

# Strandings of Beaked Whales (Ziphiidae) in Galicia (NW Spain) between 1990 and 2013

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*In the coast of Galicia an average of 200 stranded cetaceans are reported annually. From 1990 to 2013, 21 individuals of four species of the family Ziphiidae were found: 15 Cuvier's beaked whales (Ziphius cavirostris), two Sowerby's beaked whales (Mesoplodon bidens), one True's beaked whale (Mesoplodon mirus) and one Blainville's beaked whale (Mesoplodon densirostris), as well as two unidentified ones. These were the first records in Galicia for True's beaked whale and Blainville's beaked whale. The study of the distribution of oceanic species considering only stranded animals has limitations, but is a good approach to this not well-known cetacean family. Due to the small number of individuals of the different species, statistical analyses for geographic or seasonal patterns were only carried out for the Cuvier's beaked whales. Between the periods of 1990–2002 and 2003–2013 significant differences were found for geographic and seasonal occurrence patterns. Over the last decade strandings were located only in the north area of the region, mainly during the spring season, while in the previous decade they were located along the three considered areas and only in autumn and winter.*

**Keywords:** Beaked whale, Ziphiidae, *Mesoplodon*, *Ziphius*, Iberian Peninsula, distribution, cetacean, strandings

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## INTRODUCTION

Stranded cetaceans have been an important source of information on the species distribution over time and they have also been the main way to obtain samples used for natural history and conservation studies of these species. Technological advances have led to the use of other sampling methods and new field studies have been developed, such as acoustic, satellite tracking or diving behaviour, but strandings can be a good approach for local species diversity and distribution studies (Pyenson, 2011) and above all for little-known species, such as the family Ziphiidae (MacLeod *et al.*, 2006). Beaked whales are medium-sized cetaceans, all live in open oceans and feed on deep-water squid and fish (Mead, 2009). As extreme divers, the Cuvier's beaked whale *Ziphius cavirostris* (Cuvier, 1823) has the mammalian dive record of 2992 m and 137.5 min (Schorr *et al.*, 2014). The family has a wide-ranging distribution around the world, from both ice edges to the equator, but knowledge of the 21 recognized species of beaked whales varies greatly due to the limited information about some of them (Dalebout *et al.*, 2004; MacLeod *et al.*, 2006). Cuvier's beaked whale is the most widely distributed beaked whale species in the Atlantic (Ross, 1984; MacLeod *et al.*, 2004, 2006; Otley *et al.*, 2012; Bachara & Norman, 2013); together with the Sowerby's beaked whale

*Mesoplodon bidens* (Sowerby, 1804), the Blainville's beaked whale *Mesoplodon densirostris* (Blainville, 1817), the Gervais' beaked whale *Mesoplodon europaeus* (Gervais, 1855) and True's beaked whale *Mesoplodon mirus* (True, 1913) they have a regular occurrence in the North Atlantic and therefore they have a potential distribution in the studied area (MacLeod, 2000; Pitman, 2009).

In Galicia (NW Spain) stranded cetaceans, seals and sea turtles are found each year (López *et al.*, 2002, 2014). The most frequent families of cetaceans are Delphinidae, Phocoenidae, Balaenopteridae and Physeteridae, although less frequent individuals of Kogiidae and Ziphiidae are also found – they are classified as rare species because they represent less than 1% of total stranding records (López, 2003). Only three individuals of the family Ziphiidae have been reported in the literature before 1990 for this area, all of them Cuvier's beaked whales (Penas-Patiño & Piñeiro, 1989). Nevertheless, the skull of one of them located in a beach in Fisterra in 1983 and conserved in the Osteological Collection of the Marine Mammal Section of the Sociedade Galega de Historia Natural (MA0285A01) in Ferrol (Spain) has been identified as a Sowerby's beaked whale (I. Miján and J. I. Díaz, personal communication). Three other Cuvier's beaked whales stranded in 1990, 1991 and 1995 have been reported in two diet studies (González *et al.*, 1994; Santos *et al.*, 2001a) and one more stranded in 1998 was cited by Covelo & Martínez (2001).

The aim of this work is: (i) to analyse the strandings from 1990 to 2013 in order to know the Ziphiidae species that have been registered in the area and their frequency, and

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(ii) evaluate the seasonal and geographic patterns of occurrence of the strandings.

