Current knowledge of the cetacean fauna of the Greek Seas

A. FRANTZIS[*+], P. ALEXIADOU[*], G. PAXIMADIS[*], E. POLITI[#], A. GANNIER[**] and M. CORSINI-FOKA[++]

Contact e-mail: afrantzis@otenet.gr

ABSTRACT

From 1991-2002 data on the presence and distribution of cetaceans in the Greek Seas have been systematically collated in a database (821 sightings and 715 strandings). Data originated from dedicated surveys, stranding reports, opportunistic sightings and published or unpublished photographic and video documents. Twelve cetacean species have been recorded. Seven of them are permanently present and commonly observed in one or more of the Greek Seas: striped dolphin, common bottlenose dolphin, short-beaked common dolphin, Cuvier's beaked whale, sperm whale, Risso's dolphin and fin whale. In addition, the harbour porpoise is present locally in the Thracian and northern Aegean Seas. The humpback whale, false killer whale and common minke whale are occasional Mediterranean species that were sighted or stranded infrequently; the Sowerby's beaked whale is an accidental species that was found floating dead only once. Five other species (white whale, Blainville's beaked whale, long-finned pilot whale, killer whale, blue whale) have been erroneously included in the Greek cetacean fauna in the past due to wrong assumptions, false identifications or lack of supporting evidence. The occasional occurrence of pilot and killer whales in the Greek Seas should still be regarded as unconfirmed. The distributional range, stranding numbers and sighting frequencies of sperm whales, Cuvier's beaked whales and short-beaked common dolphins in the Greek Seas indicate that their local 'sub-populations' are among the most important in the entire Mediterranean Sea. Harbour porpoises in the Thracian and northern Aegean Seas are important from a conservation perspective since this species does not inhabit any other part of the Mediterranean Sea.

KEYWORDS: MEDITERRANEAN; EUROPE; DISTRIBUTION; SURVEY-COMBINED; INCIDENTAL SIGHTINGS; STRIPED DOLPHIN; COMMON BOTTLENOSE DOLPHIN; SHORT-BEAKED COMMON DOLPHIN; CUVIER'S BEAKED WHALE; SPERM WHALE; RISSO'S DOLPHIN; FIN WHALE; HARBOUR PORPOISE; FALSE KILLER WHALE; HUMPBACK WHALE; COMMON MINKE WHALE; SOWERBY'S BEAKED WHALE

INTRODUCTION

The Greek Seas include the eastern Ionian, Aegean, Cretan and northwest Levantine Seas as well as the northern Cretan Passage between Crete Island and North Africa (Fig. 1). These seas occupy the northern part of the eastern Mediterranean (roughly between 35°-41°N and 19°-30°E) and are characterised by: (1) pronounced oligotrophy in most of their range; (2) highly irregular and very long coastlines (> 15,000km) that account for one third of the total Mediterranean coastline; (3) almost 10,000 islands and islets; (4) some extended plateaux; and (5) steep underwater relief of depressions and trenches reaching a maximum depth of 5,121m (Stergiou *et al.*, 1997). This rich geomorphology creates a variety of marine ecosystems and potential habitats for various cetacean species. Nevertheless, until recently the Greek Seas have been seen only as part of the oligotrophic eastern Mediterranean basin — considered poor in terms of its cetacean fauna (Marchessaux, 1980; Viale *et al.*, 1988; Notarbartolo di Sciara and Demma, 1997). This general view was not based on data, since no dedicated surveys were made in this part of the Mediterranean (Notarbartolo di Sciara and Gordon, 1997) before those described in this study.

Although Aristotle (345 BC [1994a; b]) was the first to study and classify cetaceans (he did so in the Aegean Sea), little further interest in his research was expressed until the early 1980s. Due to the absence of any commercial exploitation and the lack of significant scientific interest from naturalists, extremely few skeletal materials exist in museum collections and no records of origin are available in most cases. The first 'modern' studies with references to cetaceans of the Greek Seas were based on the few historical or anecdotal stranding records, the rare museum material and a few opportunistic sightings that were often second hand and difficult to confirm (Marchessaux, 1980; Pilleri and Pilleri, 1982; 1987; Kinzelbach, 1985; 1986a; b; 1991). Occasional efforts to record cetacean strandings along the Greek coasts started in the late 1980s, however, the establishment of a national stranding network did not occur until the end of 1991 (Frantzis, 1997). The first systematic efforts to explore the cetacean fauna of the Greek Seas *in situ* started in 1991 and 1993, by two independent teams that surveyed parts of the Ionian (Politi *et al.*, 1994) and Aegean Seas (Carpentieri *et al.*, 1999). Some additional studies were stimulated by the die-off that affected Mediterranean striped dolphins when the epizootic reached the Greek Seas in summer 1991 (Aguilar and Raga, 1993; Cebrian, 1995). Although those studies gave a useful first picture of cetacean presence in the Greek Seas (Cebrian and Papaconstantinou, 1992; Androukaki and Tounta, 1994), they were mostly based on reports made by unskilled observers and have since been shown to contain erroneous species identifications (Frantzis, 1997).

There are several references to cetacean presence and distribution in the western and central parts of the Mediterranean Sea, however, the literature covering the eastern basin is scarce (Notarbartolo di Sciara and Gordon, 1997). Recent studies have shown that important population units of cetacean species that are the subject of conservation priorities for the entire Mediterranean Sea (ACCOBAMS, 2002) are found within the Greek Seas (Politi *et al.*, 1999; Frantzis *et al.*, 1999; 2001). The Agreement on the Conservation of the Cetaceans of the Black Sea,

[*] *Pelagos Cetacean Research Institute, Terpsichoris 21, 16671 Vouliagmeni, Greece.*
[+] *National Centre for Marine Research, Agios Kosmas, 16604 Hellenikon, Greece.*
[#] *Tethys Research Insitute, Viale G.B. Gadio 2, 20121 Milano, Italy.*
[**] *Centre de Recherche sur les Cétacés, Marineland, 306 avenue Mozart, 06600 Antibes, France.*
[++] *National Centre for Marine Research, Hydrobiological Station of Rodos, Ko street, 85100 Rhodes, Greece.*

Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS) recommended that urgent measures are undertaken to address the status of those species and identify key areas containing critical habitats for them (ACCOBAMS, 2002). The aim of this paper is therefore to review current knowledge of the presence and distribution of cetacean species in the Greek Seas, and discuss preliminary information regarding their status and relative abundance.

DATA AND METHODS

Data collection

Over the last decade, all available data concerning the cetaceans of the Greek Seas have been systematically collated in a database. The sources for these data included dedicated surveys conducted by the authors, opportunistic sightings, stranding reports from stranding networks, occasional stranding records previously published in the scientific literature, a few samples of skeletal material and published or unpublished photographic and video documents. Sightings from a previously published work on the cetaceans of the Aegean Sea (Carpentieri *et al.*, 1999) and all confirmed, first hand sightings found in the literature have also been included in the database, which totalled 1,536 records.

Surveys and sighting data

Eighteen dedicated surveys were organised during the summer and autumn months between 1991 and 2002. Survey length ranged from ten days up to three months and covered the eastern Ionian Sea, the sea area off southwest Crete, the Gulf of Corinth and to a lesser degree the Myrtoon Sea and the sea area between the Northern Sporades Islands and the Chalkidiki Peninsula (Figs 1, 2a). Ferries with standard routes were used as platforms of opportunity by Carpentieri *et al.* (1999) for their surveys in the Aegean and Cretan Seas. Conventional visual methods for detecting cetaceans were used in most survey areas. At least one experienced observer continuously scanned the sea surface, 180° in front of the vessel. Observers used binoculars intermittently and observations were interrupted when sea surface conditions reached sea state 3 (appearance of the first white caps). Sightings made at sea state ≥3 (when it is known that sighting efficiency for at least smaller cetaceans is poor) were not taken into consideration in the sighting frequencies calculated in this study. Geographic coordinates of the sightings were recorded with the aid of a Global Positioning System (GPS). Only the initial position of each sighting was considered, disregarding sighting duration or group-size changes, resulting in plots of one spot per sighting. Minimum distances from the closest coast and approximate bottom depths for all sightings were calculated *a posteriori*

