

DISTRIBUTION, RELATIVE ABUNDANCE AND BATHYMETRIC PREFERENCES OF TOOTHED CETACEANS IN THE ENGLISH CHANNEL AND BAY OF BISCAY

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Introduction

Data on habitat utilization by pelagic cetaceans are generally difficult to collect. Such information is beneficial to most conservation and management purposes. Since the late 1990s, platforms of opportunity have been intensively used to monitor cetacean populations, notably in terms of distribution, relative abundance and habitat preferences, in many areas of the world (Smeenk *et al.*, 2002; Fletcher & Curtis, 1999; Hammond & Williams, 2003). In this context, we used data from 1998 to 2002 collected during ferry-based surveys conducted in the English Channel and Bay of Biscay. The aims of this study are to assess distribution, relative abundance and bathymetric preferences of toothed cetaceans encountered during this period.

Material and methodology

The data were collected using two ships, travelling from southern England to northern Spain (*Pride of Bilbao* and *Val de Loire*). The survey lines cross several habitat types: the continental shelf, the shelf edge and the abyssal plain (Figure 1 and 1'). A standardised protocol was applied to permit a complete collection of data, consisting in position of the sightings, species encountered, mean group size, and behaviour.

Figure 1 and 1': Position of the two used ferry-lines (*in* Cresswell & Walker, 2001), and photograph of the *Pride of Bilbao*.

Data analysis

The study area was divided into three sub-areas i.e. the **English Channel and Celtic Sea** (north of 47°30'), the **northern Bay of Biscay** (47°30'/45°30') and the **southern Bay of Biscay** (45°30'/43°30'), in order to determine differences in occurrence of species (diversity, occurrence) throughout the Bay. Occurrence and relative abundance were defined as:

Occurrence = Number of encounters (N) / 100 NM; **Relative abundance** = Number of individuals (n) / 100 NM.

Diversity (Shannon index) was calculated for the whole area, and for each sub-areas using. This index integrate both specific diversity and the quantitative contribution of each species (Frontier et Pichod-Viale, 1998):

$$H' = - \sum p_i \log_2 p_i$$

Where P_i is: the relative abundance of each species.

All species were used to assess diversity within the Bay and English Channel. Only seven of the most frequently recorded species were used to assess relative abundance and bathymetric preferences. The other species (i.e Risso's dolphin, northern bottlenose whale, mesoplodon *sp.*, false killer and killer whales) were relatively rare and the number of encounters too low to consider further. Positions of sightings data were assigned values for depth using ArcGIS 8.2 software. Maps distribution and relative abundance were produced with the same software.

Results

Survey effort

From 1998 to 2002, 147 surveys were accomplished, totalling **17,872.5** nautical miles (NM), conducted mainly during the summer months and in the Bay of Biscay (July-September, Figure 2 and 3). Each surveys was highly variable in the number of NM made (min.=5; max.=288; $\mu=119.4$; ± 53.5).