## MATERIALS AND METHODS

### Study area

Galicia is an autonomous region located in NW Spain (Figure 1), with a coastline of 1195 km from  $41^{\circ}52'N$   $008^{\circ}52'W$  to  $43^{\circ}33'N$   $007^{\circ}02'W$  at the north-east Atlantic Ocean. This area has the influence of winds from south and south-west in autumn and winter, but in spring and summer it changes because of the northward displacement of the Os Açores High that promotes northerly winds, inducing a high primary productivity due to the coastal upwelling process, that typically occurs between March and September (Fraga, 1981; Ríos *et al.*, 1992; Figueiras *et al.*, 2002), although some upwelling events have been reported for autumn and winter (Álvarez *et al.*, 2012).

### Data collection and analysis

A stranding network was established in Galicia in 1990 and carried out by NGO Coordinadora para o Estudo dos Mamíferos Mariños (CEMMA), in order to locate stranded cetaceans, pinnipeds and sea turtles, ensuring the biological samples collection and the rehabilitation actions for live

animals. Basic data recorded includes species, location, biometrics, sex identification, body condition and external examination for each animal. Photographs were also obtained. Necropsies were carried out on fresh and moderate decomposed animals. Both external studies and necropsies followed standardized protocols (Kuiken & García, 1991; Geraci & Lounsbury, 1993; SEC, 1999). In order to compare and evaluate spatial patterns along the Galician coast, the coastline was divided in three areas of similar length for the data analysis (Figure 1): North coast (from Eo River estuary to Mugardos), North-west coast (from Ares to Punta Couso (Ribeira)), and South coast (from Punta Couso (Ribeira) to Miño River estuary). Due to the reduced number of individuals data were grouped by season to study seasonal patterns into winter (January–March), spring (April–June), summer (July–September) and autumn (October–December). Chi-squared tests were used to study two hypotheses, that strandings do not differ between (i) the three areas and (ii) the four seasons along the year. To study the possible pattern of changes over time, the analysis was carried out for the whole dataset (from 1990 to 2013) and between two time periods: 1990–2002 and 2003–2013.

## RESULTS

Between 1990 and 2013 a total of 4646 stranded cetaceans were recorded by the Galician stranding network. Of them,