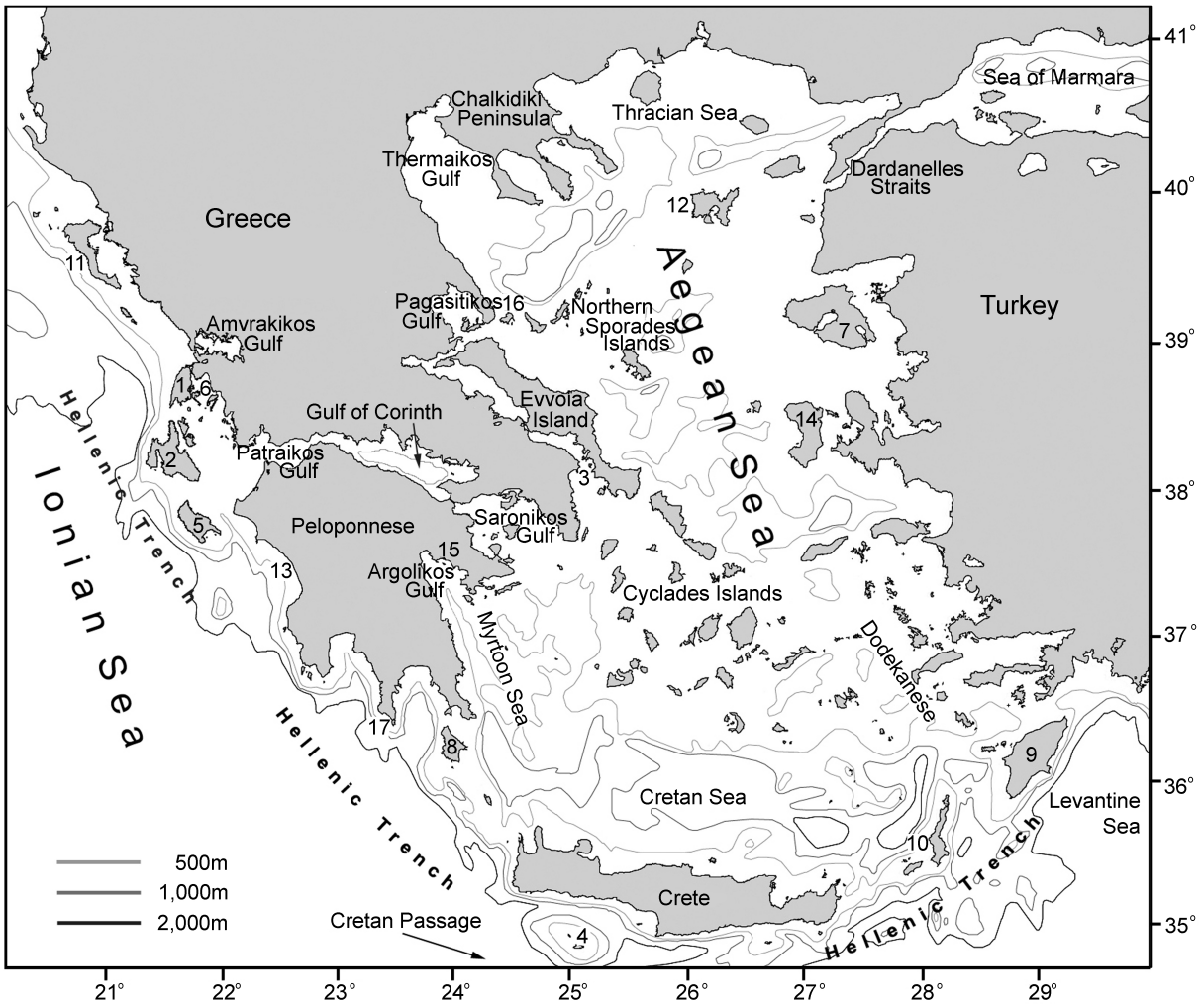

Fig. 1. Map of the Greek Seas showing their bathymetry and the locations cited in the text: (1) Lefkada Island; (2) Kefallonia Island; (3) South Evvoikos Gulf; (4) Gavdos Island; (5) Zakynthos Island; (6) Kalamos Island; (7) Mytilini Island; (8) Kythira Island; (9) Rodos Island; (10) Karpathos Island; (11) Corfu Island; (12) Limnos Island; (13) Kyparissiakos Gulf; (14) Chios Island; (15) Bay of Tolo; (16) Skiathos Island; (17) Gerolimenas.

by plotting the geographical coordinates of the sightings on bathymetric maps from the Hellenic Hydrographic Service. In surveys off southwest Crete, in the southeast Ionian Sea, in the northern Sporades-Chalkidiki area and Myrtoon Sea, joint acoustic and visual methods were used. A stereo towed hydrophone array was used to allow passive acoustic localisation of sperm whales. Opportunistic sightings recorded up to the end of 2002 in the Greek Seas have also been included in the database, when supported by photos or videos. Sightings from the core research area of a long-term study on short-beaked common dolphins and common bottlenose dolphins in the inner east Ionian Sea (Politi, 1998; Politi *et al.*, 1999) were not used, since the high numbers would have created a very significant geographical unbalance in the dataset.

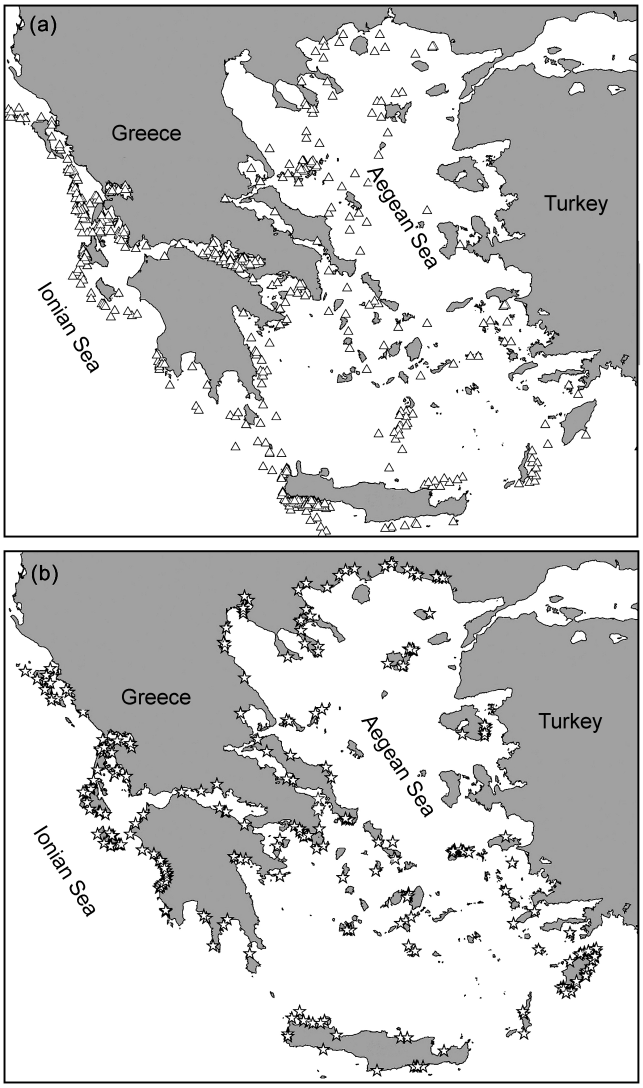

Fig. 2. Distribution of all identified cetacean sightings (a) and strandings (b) recorded in the Greek Seas. The higher density of sightings in some areas (a) is due to the larger effort during short or long-term dedicated surveys or while using ferries as platforms of opportunity.

Caution is due in the interpretation of the number of sightings recorded per species (Table 1) since data include both opportunistic sightings and results of dedicated surveys which used different methods (e.g. visual versus joint visual-acoustic surveys). In addition, some areas have been surveyed more intensively than others (Fig. 2a) for the known or expected, frequent presence of the targeted study species. As a result the number of sightings recorded per species is not directly indicative of the relative sighting frequencies per species in this study.

Strandings data

Strandings data (including floating carcasses and incidentally caught animals) were obtained mainly through a national network organised and coordinated by the National Centre for Marine Research and the Pelagos Cetacean Research Institute. The network's data cover the period September 1991-December 2001, and were derived from standardised forms completed by local port-police authorities. This network cannot be considered complete since the number of unreported strandings (from sources other than the network) is not negligible; this was particularly true during the first years of its existence. Therefore, stranding numbers have to be interpreted with some caution, since they may be biased in favour of the larger whales (mainly fin, sperm and to a lesser degree Cuvier's beaked whales), which are conspicuous and constitute 'exceptional' events of high interest when they strand. In addition, port-police and local veterinarians did not have the required knowledge to identify cetaceans to species as witnessed by the conflicts between the recorded species and the associated photos. The use of such erroneous data resulted in inaccurate results in older studies, therefore, all information coming from the network was initially considered with caution, except for the fact that a stranding did occur. After meticulous checking, stranding reports were classified as 'unidentified' if no visual documents (photos or videos) allowed reliable species identification – this applied to 63.3% of the total stranding network records. Unidentified animals were not homogeneously distributed among all species, and appeared to be exclusively the smaller delphinids (bottlenose dolphins, striped dolphins and short-beaked common dolphins). This is problematic given that they were actually the most abundant among strandings (Table 1).