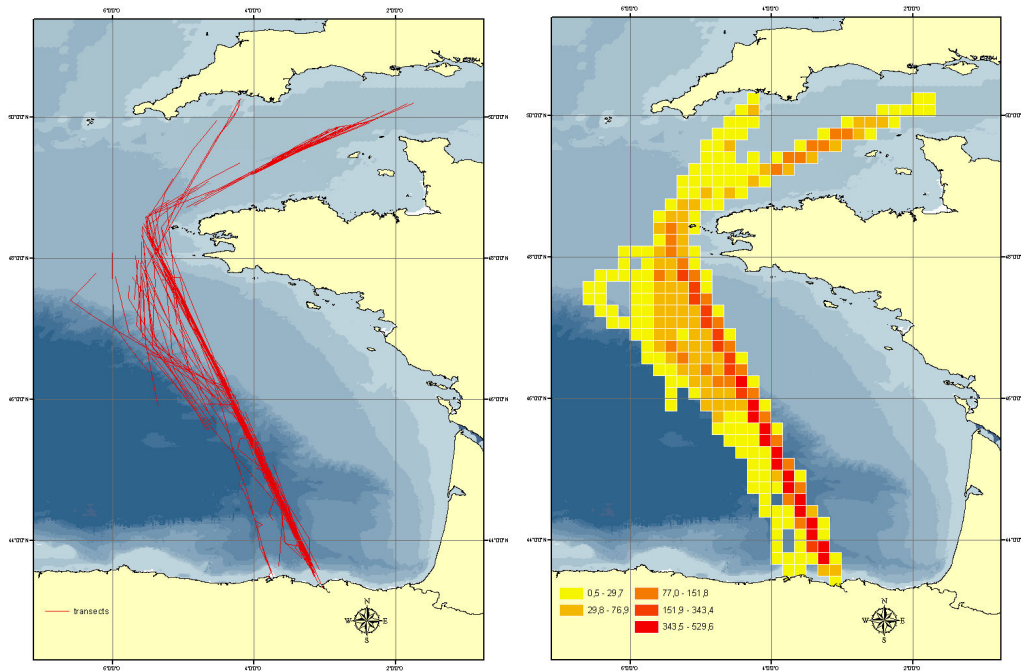


Figure 2 : Survey effort carried out from 1998 to 2002 in the English Channel and Bay of Biscay. The right figure represents effort in 20 nautical mile quadrats (400NM^2)

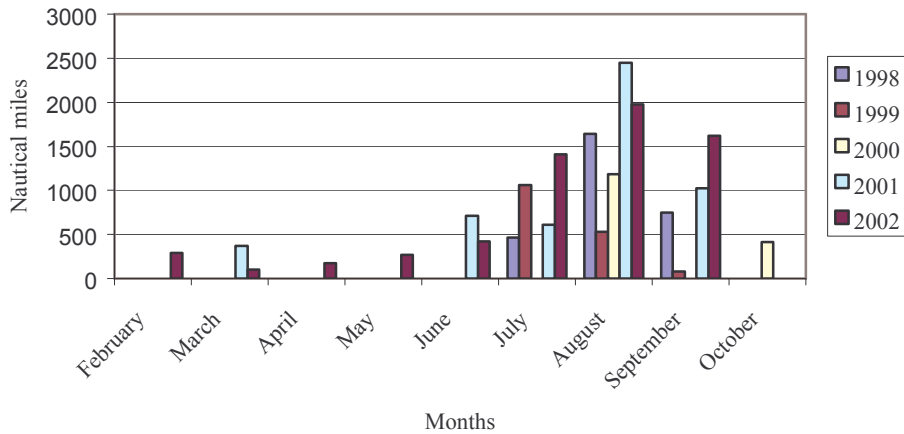


Figure 3: The survey effort per month and year between 1998 and 2002 on both ferry-lines.

A total of **1,008** sighting of single species odontocete groups were recorded between 1998 and 2002, with an estimated number of **20,481** individuals of thirteen species. Numbers of sightings and individuals for each species are given in Table 1.

Table 1: Numbers and percentages of sightings and individuals for each species.

Species	N sightings	N individuals	% sightings	% individuals
<i>Delphinus delphis</i>	329	11,297	32.6	55.3
<i>Stenella coeruleoalba</i>	187	6,103	18.5	29.9
<i>Globicephala melas</i>	134	895	13.3	4.4
<i>Tursiops truncatus</i>	110	1,536	11	7.4
<i>Phocoena phocoena</i>	114	313	11.3	1.5
<i>Ziphius cavirostris</i>	60	146	6.1	0.6
<i>Physeter macrocephalus</i>	42	68	4.2	0.3
<i>Grampus griseus</i>	14	58	1.2	0.3
<i>Hyperoodon ampullatus</i>	9	32	0.9	0.2
<i>Orcinus orca</i>	5	16	0.5	0.07
<i>Pseudorca crassidens</i>	2	13	0.2	0.06
<i>Mesoplodon bidens</i>	1	3	0.1	0.015
<i>Mesoplodon mirus</i>	1	1	0.1	0.005
TOTAL	1,008	20,481	100	100

Spatial differences in diversity and occurrence of odontocetes

Thirteen odontocetes were encountered in the study area, of which six were encountered in the English Channel and Celtic Sea area, eleven in the northern Bay of Biscay, and twelve in the southern Bay. Shannon index value is **1.69** for the whole area, **0.57** for the English Channel and Celtic Sea area, **1.3** for the northern Bay of Biscay, and **0.88** for the southern Bay. These results show that diversity is higher in the northern Bay of Biscay, and decreases for the southern Bay and the English Channel sectors, respectively (even the southern Bay sectors is characterised by a bigger number of recorded species).