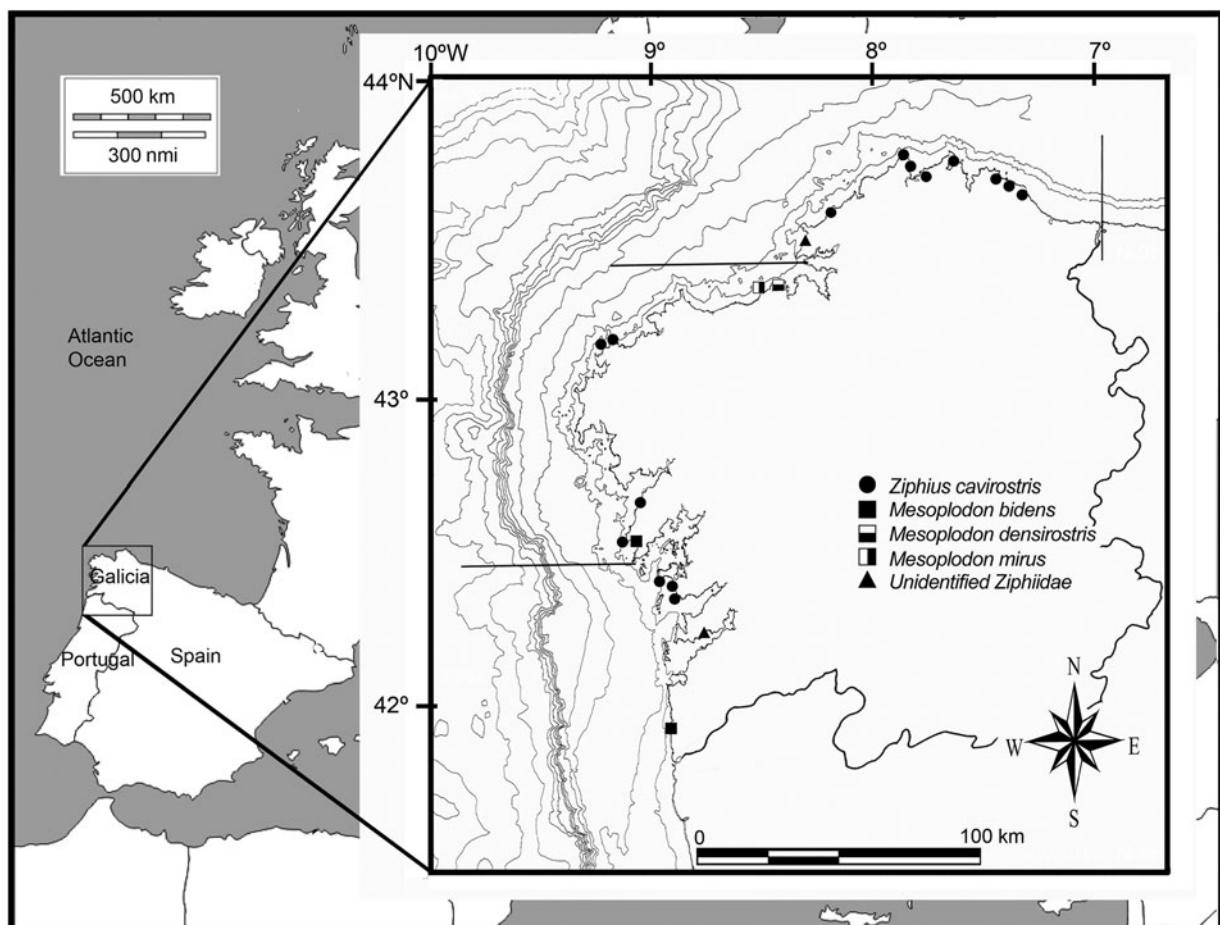


Fig. 1. Beaked whales stranded in the coast of Galicia between 1990 and 2013.

21 (0.45%) belonged to the Ziphiidae family: 15 Cuvier's beaked whales, two Sowerby's beaked whales, one Blainville beaked whale, one True's beaked whale and two unidentified animals, Table 1, Figure 1. Ten animals were found at the North area, six at the Northwest area and five at the South area. The Cuvier's beaked whale found in Vares on 1 October 1998 is not considered for monthly analysis as the skull was recovered by fishermen from the bottom of the sea, so the real stranding date is unknown. The number of strandings was higher in October, February, March and April, and there were no records for any species in the summer season (July–September) (Figure 2). None of the animals had signs of interaction with fishing gear or bycatch.

### Cuvier's beaked whale

Of the 15 individuals reported (71.4% of the Ziphiidae), five were males between 510 and 572 cm, six were females between 450 and 650 cm and the sex could not be determined for four individuals. Nine individuals were found in the North area, three in the North-west area and other three in the South area (Figure 1), but the distribution did not differ significantly between the areas ( $\chi^2 = 4.80$ , d.f. = 2,  $P = 0.090$ ). The months with more strandings were February and April, with no records between July and September (Figure 2). When strandings are grouped by season, differences were found to be not statistically significant ( $\chi^2 = 6.00$ , d.f. = 3,  $P = 0.112$ ). In contrast, if records are grouped into two time periods (1990–2002 and 2003–2013) to study geographic or seasonal pattern changes over time, the geographic distributions differ significantly ( $\chi^2 = 8.76$ , d.f. = 2,  $P = 0.013$ ) and they also differed significantly depending on the season ( $\chi^2 = 10.80$ , d.f. = 3,  $P = 0.013$ ). Between 1990 and 2002 strandings were recorded only in autumn and winter, and located along the three areas with similar values. Between 2003 and 2013 most of them were registered in spring and all of them in the North area (Figure 3).

### Sowerby's beaked whale

Only two individuals of this species were found (9.5% of the Ziphiidae): a male of 425 cm located in the North-west coast, and a female of 364 cm located in the South coast (Figure 1), both of them in the autumn period. The male complete skeleton was stored in the Osteological Collection of the Marine Mammal Section of the Sociedade Galega de Historia Natural, Ferrol (MA1004E00). With only two animals it is not possible to analyse seasonal and geographic patterns with statistical significance.

### True's beaked whale

Only one individual was found (4.8% of the Ziphiidae): a female of 497 cm located in the North-west coast (Figure 1) in the autumn period. The skull was stored in the Osteological Collection of the Marine Mammal Section of the Sociedade Galega de Historia Natural, Ferrol (MA0157E01).