In order to overcome this problem and reach a better approximation of the true situation, the category of unidentified small delphinids was split into common bottlenose dolphins, striped dolphins and short-beaked common dolphins according to the ratio 59:37:16 found among 112 identified stranded dolphins from 1996 to 2001 (Table 1). This seven-year period was selected for two reasons: (1) before 1996 and depending on the year, either the bottlenose dolphins or the short-beaked common dolphins or both species were not among identified strandings; and (2) the ratio among these species' strandings stabilised only after 1995. Previously it had been strongly altered in favour of striped dolphins due to the Mediterranean morbillivirus epizootic, which peaked in 1992 in Greece (Aguilar and Raga, 1993; Cebrian, 1995; Aguilar, 2000). Except for calculating new percentages for the occurrence of the small delphinid species among strandings from 1996 to 2001 (Table 1), the results of the above extrapolation were not used for any other analysis of strandings data (i.e. seasonal presence, monthly average, mass strandings and distribution maps). A total of 34 records from the period 1840 −August 1991 were also included in the database since they were accompanied by photos or were cited in credible scientific literature. The sex of stranded animals was determined only after examination *in situ* or when good photos of the genital area were available. Data on total lengths were retained only if taken by specialists *in situ*, or by local authorities guided by our instructions. Strandings data refer to number of animals stranded and not to stranding

Table 1

Number of sightings and stranded animals per cetacean species. The 428 unidentified strandings concern the small delphinids: bottlenose dolphin, striped dolphin and short-beaked common dolphin (the latter to a lesser degree). The three unidentified cetaceans were probably Risso's dolphins according to the reports, but no photos were provided. Results marked with an asterisk have been extrapolated according to methods described in the text.

	Species	Sightings	Total stranded animals	Stranded animals					
				1840- Aug. 1991	Sept. 1991-2001		1996-2001	Extrapolated 1996-2001	
1	Striped dolphin	258	63	1	62	9.1%	37	115*	27.4%*
2	Bottlenose dolphin	224	65	1	64	9.4%	59	183*	43.6%*
3	Short-beaked common dolphin	68	17	-	17	2.5%	16	50*	11.9%*
4	Cuvier's beaked whale	53	86	13	73	10.7%	46	46	11.0%
5	Sperm whale	166	17	7	10	1.5%	8	8	1.9%
6	Risso's dolphin	21	22	6	16	2.3%	10	10	2.4%
7	Fin whale	27	8	5	3	0.4%	3	3	0.7%
8	Harbour porpoise	1	3	-	3	0.4%	3	3	0.7%
9	False killer whale	1	1	-	1	0.1%	-	-	-
10	Humpback whale	2	-	-	-	-	-	-	-
11	Minke whale	-	1	-	1	0.1%	1	1	0.2%
12	Sowerby's beaked whale	-	1	1	-	-	-	-	-
Total identified		821	287	34	250	36.7%	183	419*	99.8%*
Unidentified small delphinids			428	-	428	62.9%	236	0*	0.0%*
Unidentified cetaceans			3	-	3	0.4%	1	1	0.2%
Total		**821**	**715**	**34**	**681**	**100.0%**	**420**	**420**	**100.0%**

events (unless otherwise stated). A single factor ANOVA (Zar, 1984) was applied to test for the effect of the month on the recorded number of strandings. Statistical significance was set at $p = 0.05$.

RESULTS

Recorded species

Twelve cetacean species have been identified from a total of 821 sightings and 715 stranded animals (involved in 669 stranding events) recorded in the Greek Seas (Table 1). Seven of these species are permanently present and commonly observed in one or more of the Greek Seas: striped dolphin (*Stenella coeruleoalba*), common bottlenose dolphin (*Tursiops truncatus*), short-beaked common dolphin (*Delphinus delphis*), Cuvier's beaked whale (*Ziphius cavirostris*), sperm whale (*Physeter macrocephalus*), Risso's dolphin (*Grampus griseus*) and fin whale (*Balaenoptera physalus*). Among the remaining five species, the harbour porpoise (*Phocoena phocoena*) is restricted to a relatively small area; the humpback whale (*Megaptera novaeangliae*), the false killer whale (*Pseudorca crassidens*) and the common minke whale (*Balaenoptera acutorostrata*) are occasional Mediterranean species that have been sighted or stranded infrequently; and finally the Sowerby's beaked whale (*Mesoplodon bidens*) is an accidental species that has been recorded only once in the Greek Seas.

After checking the original data of some older studies, five more species were found to have been erroneously included in the Greek cetacean fauna in the past. Original photos showed that a stranded 'pilot whale' (Androukaki and Tounta, 1994) was actually a misidentified false killer whale. The same happened with a floating carcass of a supposed Blainville's beaked whale (*Mesoplodon densirostris*; Cebrian and Papaconstantinou, 1992), which was in fact a Sowerby's beaked whale according to the existing documents. Due to a wrong assumption, the white whale (*Monodon monoceros*) was referred to as accidental in the Greek Seas (Cebrian and Papaconstantinou, 1992). The authors thought that a specimen found along the coast of the Black Sea had previously crossed the Aegean Sea, however, later it became known that the whale had escaped from an Ukrainian dolphinarium in the Black Sea. The blue whale (*Balaenoptera musculus*) incorrectly appeared in editions, leaflets and posters of some public services, based on a single fisherman's report referring to a '30m long whale'. McBrearty *et al.* (1986) reported a sighting of a lone killer whale (*Orcinus orca*) in the Aegean Sea and a sighting of long-finned pilot whales (*Globicephala melas*) in southern Greece. One more killer whale sighting from the Aegean Sea exists in the literature as personal communication from McBrearty (Hammond and Lockyer, 1988). However, McBrearty's original data were destroyed some decades ago after he wrote his paper (Evans, pers. comm.). These data originated from individual observers who were not specialists (i.e. fishermen, yachtsmen, captains, etc.), and species identifications were often retained even without supporting photographic documents (McBrearty *et al.*, 1986; Evans, pers. comm.). Long-finned pilot whale and killer whale sightings were also reported during this study, but whenever photos or videos were available they turned out to be misidentifications (mainly of Risso's dolphins). In conclusion, no records of pilot or killer whales accompanied by supporting evidence were found, although the accidental or occasional occurrence of pilot and killer whales in the Greek Seas cannot be ruled out.

Stranding data

The national stranding network was set up in the summer of 1991; records started to become available in September of the same year, shortly after the appearance of striped dolphins infected by morbillivirus (Cebrian, 1995; Aguilar, 2000). The maximum number of stranded cetaceans was recorded in 1992 (97 animals); in 1993 strandings dropped to less than half that of the previous year (Fig. 3). Since 1994, the year of the minimum number recorded (40 animals), the number of stranded cetaceans per year increased steadily and within six years reached the levels of 1992, with 94 and 89 stranded animals in 2000 and 2001, respectively. This rapid increase may be due mostly or partly to the parallel increase in public awareness and the port-police authorities, which resulted in a higher ratio of reported to non-reported strandings.

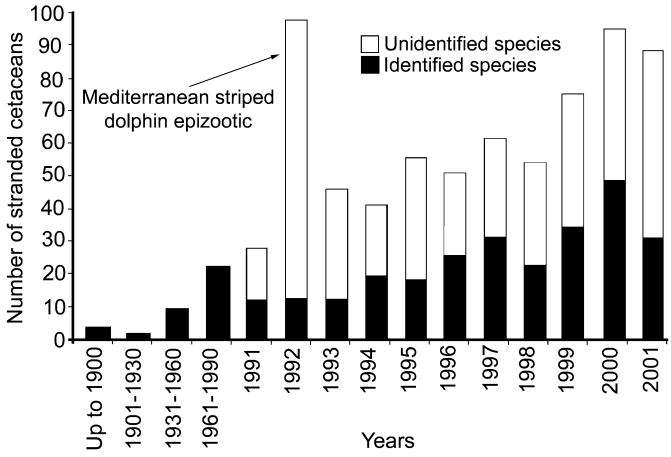

Fig. 3. Number of stranded cetaceans recorded per year. The national stranding network started to provide data in September 1991.

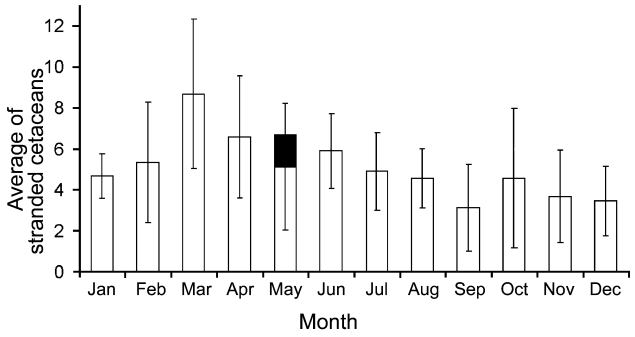

Fig. 4. Average number of stranded cetaceans per month and 95% confidence intervals from years 1993-2001. Strandings from the years of the epizootic (1991-1992) have been excluded, so that they do not affect any yearly pattern related to seasons. Similarly, the mass stranding of 14 Cuvier's beaked whales is presented separately (additional black column in May), because of its anthropogenic cause, which was independent of any seasonal factor.

Eleven species (all but the humpback whale) have been identified among strandings (Table 1). As noted earlier, the percentage of identified animals among 681 strandings from 1991 to 2001 was low (36.7%). As the unidentified animals belonged almost exclusively to three small delphinid species, extrapolated numbers (see methods) are considered here. The common bottlenose dolphin is the most common species among strandings (43.6%) followed by the striped dolphin (27.4%). Averages of *ca* 31 and 19 stranded animals per year were recorded respectively for these two dolphin species. The short-beaked common dolphin and the Cuvier's beaked whale were commonly found among strandings, with about 8 stranded animals per year (11.9 and 11.0%, respectively). The Risso's dolphin (2.4%) and the sperm whale (1.9%) accounted for about 1.5 strandings per year. Finally, the fin whale, the harbour porpoise and the common minke whale represented rare stranding events (less than 1% of the total strandings each).