Proportions of occurrences varied significantly according to the sub-areas, as showed in the Figure 4. The proportion of occurrence shows, for each sub-areas, the relative importance of occurrence for each species (example: occurrence of the harbour porpoise is 0.49 encounters per 100 NM in the English Channel. It represents 50% of the occurrence of all cetaceans species).

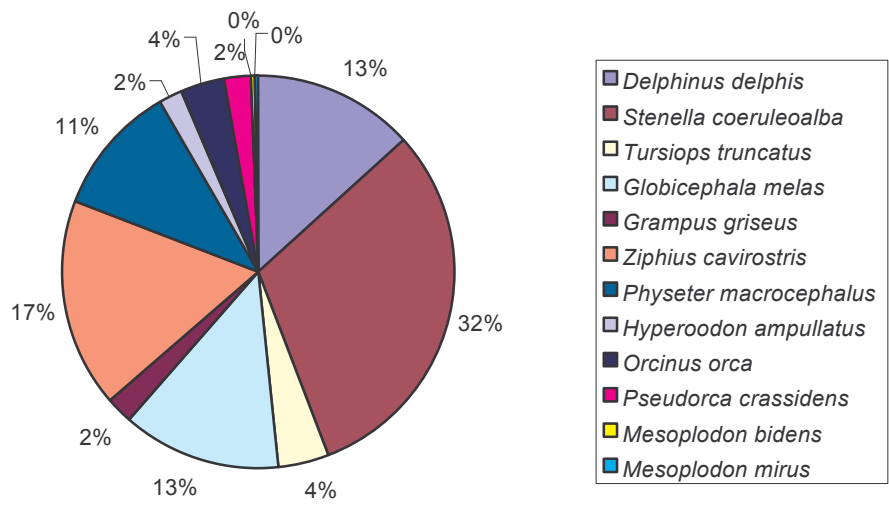
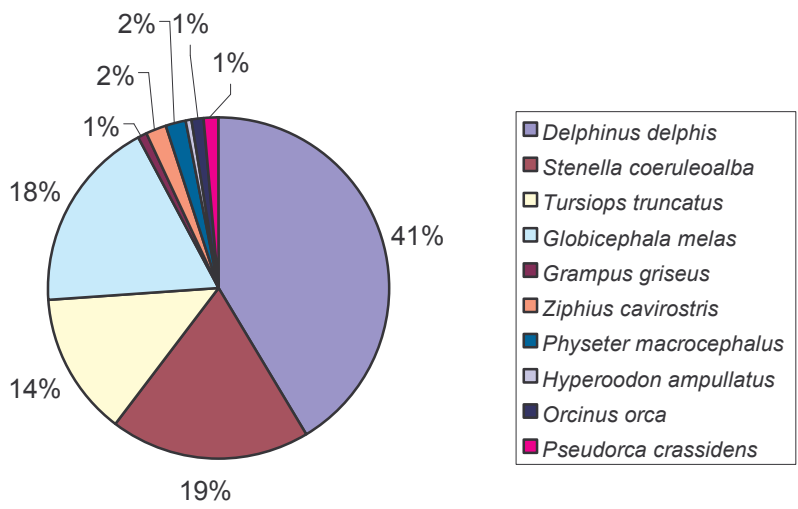
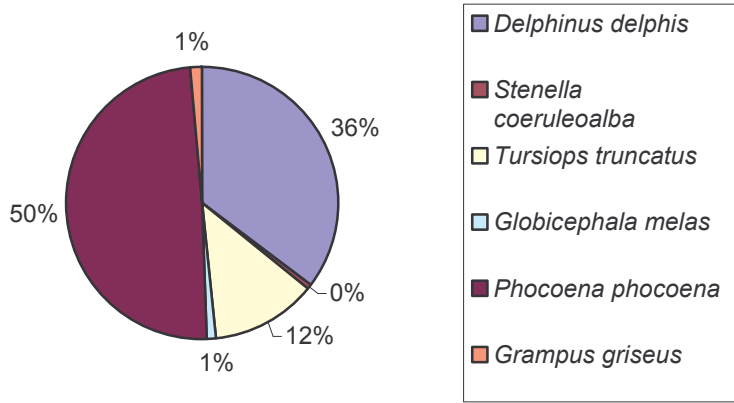