### Blainville's beaked whale

Just one individual was recorded (4.8% of the Ziphiidae): a male of 436 cm located in the North-west coast (Figure 1) in the winter period. The complete skeleton was stored in the Osteological Collection of the Marine Mammal Section of the Sociedade Galega de Historia Natural, Ferrol (MA0158E00).

## DISCUSSION

The low number of strandings of individuals of the family Ziphiidae during the last 24 years confirm the sporadic presence of the species in Galicia that were reflected in previous reviews (Penas-Patiño & Piñeiro, 1989; López, 2003). It has to be considered that the present work focuses on stranded

Table 1. Beaked whales stranded in the coast of Galicia between 1990 and 2013.

Species	Date	Location	Sex	Length (cm)	Observations
<i>Ziphius cavirostris</i>	09/02/1990	A Lanzada, O Grove	M	510	Dead, unknown stage
Unidentified	04/10/1990	Moaña	I	N/A	Alive
<i>Ziphius cavirostris</i>	12/10/1990	O Trece, Camariñas	I	N/A	Skeletal remains
<i>Ziphius cavirostris</i>	19/01/1991	Con da Corva, O Grove	F	650	Dead, unknown stage
<i>Ziphius cavirostris</i>	16/02/1995	Portonovo, Sanxenxo	F	510	Dead, unknown stage
<i>Ziphius cavirostris</i>	01/10/1998	Vares, Mañón	I	N/A	Skull caught by a fishery boat
<i>Ziphius cavirostris</i>	23/11/2000	Fonforrón, Porto do Son	M	520	Advanced decomposition
<i>Mesoplodon mirus</i>	01/10/2001	Caión, A Laracha	F	497	Freshly dead
<i>Ziphius cavirostris</i>	10/02/2002	Foz, Foz	F	450	Freshly dead
<i>Mesoplodon densirostris</i>	07/03/2002	Barrañán, Arteixo	M	436	Freshly dead
<i>Ziphius cavirostris</i>	22/12/2002	Reira, Camariñas	I	–400	Advanced decomposition
<i>Ziphius cavirostris</i>	13/03/2004	Benquerencia, Barreiros	F	586	Advanced decomposition
<i>Ziphius cavirostris</i>	30/04/2004	O Rego, Valdoviño	F	570	Advanced decomposition
Unidentified	13/03/2008	Doniños, Ferrol	M	–188	Body remains
<i>Ziphius cavirostris</i>	13/06/2008	Basteira, Cariño	M	–500	Mummified remains
<i>Ziphius cavirostris</i>	14/04/2010	Basteira, Cariño	M	572	Advanced decomposition
<i>Ziphius cavirostris</i>	17/04/2010	Gaivoteira, Ortigueira	F	510	Advanced decomposition
<i>Ziphius cavirostris</i>	02/05/2010	Piñeira, Ribadeo	M	–500	Advanced decomposition
<i>Mesoplodon bidens</i>	26/11/2012	O Vilar, Ribeira	M	425	Alive, died after 2 h
<i>Ziphius cavirostris</i>	01/05/2013	Cubelas, Cervo	I	N/A	Advanced decomposition
<i>Mesoplodon bidens</i>	13/10/2013	Río de Ósos, Oia	F	364	Advanced decomposition

M: male. F: female. I: indeterminate sex. (–) means that the length is incomplete due to amputation or decomposition of the body.