All seven of the common cetacean species in the Greek Seas were present among the strandings in all seasons of the year, with the exception of fin whales for which the few stranded animals were recorded in November, December and January. The average number of stranded cetaceans per month is presented in Fig. 4. The differences observed between months are significant (ANOVA, $F = 1.95$, $F0.05(1),11,96 = 1.89$, $p < 0.05$). The maximum (8.7 strandings) occurred in March and is followed by a gradual decrease in number until it reaches its minimum in September (3.1 strandings). Numbers remain low in November and December, then increase gradually until March. Further analysis showed that: (1) this pattern is due to unidentified small delphinids and to common bottlenose dolphins which dominate the strandings; and (2) the maximum is not due to strandings of young specimens (total length < 1.5m), which present a clear peak in July and August.

Mass strandings were relatively rare. Twenty-one strandings involving more than one animal (couples, mass strandings *sensu* Geraci and Lounsbury, 1993, or atypical mass strandings as described in Frantzis, 1998) have been recorded during the period September 1991 – December 2001. They represent 3.3% of the total stranding events (641) for the same period of time. Two older mass strandings of four Cuvier's beaked whales in each case were recorded in 1987 and 1988. If all the data including the strandings before September 1991 are considered, 715 cetaceans have stranded in 669 stranding events (Table 2). In 23 stranding events involving more than one individual, 12 cases (52%) concerned Cuvier's beaked whales, 3 cases (13%) concerned striped dolphins, and 8 cases (35%) concerned unidentified small delphinids. The mass stranding of 14 Cuvier's beaked whales in 1996 was linked with military exercises (Frantzis, 1998). In at least two cases, striped dolphins and unidentified small delphinids bore obvious anthropogenic wounds. In another case three unidentified delphinids were found dead in neighbouring sites of the same coast during the same day. Their sizes (2.65, 2.80 and 2.90m) suggest that these were probably common bottlenose dolphins since short-beaked common dolphins and striped dolphins do not reach such lengths, especially in the Mediterranean Sea (Notarbartolo di Sciara and Demma, 1997; Aguilar, 2000; Bompar, 2000). In two other cases, striped dolphins stranded alive showed symptoms similar to those of striped dolphins infected by the Mediterranean morbillivirus. No data are available for the rest of the strandings which involved more than one individual.

Table 2

Number of animals and cetacean species per stranding event. Key: Cb = Cuvier's beaked whale; Sd = Striped dolphin; Unid.S.del = unidentified small delphinid.

Individuals stranded per stranding event	Stranding events	Stranding events with more than one individual per species		
		Cb	Sd	Unid.S.del.
1	646			
2	14	6	1	7
3	5	3	1	1
4	3	2	1	-
14	1	1	-	-
Total	669	12	3	8

Sightings data

Ten free-ranging cetacean species have been recorded in the Greek Seas (Table 1). These include seven common species, two occasional or rare species (the humpback whale and the false killer whale) and one species present only locally (the harbour porpoise). Two dolphin species, the striped dolphin (31.4%) and the common bottlenose dolphin (27.8%) accounted for more than half of the total number of sightings recorded (31.4 and 27.8%, respectively). Due to the occurrence of dedicated sperm whale surveys (joint acoustic and visual methods), the sightings of this species represented a large part of the total (20.2%). Sightings of short-beaked common dolphins and Cuvier's beaked whales were less frequent (8.3 and 6.5%, respectively); sightings of fin whales

and Risso's dolphins were relatively rare (3.3 and 2.6%, respectively). Finally, sightings of humpback whales, false killer whales and harbour porpoises were very rare (less than 0.3% for each of these species. If only the surveys made in pelagic waters and those near or over the edge of the continental shelf are considered, the striped dolphin was the most abundant species, followed by the Cuvier's beaked whale, the sperm whale, the Risso's dolphin and the fin whale (Frantzis *et al.*, In prep.). If the coastal areas of the Greek Seas are considered as a whole, the common bottlenose dolphin was the most abundant species followed by the short-beaked common dolphin.

Distribution, biological data and status of species

The distributions of all known records of cetacean species found in the Greek Seas are presented in Figs 5 and 6. Although some geographical areas have yet to be surveyed sufficiently and gaps in some species' distribution may reflect the absence of effort in these particular areas (Figs 2a and 2b), the available data provide a reasonably good approximation of the real figures. It appears that cetacean species can be divided into three major categories according to their distribution: (1) the striped dolphin, the common bottlenose dolphin, the sperm whale and the Cuvier's beaked whale are present in the entire range of the habitat that is considered typical for them; (2) the short-beaked common dolphin, the fin whale and the harbour porpoise present heterogeneous distributions within their potential habitats; (3) the Risso's dolphin cannot be predictably found in any area or habitat, although its presence has been recorded in most geographical areas of the Greek Seas. The available data per species are summarised below. Although no abundance estimates are available, the species are listed in decreasing order based on absolute number of individuals in the Greek Seas.

Greek common names

The Greek common names of cetacean species given in this paper are those proposed by a monograph of the Greek National Marine Research Centre (Frantzis and Alexiadou, In press) and adopted by ACCOBAMS (2002). Greek names are followed by their transcription in Latin characters in parenthesis (according to ELOT, 1982), and by their pronunciation in Greek. The symbols of the International Phonetic Alphabet (IPA) and tonic accents have been used to describe this pronunciation. For the reader who is not habituated to these symbols a few examples through English words follow: i = s*ee*, ð = *th*is, j = *y*ours, ŋ = ri*n*g, x =

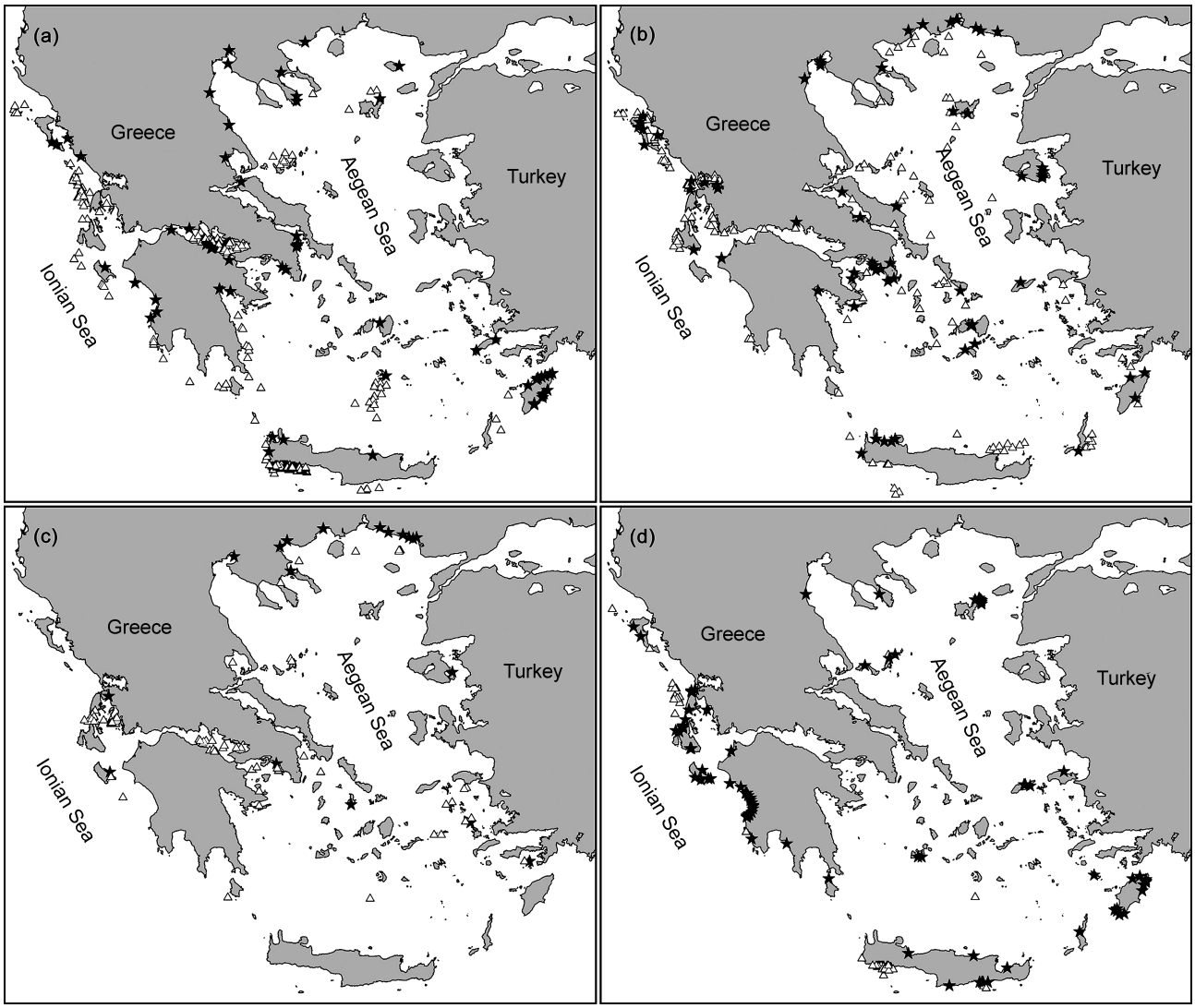

Fig. 5. Distribution of all known sightings (triangles) and strandings (asterisks) of: striped dolphins (a); common bottlenose dolphins (b); short-beaked common dolphins (c); and Cuvier's beaked whales (d) in the Greek Seas. Some hundreds of sightings of short-beaked common dolphins and common bottlenose dolphins available for the sea area around the Kalamos Island in the Ionian Sea are not shown in the relevant figures (see Methods).