Figure 4: Proportions of cetacean occurrences for each sub-area (**top:** English Channel; **middle:** northern Bay of Biscay; **bottom:** southern Bay of Biscay).

The English Channel and the Celtic Sea is dominated by two main species, *e.g.* the harbour porpoise and common dolphin. Conversely, the northern Bay of Biscay was dominated by the common dolphin, the striped dolphin, the pilot whale and the bottlenose dolphin. The southern Bay was different from both sub-areas, with a predominance of the striped dolphin, the Cuvier's beaked whale and the other large odontocetes (mainly squid feeders).

Distribution, relative abundance and bathymetric preferences

The **harbour porpoise** is restricted to the English Channel and the western approaches. It is a typical neritic species, with a preference for waters of the continental shelf [μ (mean depth of encounters)=151 meters; SD=402; min=78, max=3,941).

The **common dolphin** showed a wide distribution, throughout the study area, with higher values in the northern Bay of Biscay, both over the continental shelf (37.7% of sightings), shelf-edge, and in deep oceanic waters ($\mu=1,1315\text{m}$; SD=1,347; min=67; max=4,385).

The **striped dolphin** is an oceanic delphinid, occurring in deep oceanic waters of the central and southern Bay of Biscay ($\mu=3,171\text{m}$; SD=1,024; min=136; max=4,421).

The **bottlenose dolphin** is a species occurring mainly over the continental shelf in the northern Bay of Biscay ($\mu=714$; SD=967; min=60; max=3,920), but also in deep oceanic waters (20.9% of sightings off the 2,000 isobath).

The **long-finned pilot whale** is a typical oceanic odontocete species, occurring in the central and southern Bay of Biscay, both over the shelf edge and deep waters (>2,000 meters: 57% of the sightings; $\mu=2,367\text{m}$; SD=1,309; min=103; max=4,237).

The **Cuvier's beaked whale** is the commonest beaked whale species in the Bay of Biscay, inhabiting deep oceanic waters of the southern Bay (93.8% of the sightings >2,000 meters depth; $\mu=3,147\text{m}$; SD=747; min=685; max=4,259). In the area, deep submarine canyons (Torrelavega and Santander canyons) were characterised by high sighting rates.

The **sperm whale** is a regularly sighted species in deep oceanic waters of the central and southern Bay of Biscay, but regularly occurring over the shelf edge ($\mu=3,168$; SD=774; min=1,185m; max=4,195).

Discussion and conclusion

This study shows the French Atlantic is a very important area for toothed cetaceans, with high relative abundance and diversity. Its geographic position, between cold and warm temperate waters, probably is an important contributor to this fact. The wide variety of potential habitats for odontocetes may also explain this diversity. In fact, we find both typical shallow water species (harbour porpoise), “intermediary species”, using different bathymetric ranges (common and bottlenose dolphins), and deep oceanic species (striped dolphin, pilot whales, beaked and sperm whales).

Now, to understand the habitat and population characteristics of toothed cetaceans in the French Atlantic, it is necessary to consider other environmental variables than depth, such as salinity, SST, chlorophyll-a and prey distribution. This could help to define conservation and management strategies for these species, severely threatened by fishing activity (both biological and operational interactions).

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