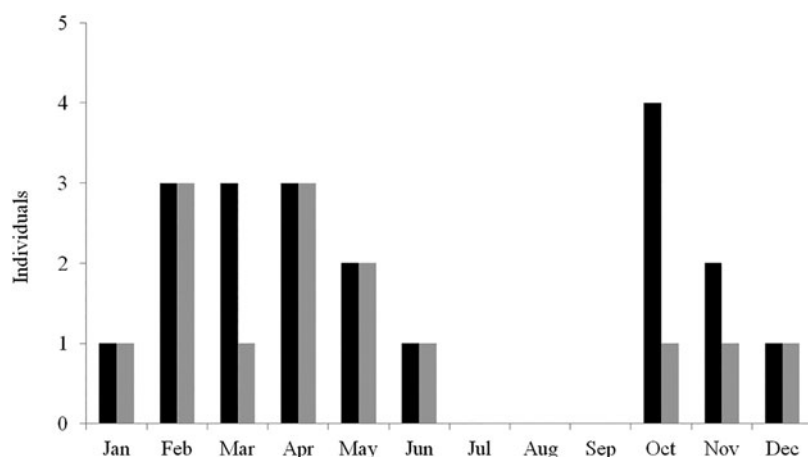


Fig. 2. Monthly distribution of the beaked whales strandings in the coast of Galicia between 1990 and 2013. Black: all the species ( $N = 20$ ). Grey: Cuvier's beaked whale ( $N = 14$ ).

animals, and therefore only the presence of the species can be studied. Different experiences carried out with offshore tagged dead dolphins proved that the stranding rate of the floating carcasses varied widely: 0% in South-west England (de Boer *et al.*, 2012), 8.0% in the Atlantic French coast (Peltier *et al.*, 2012) and 26.7% in the Galician coast with drifts between 27 and 320 km before getting ashore (Martínez-Cedeira *et al.*, 2011). Then it has to be considered that the absence of records does not mean that the species is not present in the area, as it could be possible that the dead animals did not reach the shore and are not recorded. In the case of the family Ziphiidae there are even some species that have never been seen alive in the wild and everything that is known about their distribution has been inferred from strandings (MacLeod *et al.*, 2006; Pitman, 2009). The presence of the two previously known species for the studied area (Cuvier's beaked whale and Sowerby's beaked whale) was confirmed

with new records, and two new species were found (True's beaked whale and Blainville's beaked whale). Although mass strandings are known for these species (Heyning & Mead, 2009; Pitman, 2009; Bachara *et al.*, 2014) all the records in the Galician coast were single-animal strandings. Beaked whales inhabit deep ocean waters (>2000 m deep) or continental slopes (200–2000 m) and are rarely seen over the continental shelf (Pitman, 2009), so they are not expected to be close to the Galician coast, where there is a continental shelf of 30–60 km (Fariña *et al.*, 1997). Therefore the stranded animals have been moved by currents or winds towards the coast and most of them presented in an advanced state of decomposition. Just two individuals (9.5% of total) stranded alive and one died on the same day.

### Cuvier's beaked whale

In Spain the first recorded individual was a male captured near Santander in the Cantabrian coast in 1893 (Cabrera, 1914). This has also been the most common beaked whale species in Galicia, with strandings all over the studied period and along the three considered areas. In the other areas of the East Atlantic, such as the coast of France, seasonal differences in strandings were described, with peaks in winter and spring (Robineau & di Natale, 1995; Smith, 2010). In UK and Ireland a similar pattern was found, with most strandings between winter and spring with peaks in January and July (MacLeod *et al.*, 2004; Smith, 2010; Rogan & Hernández-Milián, 2011). In Portugal there were few strandings, and then it was not possible to detect any seasonal trends (Sequeira, 1990; Ferreira *et al.*, 2012). However, some seasonal local migrations were suggested for the Cuvier's beaked whale and other beaked whales species in UK and Northern Sea from stranded animals (Santos *et al.*, 2001b; MacLeod *et al.*, 2004; Fernández *et al.*, 2014) and even higher migrations from southern areas were inferred in diet studies of the Cuvier's beaked whale (MacLeod *et al.*, 2004), and a sightings study in the Bay of Biscay proved that there is a seasonal northward movement from the south during spring through summer (Smith, 2010). In Galicia annually seasonal patterns were not observed with statistical significance, but there was never a stranding between July and September. Considering two periods (1990–2002 and 2003–2013) the seasonal and