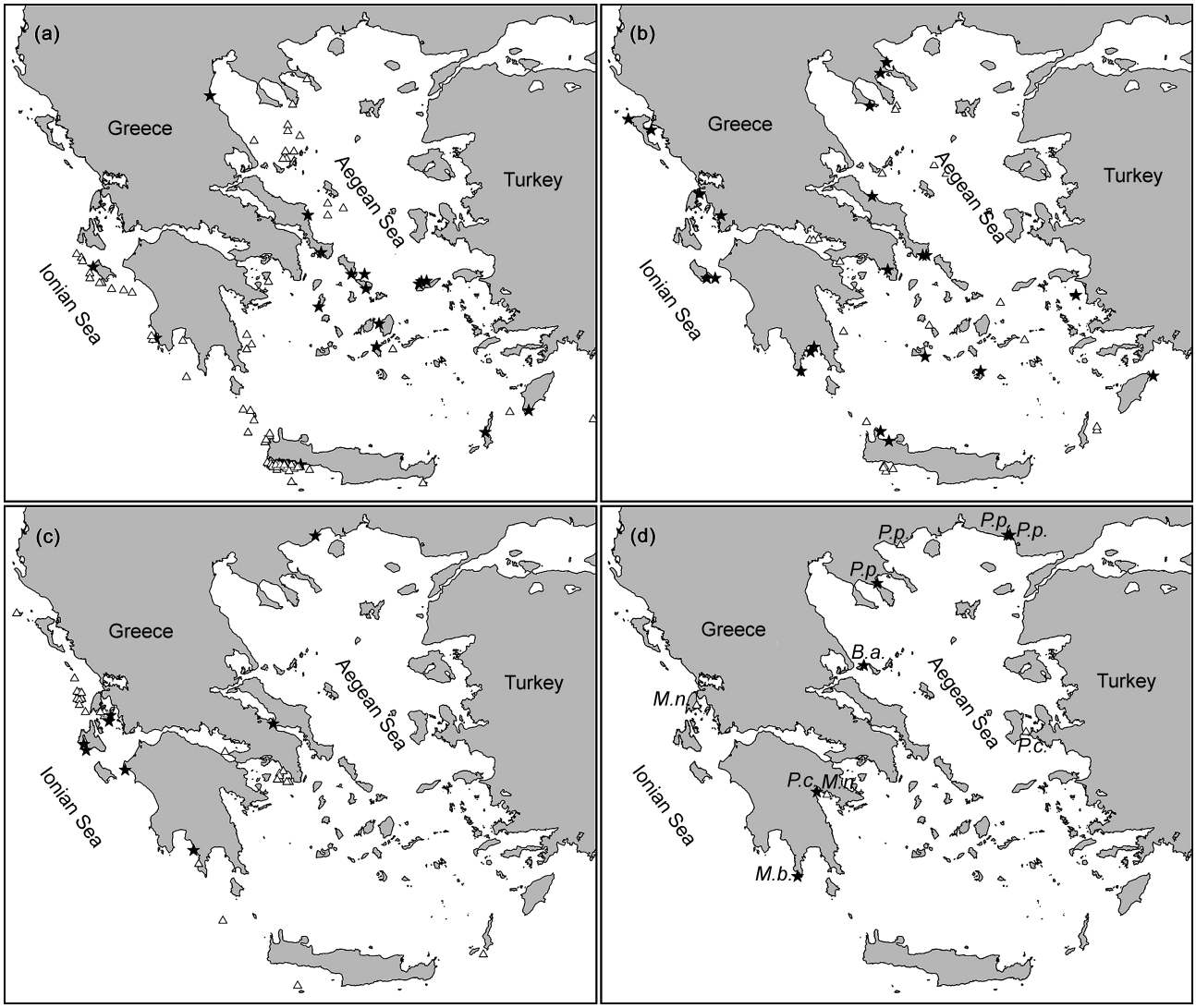

Fig. 6. Distribution of all known sightings (triangles) and strandings (asterisks) of sperm whales (a); Risso's dolphins (b); fin whales (c); and occasional or rare cetacean species (d) in the Greek Seas. Key to (d): *P.p.* = harbour porpoise; *P.c.* = false killer whale; *M.n.* = humpback whale; *B.a.* = common minke whale; *M.b.* = Sowerby's beaked whale.

Scottish lo*ch*. No English equivalents exist for the symbols 'c' and 'γ'. However the closest sounds for the use of 'c' are 'kye' in fó*ce*na (= harbour porpoise) and 'kyee' in *ci*nó ðelfíni (= common dolphin). The sound of 'γ' in meγά*p*teri fálena (= humpback whale) is between 'g' in the word 'mega' and 'y' in the word 'yes'.

Striped dolphin – Stenella coeruleoalba (Meyen, 1833)
Greek name: Ζωνοδέλφινο (Zonodélfino), pronunciation: zonoðélfino

In all surveys conducted for this study in pelagic or deep waters, the striped dolphin was the most frequently sighted species and presented the highest number of encountered individuals. It was also the second most frequent species found among strandings (extrapolated data 1996-2001), following the common bottlenose dolphin. Although some authors considered the striped dolphin 'less common' or locally rare in the Eastern Mediterranean (Kinzelbach, 1997; Aguilar, 2000), this is the most abundant species in the Greek Seas. There are no geographical areas where it could be considered absent, with the probable exception of the shallow northern Thracian Sea. Its regular presence in this sea is doubtful, since no sightings and only two strandings have been recorded. There is a lack of data for striped dolphins in the central Aegean Sea and the Cyclades Islands (Figs 1 and 5a), where their presence remains to be confirmed because no surveys have been made in this area. Very few sightings occurred above the shallow waters of the continental shelf, where striped dolphins are probably rare. For example, there are only two sightings in the area between Lefkada Island, Kefallonia Island and the mainland (inshore east Ionian Sea), which has been surveyed intensively during the last ten years. Nevertheless, more than ten strandings (including individuals that stranded alive) occurred several tens of miles away from pelagic waters, in shallow (less than 100m) and often enclosed gulfs (South Evvoikos Gulf, Thermaikos Gulf, Saronikos Gulf, Pagasitikos Gulf and North Evvoia), indicating that striped dolphins may visit those areas occasionally. Due to some steep depressions and trenches, striped dolphins are often found close to the coast in Greece (less than 2km south of Crete and in the Gulf of Corinth). In the long, deep, but almost enclosed Gulf of Corinth, striped dolphins are encountered much more frequently (0.043 sightings/km) than in the neighbouring pelagic waters of the Ionian Sea, and they often form mixed groups with short-beaked common dolphins and Risso's dolphins (Frantzis and Herzing, 2002; Frantzis and Paximadis, unpublished data). It is possible that their population unit is isolated from offshore striped dolphins in the Ionian Sea (there are no records for the shallow western

part of the gulf and the neighbouring Patraikos Gulf and inshore east Ionian Sea). Genetic evidence is needed to test this hypothesis, since it may represent a rare or even unique case of an enclosed population unit of this species, offering a great opportunity to use study methods that are not applicable in the open sea. Among 47 stranded striped dolphins that were measured, the maximum total length was 2.15m for each of the sexes. The minimum length recorded was 0.81m (in the Gulf of Corinth). As far as it is known, this is the smallest individual with erupted teeth ever recorded in the Mediterranean Sea (Aguilar, 2000; Bompar, 2000), where striped dolphins are the smallest length in the world (Aguilar, 2000). Among the five youngest stranded striped dolphins that measured less than 1m, three (0.81, 0.88, 0.89m) were found on 13, 16 and 22 August respectively, the fourth (0.93m) on 10 September and the fifth (0.97m) on 24 July. These dates suggest a peak in births by the end of July and beginning of August, although births may also occur in late spring or early summer.

Common bottlenose dolphin – Tursiops truncatus (Montagu, 1821)

Greek name: Ρινοδέλφινο (Rinodélfino), pronunciation: rinoðélfino

The common bottlenose dolphin is the most common species in coastal waters and probably the second most abundant species after the striped dolphins. In some areas it shares the same habitat with short-beaked common dolphins, but in a few areas (e.g. the inner east Ionian Sea; see Politi *et al.*, 1999) it is or may be the minority cetacean species. The common bottlenose dolphin is present in all coastal areas, straits and gulfs, but also between islands in the Ionian Sea and in the Aegean Sea from the northern Thracian Sea to the southern Gavdos Island (Figs 1, 5b). It is the only cetacean species present in the shallow and enclosed Amvrakikos Gulf, with an important and possibly isolated population unit. The common bottlenose dolphin is also present along steep coasts with no continental shelf (such as those in southern Crete), although less common compared to shallow areas and plateaux. It is by far the most common species among strandings (Table 1). The largest stranded individuals measured 3.30 and 2.95m for males and females, respectively. Both of these dolphins had extremely worn teeth, indicative of old age. Two individuals with total lengths of 2.16 and 2.54m were one and twelve years old respectively (ages estimated through GLG counting in their teeth according to Pierce and Kajimura, 1980). The two smallest individuals found measured 1.20m each and stranded in early June and late April.

