5 m (75')	This paper*
5	1870-11	Jadebusen	SW (NI)	U 18 m	Goethe (1983)
6	1870-12	Juist	SW (NI)	U 18 m	Goethe (1983)
7	1882-03-02	Dorum, Cuxhaven	SW (NI)	U 24 m (80')	This paper**
8	1882-03-13	Duhnen, Cuxhaven	SW (NI)	U 25.5 m (85')	This paper***

(Continued)

Appendix 1. (Continued.)

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
9	1888	Großflie, Sylt	NE (SH)	U 15 m	Borkenhagen (2011)
10	1911	Sylt	NE (SH)	U	Mohr (1931)
11	1915-08	Amrum Riff	NE (SH)	U	This paper****
12	1918-11-28	Breitenfeld, Sylt	NE (SH)	U 25 m	Mohr (1931)
13	1930-11	Kniepsand Amrum	NE (SH)		Mohr (1931)
14	1944-02-08	Budjadingen	SW (NI)	F 20 m	Goethe (1983)
15	1946-03-20	St Peter Ording	NE (SH)		Schultz (1970)
16	1958-04-17	Jadewatt	SW (NI)	F 14 m 18.5 t	Goethe (1983)
17	1984-12-16	Hamburger Hallig	NE (SH)	F 2063 cm	Specimen 28910
18	1990-06-27	Tertius near Büsum	NE (SH)	M 1245 cm	Specimen 31432
19	1995-02-07	Wenningstedt, Sylt	NE (SH)	F 1730 cm	Borkenhagen (2011)
20	2001-06-02	Hörnum, Sylt	NE (SH)	M 15 m	Borkenhagen (2011)
21	2005-09-21	Außenelbe Rede	R Elbe	F 14 m 15 t	Borkenhagen (2011)
22	2006-08	30 km NW Neuwerk	German Bight	M 17 m 26.5 t	Borkenhagen (2011)
23	2012-09-23	Juist	SW (NI)	U	This paper

* Archival evidence: a letter by F.M. Claudius (1822–1869) to J.H. Blasius (1809–1870) dated 28 August 1857 refers to this incident as a stranding of *Pterobalaena vulgaris* which is a junior synonym of *Balaenoptera physalus*; Newspaper *Deutsche Allgemeine Zeitung*, Leipzig, 9-12-1849); ** *Berliner Tageblatt* 02-03-1882; *** *Altonaer Nachrichten* 15-03-1882; **** *Neue Hamburger Zeitung* 01-09-1915.

Blue whale (*Balaenoptera musculus* (Linnæus, 1758))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1881-06-26	Rantum, Sylt	NE (SH)	F 1525 cm	Möbius (1885)

Humpback whale (*Megaptera novaeangliae* (Borowskii, 1791))

Record no	Date	Locality	Subarea	Sex, TL and TW	Validation
1	1824-11	Vogelsand	R (Elbe)	M 11.6 m (37')	Mohr (1931)
2	1991-04-15	Jade	SW (NI)	W 690 cm	Meyer (1994)
3	1994	54;20.8 N, 6;50.5 E	German Bight	F > 10 m	Stede <i>et al.</i> (1996)