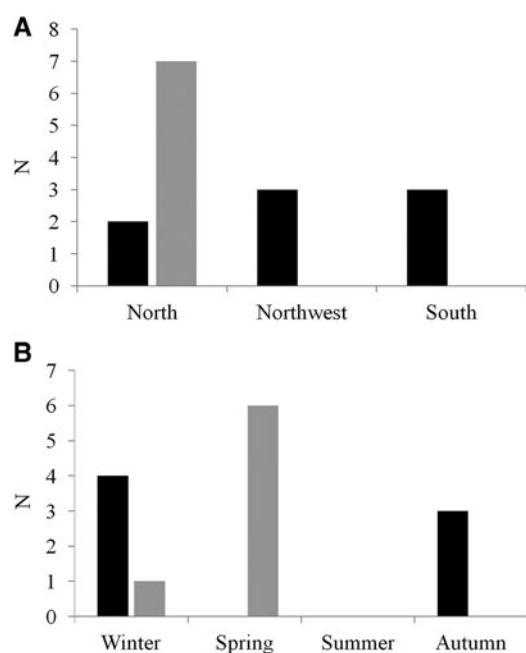


Fig. 3. Cuvier's beaked whales strandings by (A) geographic ( $N = 15$ ) and (B) seasonal distribution ( $N = 14$ ). Black: 1990–2002. Grey: 2003–2013.



geographic occurrence patterns changed with statistical significance along the years in the studied area. Between 1990 and 2002 the strandings were located along the three considered areas and only in autumn and winter, while in the last decade all the strandings were located in the north area and 85.7% in the spring period, when there is a prevalence of northern winds. It has been suggested that warming of local waters can lead to change in the local community of cetacean species (MacLeod *et al.*, 2005) and it is known that the water temperature has increased in the Mediterranean Outflow Waters that reach the Galician slope from the south by 0.020°C per year (González-Pola *et al.*, 2005) and has also increased in the Eastern North Atlantic Central Water in the central Bay of Biscay at a maximum rate of 0.11°C per decade (Gómez-Gesteira *et al.*, 2013), but the movement caused by warming does not seem to be the case of this species, since the Cuvier's beaked whale has a wide distribution from tropical to sub-polar waters (MacLeod *et al.*, 2006).

The maximum size for the species is 7 m, both for males and females, and the average length for sexual maturity is 580 cm for females and 550 cm for males (Heyning, 1989). Here, the larger animal recorded was a female of 650 cm and two of the stranded females and a male were adults.

### Mesoplodon species

The Sowerby's beaked whale is endemic to the North Atlantic and the majority of stranding records are from northern Europe, mainly from the British Isles (Mead, 1989). The record of this species in Galicia is not unexpected as some individuals had stranded in southern locations, such as Madeira (Maul & Sergeant, 1977), Azores (Bachara *et al.*, 2014), Portugal (Ferreira *et al.*, 2012), Andalucía (Bellido *et al.*, 2009) and the Canary Islands (Martín *et al.*, 2011). The two individuals stranded in the Galician coast in autumn, but no seasonal pattern can be inferred from just two records. In the closer areas they were found in different seasons: in Andalucía stranded in September (Bellido *et al.*, 2009), in the Canary Islands stranded in April (Martín *et al.*, 2011) and in Euskadi (N of Spain) in July (Bachara *et al.*, 2014). Both males and females can reach lengths of 5.5 m. Both individuals reported in this work are considered juveniles.

The True's beaked whale in the North Atlantic is distributed in temperate waters, and in the East Atlantic from Ireland to the Canary Islands (Vonk & Martin, 1988; Berrow & Rogan, 1997; MacLeod *et al.*, 2004, 2006; Brownell *et al.*, 2011). This is the first known record for Galicia, with the closest records being some sightings in the Bay of Biscay (Weir *et al.*, 2004). Two strandings have been reported in Cantabria region (N Spain) (Rey & Cendrero, 1980, 1981) but they have been considered as probably Cuvier's beaked whales in a recent review (Bachara *et al.*, 2014). The maximum size for both sexes is slightly over 5 m (Jefferson *et al.*, 1993), so the individual found at the Galician coast is considered an adult female. The total number of records from the northern hemisphere is only 58 (W. Bachara, personal communication).

The Blainville's beaked whale is the species with wider distribution of the genus *Mesoplodon* and it is thought to be continuous throughout the tropical, sub-tropical and warm-temperate waters of the world's oceans, with occasional occurrences in cold-temperate areas (MacLeod *et al.*, 2006). It was recorded before in areas near to Galicia, such as Portugal

(Sequeira, 1990) and Andalucía (Valverde, 1996; Bellido *et al.*, 2009). The maximum size for both sexes seems to be 4.7 m (Jefferson *et al.*, 1993). The individual stranded in 2002 was 436 cm long, with the arching jaw and two flattened tusks, which allow it be identified as a male. This was the first known record for Galicia.

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