Short-beaked common dolphin – Delphinus delphis (Linnaeus, 1758)

Greek name: Κοινό δελφίνι (Koinó delfíni), pronunciation: cinó ðelfíni

Most observations of short-beaked common dolphins recorded in the Greek Seas come from shallow and coastal areas (Fig. 5c). Until recently, a resident, coastal community was the dominant species in the waters of the inner east Ionian Sea, between the islands of Lefkada and Kefallonia and the mainland (Politi, 1998; Politi *et al.*, 1999). However, ongoing rarefaction has been recently observed, resulting in a significant and continuous decrease in sighting frequency and number of encountered individuals (Politi and Bearzi, In press; Bearzi *et al.*, 2003). The range of this population unit extends south to southeast Zakynthos Island, but its core area is located north, around the island of Kalamos. No more than 100-150 individuals (Bearzi *et al.*, 2003) live in that area, above depths that usually do not exceed 150m. Another, smaller population unit lives in the pelagic (although enclosed) environment of the neighbouring Gulf of Corinth, over depths of 340-910m (Frantzis and Herzing, 2002). These short-beaked common dolphins live permanently in mixed-species groups with the dominant striped dolphins, and occasionally also with Risso's dolphins. No short-beaked common dolphins have been observed in the western Gulf of Corinth, and in the inner and outer Patraikos Gulf. Although their presence there cannot be ruled out, it seems that there is no significant exchange (if any) between the population units of the inner east Ionian Sea and the Gulf of Corinth. The short-beaked common dolphin is present, common or even abundant in at least five coastal, shallow areas of the Aegean Sea. These are the Dodecanese, the Saronic Gulf, the South Evvoikos Gulf, the Northern Sporades Islands and the Thracian Sea. Sightings and strandings have also been recorded in Thermaikos Gulf, Mytilini Island, Pagasitikos Gulf, Cyclades Islands and Kythira Island. It is probable that short-beaked common dolphins are not rare around most islands of the Aegean Sea, however, dedicated surveys are needed to evaluate their abundance. It is worth noting that half of the recorded strandings of short-beaked common dolphins and three opportunistic sightings originate from the Thracian Sea (Figs 1, 5c), although no surveys were conducted in this area. Short-beaked common dolphins are absent or very rare south of the line that links south Kythira and the Rodos Islands. Despite intensive searching effort in northeast Crete, southwest Crete and around Karpathos Island, they have never been observed there.

Cuvier's beaked whale – Ziphius cavirostris (G. Cuvier, 1823)

Greek name: Ζιφιός (Zifiós), pronunciation: zifjós

The Cuvier's beaked whale was observed in all surveys made near or above the waters of the continental shelf edge. Surprisingly for this elusive species (Heyning, 1989), there were more individuals observed in the open sea (112) than recorded as stranded (73) for the period 1991-2001. Sighting frequencies reached 13 sightings $100h^{-1}$ under favourable conditions in some areas (Pelagos Cetacean Research Institute, unpublished data). Both sightings and strandings indicate that the Cuvier's beaked whale is regularly present along the Hellenic Trench, from eastern Rodos Island to northwest Corfu Island (Fig. 5d). In addition, Cuvier's beaked whale seems to be present over all steep depressions of the Aegean plateau, such as the sea area between the Northern Sporades and the Chalkidiki peninsula, the trench north of Limnos Island (Figs 1, 5d). Sightings occurred above depths of 500-1,500m (except one in 250m), at distances ranging from 2-36km from the closest coasts, depending on the underwater topography. It is not actually known if Cuvier's beaked whales are also present further offshore, over the abyssal plains. Very few strandings were recorded away from steep depressions and deep trenches and no sightings were made in the shallow waters of the continental shelf and the enclosed gulfs, where the Cuvier's beaked whales are apparently absent. The Cuvier's beaked whale is common among strandings, often coming ashore in groups of 2-4 individuals (Table 2). It is the only species that has mass-stranded on the Greek coasts (at least 14 individuals), during military exercises in Kyparissiakos Gulf in 1996 (Frantzis, 1998). At least nine more individuals stranded along the coasts of the Ionian Islands the following

year, in a short period of two weeks. Although military exercises were also taking place in that case (documents of the Hellenic Hydrographic Service, 1997), no detailed data are available to allow a clear spatio-temporal link.

Sperm whale – Physeter macrocephalus (Linnaeus, 1758)
Greek name: Φυσητήρας (Fysitíras), pronunciation: fysitíras

The existence of a deep trench around Greece (Hellenic Trench) and smaller steep depressions and trenches in the Aegean Sea (Fig. 1) make the Greek Seas an important habitat for sperm whales (Fig. 6a; see also Gannier *et al.*, 2002). Almost all sightings were recorded along the Hellenic Trench from west of the Ionian Islands and the Peloponnese to south Crete and southeast Rodos Island, in the Myrtoon Sea, in steep depressions of the Aegean Sea and particularly in the area between the northern Sporades and Chalkidiki peninsula. Strandings and one sighting in the shallow Cyclades Islands area (not yet surveyed) indicate that sperm whales may cross it while moving from one area of steep underwater relief to another. Most observations (80%) were recorded in depths of 500-1,500m, and at distances ranging between 2.5-8km from the closest coast (range 200-2,100m and 1-36km). It is not known if sperm whales are also present further offshore, over the abyssal plains. Resightings of photo-identified individuals on a yearly basis from 1998 to 2002 indicate that sperm whales are at least seasonally resident in the Greek Seas, and may spend many years of their life here (Frantzis *et al.*, 1999; Pelagos Cetacean Research Institute, unpublished data). Solitary mature males, as well as social groups of females with calves of four to 12 individuals are observed year round. The sighting frequency of young calves among social groups is high (Frantzis *et al.*, 1999; Pelagos Cetacean Research Institute, unpublished data). According to indirect measurements of free-ranging animals and stranded specimens, sperm whales inhabiting the Greek Seas appear smaller than Atlantic individuals. The lengths of the largest solitary males (obtained through both photographic (Gordon, 1990) and acoustic (Gordon, 1991) methods) range between 12.5 and 13.8m. The length of the lower jaw of a sperm whale stranded on Rodos Island indicates a total length of about 15m for that individual. One female and one male of 10.0 and 12.8m, respectively, were surprisingly old with respect to their total length. Their ages have been estimated at about 25 and 44 years, respectively, based on GLG counting of teeth (Frantzis and Lockyer, unpublished data).

Risso's dolphin – Grampus griseus (G. Cuvier, 1812)
Greek name: Σταχτοδέλφινο (Stachtodélfino), pronunciation: staxtoðélfino

The distribution of the recorded sightings and strandings of Risso's dolphins in the Greek Seas is relatively homogeneous (Fig. 6b) and indicates that the species may be present in all geographical areas of deep water or steep underwater relief. However, sighting frequencies were low in almost all surveys conducted for this study, and there were no areas where Risso's dolphins can be considered common, regular, or of predictable abundance. It is worth noting that in the waters off southwest Crete that have been surveyed more intensively, Risso's dolphins were encountered several times in 1998 and 1999, but were not observed in the years 2000-2001. The presence of two photo-identified individuals observed from 1997 to at least 2001 in mixed-species dolphin groups in the enclosed Gulf of Corinth (Frantzis and Herzing, 2002; Frantzis and Paximadis, unpublished data) is rather surprising considering that no other Risso's dolphins have been observed so far. The recorded sightings of Risso's dolphins occurred in depths of 200-1,700m (except for one in 80m). Sightings distance from the closest coast ranged from 0.5-32km. The two younger individuals found among strandings measured 1.73 and *ca* 1.70m, found in late November and late June, respectively.

Fin whale – Balaenoptera physalus (Linnaeus, 1758)
Greek name: Πτεροφάλαινα (Pterofálaina), pronunciation: pterofálena

The fin whale seems to be predictably present only off the northern Ionian Islands (Figs 1, 6c). Four sightings and four strandings were recorded along the rest of the Hellenic Trench. Fin whales seem to be rare in the Aegean Sea and probably occur only exceptionally. In 1998, single individuals and small groups of fin whales were observed repeatedly in the Saronic Gulf from February to May. Similar, exceptional near-coast observations were made in the western Mediterranean Sea during summer and autumn 1997, and were related to particular oceanographic conditions (Beaubrun *et al.*, 1999; Notarbartolo di Sciara *et al.*, 2003). Except for the sightings in the Saronic Gulf, all other sightings occurred in the warm season from June to September. Three strandings have been recorded in November and December; however, a regular presence during the winter months remains to be confirmed. All fin whale observations in the Ionian Sea were made in pelagic waters 9-36 n.miles from the closest coasts, in depths of 1,000-2,000m. However, fin whales have occasionally been observed in shallow coastal waters or enclosed sea areas such as the inner eastern Ionian Sea or even the Gulf of Corinth (Fig. 6c). Fin whale strandings are relatively rare in Greece (Table 1).

Harbour porpoise – Phocoena phocoena (Linnaeus, 1758)
Greek name: Φώκαινα (Fókaina), pronunciation: fócena

The presence of harbour porpoise in the Thracian and northern Aegean Seas (Figs 1, 6d) has recently been confirmed (Frantzis *et al.*, 2001) by one sighting and five strandings, the last two strandings were recorded on 17 January 2003 (Nea Peramos Bay, Thracian Sea) and 25 March 2003 (Strymonikos Gulf, Thracian Sea) (Koutrakis and Kallianotis, pers. comm.). The small size for their age and the genetic signature of two of the stranded animals suggest that they originate from the Black Sea population (subspecies *Phocoena phocoena relicta)* rather than from the Atlantic. It has been suggested that movement of porpoises out of the Black Sea and into the Mediterranean Sea occurs through the Bosporus Straits, the Marmara Sea and the Dardanelles Straits (Rosel *et al.*, 2003). The stranded harbour porpoises had total lengths of 1.57m (female), 1.46m (female), 1.26m (male), 1.25m (unknown sex) and 1.13m (male). The two male specimens were 13.5 and one year old, respectively (Rosel *et al.*, 2003).

False killer whale —Pseudorca crassidens (Owen, 1846)
Greek name: Ψευδόρκα (Psevdórka), pronunciation: psevðórka

Only one observation of false killer whales in the open sea exists. At least seven individuals were photographed in 1992 in the straits between Chios Island and the Turkish coast (Chesme), in the Aegean Sea. This is one of the very few sightings of a false killer whale pod in the Mediterranean Sea, represented by vagrant individuals from the Atlantic Ocean and perhaps from the Red Sea (Notarbartolo di Sciara

and Birkun, 2002). One stranding record exists of a single individual found in 1993 in the Argolikos Gulf, Aegean Sea (Fig. 6d). One other stranding was recorded in 1995 along the Turkish coast of the Aegean Sea (Öztürk and Öztürk, 1998).

Humpback whale – Megaptera novaeangliae (Borowski, 1781)
Greek name: Μεγάπτερη φάλαινα (Megápteri fálaina), pronunciation: meγápteri fálena

Two humpback whales were observed (Frantzis *et al.*, 2004) in coastal areas of both the Aegean (spring 2001) and Ionian (summer 2002) Seas (Fig. 6d). The first of these whales spent one month feeding in the vicinity of the Bay of Tolo. These two sightings together with a probable resighting of the second whale in the Adriatic Sea (Affronte, pers. comm.; Frantzis *et al.*, 2004) are the only records existing for the entire East Mediterranean Sea (Frantzis *et al.*, 2004).

Common minke whale – Balaenoptera acutorostrata (Lacépède, 1804)
Greek name: Ρυγχοφάλαινα (Rynchofálaina), pronunciation: riηxofálena

The only record of this species in the Greek Seas concerns a floating carcass of a young common minke whale found off Skiathos Island (Fig. 6d) in May 2000 (Verriopoulou *et al.*, 2001). A few days earlier, a mature female and a calf were found dead on the Mediterranean Israel coast (Goffman, pers. comm.). These are the only available records in the east Mediterranean Sea, although two historical strandings in 1880 and 1926 in the Black Sea (Tomilin, 1957) suggest a passage through the Aegean Sea. A common minke whale skeleton exists in the Zoological Museum of the University of Athens; however, research in the museum archives showed that the skeleton was not recovered in Greece, but bought in England in 1881.

Sowerby's beaked whale – Mesoplodon bidens (Sowerby, 1804)
Greek name: Δίδοντος μεσοπλόδοντας (Dídontos mesoplódontas), pronunciation: ðíðondos mesoplóðondas

A floating carcass of a ziphiid was found and photographed in March 1989 3.5km off Gerolimenas, in south Peloponnese (Fig. 6d). The photo and observers report were published in a small bulletin of the Hellenic Society for the Protection of Nature (Poulopoulos, 1989). According to the observer's description, a 5cm long tooth —which is not clearly visible in the photo —was apparent in the middle of the lower jaw. Mead and Heyning (pers. comm.) inspected the photo and agreed that this was a *Mesoplodon sp*., which could only be a Sowerby's beaked whale if the observer's description was correct. Cebrian and Papaconstantinou (1992) incorrectly reported this specimen as a Blainville's beaked whale. There is only one other record in the Mediterranean Sea (a live stranding in southwest France in 1996) that could be attributed to a Sowerby's beaked whale (Bompar, 2000).

Long-finned pilot whale – Globicephala melas (Traill, 1809)
Greek name: Μαυροδέλφινο (Mavrodélfino), pronunciation: mavroðélfino

The long-finned pilot whale is the only regular Mediterranean cetacean species (Notarbartolo di Sciara, 2002) that has not been recorded in the Greek Seas. Only one record exists (a floating carcass in the Gulf of Taranto, Ionian Sea, Italy; Centro Studi Cetacei, 1996) in the entire East Mediterranean Sea. The long-finned pilot whale has been reported a few times during this study by unskilled observers, but whenever photos or videos were available, it appeared that other species (mainly the Risso's dolphin or the false killer whale) had been falsely identified. Although the accidental or occasional occurrence of long-finned pilot whales in the Greek Seas cannot be refuted, it should be regarded as unconfirmed due to lack of supporting evidence.

Killer whale – Orcinus orca (Linnaeus, 1758)
Greek name: Όρκα (Órka), pronunciation: órka

There are no records of killer whale strandings or sightings directly made by specialists, or supported by irrefutable evidence (photos or videos) in the Greek Seas. Unconfirmed reports of killer whales have been collected during this and older studies (McBrearty *et al.*, 1986; Hammond and Lockyer, 1988). Some reports accompanied by photos or videos appeared to correspond with Risso's dolphins. Although killer whales may occasionally occur in the Greek Seas, their presence should be regarded as unconfirmed.

White whale – Delphinapterus leucas (Pallas, 1776)
Greek name: Μπελούγκα (Beloúga), pronunciation: belúga

This species has never been recorded in the Greek Seas. Due to a wrong assumption, a white whale — escaped from an Ukranian delphinarium and observed in the Black Sea — was assumed to be a free-ranging individual which had crossed the Aegean Sea, and was therefore reported as an accidental species in the Greek Seas (Cebrian and Papaconstantinou, 1992).

Blue whale – Balaenoptera musculus (Linnaeus, 1758)
Greek name: Γαλάζια φάλαινα (Galázia fálaina), pronunciation: γalázja fálena

The blue whale has never been recorded in the Mediterranean Sea (Bompar, 2000; Notarbartolo di Sciara, 2002). However, it has been incorrectly included in editions, leaflets and posters of the Greek Ministry of Agriculture as a species belonging to the Greek cetacean fauna. The only evidence provided was a fisherman's oral report referring to an observation of a '30m long whale' in the Ionian Sea some decades ago.

DISCUSSION

There are no published studies of comparative cetacean surveys conducted along the longitudinal axis (east-west) of the Mediterranean Sea (Notarbartolo di Sciara and Gordon, 1997). Nevertheless, the number and abundance of cetacean species have always been considered lower in the eastern than in the western basin (Marchessaux, 1980; Viale *et al.*, 1988; Notarbartolo di Sciara and Demma, 1997; Notarbartolo di Sciara and Gordon, 1997). This hypothesis was based on the absence of direct contact with the Atlantic Ocean which would limit the possibility of cetacean migrations from the Atlantic Ocean, and the pronounced oligotrophy which would reduce its carrying capacity (Marchessaux, 1980; Notarbartolo di Sciara and Demma, 1997).

The Greek Seas are part of the eastern Mediterranean basin and although they occupy less than one quarter of its surface, they present a high diversity of cetacean fauna, which contradicts in part what was believed until recently. All cetacean species represented by resident populations in the Mediterranean Sea inhabit the Greek Seas, except for the

long-finned pilot whale. In addition, the harbour porpoise which is absent from all other parts of the Mediterranean Sea and was once considered extinct (Frantzis *et al.*, 2001) is locally present in the Greek Seas. It has been suggested that movement of porpoises out of the Black Sea and into the Mediterranean Sea occurs through the Bosphorus Straits, the Marmara Sea and the Dardanelles Straits (Rosel *et al.*, 2003). Nevertheless, it remains to be clarified if the harbour porpoises of the Thracian and northern Aegean Seas are occasional visitors from the Marmara Sea, or resident animals that belong to a small separate sub-population, which is more or less isolated from the Black Sea (Frantzis *et al.*, 2001; Rosel *et al.*, 2003). Three of the five cetacean species that occur occasionally in the Mediterranean Sea (false killer whale, humpback whale and common minke whale) have been documented in the Greek Seas. The current number of occasional species and relevant records are likely to increase in the Greek Seas, since current knowledge results from a relatively modest research effort (no systematic surveys, unexplored sea areas, incomplete stranding network) compared with the northwestern Mediterranean.

Abundance estimates for Mediterranean cetaceans are available for just a few species and only a portion of the west Mediterranean Sea (Forcada *et al.*, 1994; 1995; 1996; Forcada and Hammond, 1998). The surveys conducted for this current study and the relative searching effort were not distributed homogeneously in the Greek Seas. Some areas have been surveyed more intensively than others because of the known, or expected, frequent presence of the targeted study species (e.g. sperm whales off southwest Crete). As a result the total sighting numbers recorded are biased in favour of some species, and cannot be used as an index of relative abundance. Consequently, abundance comparisons between basins or particular seas of the Mediterranean are not possible at this stage. However, there is some evidence (distribution range, strandings and encounter frequencies) that the abundance of three species in the Greek Seas (sperm whale, Cuvier's beaked whale and short-beaked common dolphin) could be higher than in most other Mediterranean areas that have been surveyed so far.

Until recently, sperm whales were considered rare or infrequent in the eastern Mediterranean Sea; few historical strandings or opportunistic sightings were known (Marchessaux, 1980; Notarbartolo di Sciara and Demma, 1997). Since 1998, when the regular presence of sperm whales off southwest Crete was discovered (Frantzis *et al.*, 1999), wide areas of the Greek Seas have been shown to host this species. The year-round presence of both mature males and social groups of females with young calves indicate that the Greek Seas are a breeding and nursing ground. This is particularly important if we consider that the encounter frequency of social groups with calves recorded during surveys in the west and central Mediterranean Sea is low (Notarbartolo di Sciara *et al.*, 1993; Pavan *et al.*, 1997; 2000; Gannier *et al.*, 2002). Ten social groups of 4-13 members totalling at least 74 individuals were photo-identified and repeatedly resighted in the Greek Seas in a 172-day effort from 1998 to 2002 (Pelagos Cetacean Research Institute, unpublished data). This evidence suggests that the Greek Seas are an important habitat for the Mediterranean population of this species and supports the hypothesis that sperm whales may complete their life cycle in the Mediterranean Sea or just in its eastern basin.

The sighting frequency of Cuvier's beaked whales in the Greek Seas can reach locally 13 sightings $100h^{-1}$ under favourable sea conditions (Pelagos Cetacean Research Institute, unpublished data). This value is several orders of magnitude higher than that recorded during all surveys in the west and central Mediterranean Sea, from the Alboran Sea to Maltese waters. In all of those surveys, Cuvier's beaked whales were either not recorded at all or were very rare (see Marini *et al.*, 1992; Notarbartolo di Sciara *et al.*, 1993; Forcada *et al.*, 1994; Viale and Frontier, 1994; Gannier and Gannier, 1997; Sagarminaga and Cañadas, 1997). The average number of Cuvier's beaked whale strandings along the coasts of the Greek Seas is 5.6 individuals per year (CI 95% = 2.78) for the decade 1990-1999 (excluding 14 individuals mass stranded in 1996). This number is significantly higher than the respective average for each of the three northern countries of the west and central Mediterranean (Spain 1.9, France 0.2, Italy 2.6) for the same time interval (Bortolotto and Podestà, 1997; Duguy, 1990; Centro Studi Cetacei, 1997; 1998; 2000; 2001; Duguy, 1992; Van Canneyt *et al.*, 1998; 1999a; b; 2000; Van Canneyt, 2001; 2002; Universidad Autónoma de Madrid and Alnitak, 2002; Universidad de Barcelona, 2002; Universidad de Valencia, 2002). Both sightings and strandings indicate that Cuvier's beaked whales occur in higher numbers in the Greek Seas than any other equivalent area of the Mediterranean Sea for which data are available. The apparent abundance of Cuvier's beaked whales and sperm whales suggests that the underwater topography of the Greek Seas makes them an appropriate habitat for deep diving, teuthophagous species.

After a recent, drastic decline in their numbers since the 1970s, Mediterranean short-beaked common dolphins are now uncommon or absent in many parts of the west and central Mediterranean. (Bearzi *et al.*, 2003). Although not fully assessed, their regular presence and distribution in many areas of the Greek Seas show a completely different situation. The results in this paper suggest that short-beaked common dolphins could be particularly abundant in the Thracian Sea in comparison with all other areas. The Greek Seas seem to host an important pool of the Mediterranean short-beaked common dolphin population, in addition to the north Alboran Sea (Cañadas *et al.*, 2002; Bearzi *et al.*, 2003).

The rarity or absence of long-finned pilot whales from the Greek Seas, and probably from the entire east Mediterranean Sea, is a notable biogeographical pattern. Risso's dolphins (Kruse *et al.*, 1999), Cuvier's beaked whales (Heyning, 1989) and sperm whales (Rice, 1989), which all have habitats and feeding preferences similar to long-finned pilot whales (Bernard and Reilly, 2000; Cañadas and Sagarminaga, 2000), are widely distributed in the Mediterranean Sea (Notarbartolo di Sciara, 2002; this work). The reasons contributing to the rarity or absence of long-finned pilot whales in the Greek Seas could be due to either: (1) an important geographical barrier, such as the shallow waters of the Sicilian Channel, which may prevent them from reaching potentially convenient and exploitable habitats; or (2) the absence of specific hydrobiological conditions and phenomena (such as upwellings) that may be vital for the trophic requirements of the pods of this large delphinid. It is noteworthy that in the western basin long-finned pilot whales are abundant only in regions where a permanent frontal system increases productivity, namely the Alboran Sea (Cañadas and Sagarminaga, 2000) and the Liguro-Provençal region (Gannier, 1999).

The results in this paper show that the lack of direct contact with the Atlantic Ocean and the pronounced oligotrophy of the Greek Seas (Stergiou *et al.*, 1997) do not limit the presence of all but one resident Mediterranean

cetacean species. In addition, the pronounced oligotrophy does not seem to prevent two deep diving, teuthophagous species such as the sperm whale and the Cuvier's beaked whale, from being abundant in comparison with most other Mediterranean areas that have been surveyed. Nevertheless, the available data cannot contradict the hypothesis of reduced sighting frequency of Atlantic species due to the distance of the Greek Seas from the Gibraltar Strait. Underwater topography, degree of oligotrophy, distance from the Atlantic Ocean, particular oceanographic features (such as gyres, upwellings and fronts), climate change and anthropogenic pressure on the marine environment have variable specific weights in the complex 'equation' that determines the distribution and the abundance of each cetacean species in the Greek Seas. Although basic knowledge on the cetaceans of the Greek Seas has substantially improved in recent years, we are still far from understanding the complexity of their ecology, and remain unable to predict their status in the near future.

CONCLUSION

The lack of basic knowledge on cetacean populations that inhabit the eastern Mediterranean basin presents a serious obstacle in the elaboration of effective conservation measures (Notarbartolo di Sciara and Birkun, 2002). Although still incomplete, the current knowledge on the Greek cetacean fauna, in terms of species presence and distribution, provide a reasonably good approximation of the real figures. The variety of cetacean habitats that surround the Greek coasts is reflected by a species diversity that had been underestimated in the past. In addition, the local population units of four species (sperm whale, Cuvier's beaked whale, short-beaked common dolphin and harbour porpoise) represent an important part of their total Mediterranean population. Nevertheless, there are no quantitative data regarding the absolute abundance or population status of any cetacean species in the Greek Seas. Without such data, it is difficult to adopt proper conservation policies and to monitor the effectiveness of any conservation measure. Therefore, future effort has to focus on: (1) abundance estimates; (2) the assessment of population status, trends, and degree of isolation for cetacean species that constitute conservation priorities at the local or regional level; (3) the definition of critical areas for these species; and (4) the establishment of a properly organised national stranding network that will not hamper the collection of valid stranding data in the future.

ACKNOWLEDGEMENTS

The Pelagos Cetacean Research Institute (PCRI) wishes to thank the Vodafone Group Foundation and Vodafone-Panafon Hellenic Telecommunications Company S.A. for a grant that funded the data analysis and the preparation of this paper. We also thank all research centres, organisations and persons who offered stranding and sighting data, namely the National Centre for Marine Research (Greece) and particularly Dr. Papakonstantinou and Dr. Panayotidis who offered access to the National Cetacean Stranding Archive, Tethys Research Institute (Milano), GREC (Group de Recherche sur les Cétacés, France), MOm (Hellenic Society for the Study and Protection of the Monk Seal), Fisheries Research Institute (Kavala, Greece), Greenpeace Greece, Michael White, Aristidis Valoukas, Stelios Gialinakis and a long list of friends, colleagues and people who offered documented opportunistic sightings. We express our gratitude to the Greek port-police authorities for their collaboration in the stranding network. We are particularly grateful to Makis Pagidas, Olga Nikolaou, Gilda Hassidis, the captain of PCRI Pantelis Kiofentzis and all the eco-volunteers who supported the expeditions of PCRI. Finally, we are also grateful to Giovanni Bearzi and to a second anonymous referee who helped improve the submitted manuscript with constructive comments and advice.

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Date received: 24 February 2003.
Date accepted: 20 August 2003.