AQUATIC CONSERVATION: MARINE AND FRESHWATER ECOSYSTEMS

Aquatic Conserv: Mar. Freshw. Ecosyst. **15**: 243–257 (2005)

Occurrence and present status of coastal dolphins (Delphinus delphis *and* Tursiops truncatus) *in the eastern Ionian Sea*

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ABSTRACT

1. Boat surveys aimed at studying short-beaked common dolphins and common bottlenose dolphins in eastern Ionian Sea coastal waters were conducted between 1993 and 2003. During 835 survey days, 24 771 km of total effort was distributed within an area of 480 km^2, resulting in 428 common dolphin and 235 bottlenose dolphin sightings.

2. Individual photo-identification was performed extensively throughout this study, making it possible to monitor the number of animals seen in the study area each year and their long-term residency patterns.

3. Common dolphins declined across the study period, from 2.18 encounters/100 km in 1997 to 0.40 encounters/100 km in 2003. In contrast, there was a relatively stable presence of bottlenose dolphins, some individuals showing high levels of site fidelity and others using the area only occasionally.

4. The local decline of common dolphins and the low density of bottlenose dolphins appeared to reflect the general status of these cetacean species in the wider Mediterranean region, where common dolphins were classified as endangered in the IUCN Red List in 2003.

5. Based on the available evidence, we infer that the present unfavourable status of common dolphins in eastern Ionian Sea coastal waters is largely a consequence of prey depletion.

KEY WORDS: cetaceans; Ionian Sea; Mediterranean Sea; *Delphinus delphis*; *Tursiops truncatus*; ecology; anthropogenic impact; prey depletion

INTRODUCTION

Once one of the commonest species in the Mediterranean Sea, the short-beaked common dolphin (*Delphinus delphis*; hereinafter referred to as common dolphin) has experienced a generalized and major decline throughout the region during the last 30–40 yr, for reasons that remain poorly understood (Bearzi *et al.*, 2003). In 2003 the Mediterranean common dolphin 'subpopulation' was classified as endangered in the IUCN Red List of Threatened Animals, based on an inferred decline in abundance of $\geqslant 50\%$ over the

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Received 6 April 2004
Accepted 21 September 2004

last three generations (approximately 30–45 yr), the causes of which 'may not have ceased *or* may not be understood *or* may not be reversible' (http://www.iucnredlist.org).

The common bottlenose dolphin (*Tursiops truncatus*; hereinafter referred to as bottlenose dolphin) is the commonest cetacean over the Mediterranean Sea continental shelf (Notarbartolo di Sciara and Demma, 1997). However, the distribution of coastal groups appears to be increasingly scattered and fragmented into small isolated units (Natoli *et al.*, 2004).

In the eastern Ionian Sea, two communities (*sensu* Wells *et al.*, 1987) of common dolphins and bottlenose dolphins have been the subjects of a study that started in 1993, which was designed to investigate the ecology, social organization and behaviour of two species sharing the same coastal waters (Politi *et al.*, 1994, 1999). The area offered unique opportunities to observe common dolphin groups in a portion of the Mediterranean where the species is generally rare, and its sheltered waters enabled daily surveys to be conducted under optimal sea conditions. At the beginning of the study, common dolphins were abundant and could be found every day with little navigation effort. However, the results of this study indicate that since at least 1997 there has been a substantial decline in common dolphin numbers. Here, we discuss the potential reasons for the common dolphin decline in eastern Ionian Sea coastal waters and we propose some management measures that could be used to reverse this trend.

METHODS

Study area

The survey and photo-identification effort was concentrated within a core study area situated in eastern Ionian Sea coastal waters. The area, including the islands of Meganisi, Kalamos and Kastos, covers approximately 480 km^2 of sea surface (Figure 1). The sea floor is mostly 50–150 m deep, with rocky coasts and shallows covered by seagrass meadows. Waters are transparent (Secchi disk readings ranging between 10 and 30 m), oligotrophic and unaffected by significant river and agricultural runoffs (Pitta *et al.*, 1998). Surface water temperatures ranged between 15 and 30°C during the study period (April–October).

Survey effort and encounter rates

Surveys were conducted from a 15 m sailing vessel in years 1993–1994, from 4.7 m inflatable craft with pneumatic keels powered by 40 HP outboard engines in years 1995–1996, and from 4.7–5.8 m inflatable craft with rigid hulls powered by 50–80 HP four-stroke outboard engines in years 1997–2003. The survey coverage between 1993 and 2003 totalled 24 771 km 'on effort' and 835 daily surveys, encompassing three seasons. The number of observers, eye elevation and vessel speed varied inconsistently in the first 4 yr of the study, making the data unsuitable for the comparative analysis of encounter rates. Therefore, data collected in 1993–1996 were used only for group size and photo-identification analyses unaffected by the survey method, and excluded from encounter rate analyses. Conversely, survey methods remained consistent between 1997 and 2003. Encounter rates were computed based on 18 447 km of survey effort during 572 daily surveys conducted in June–September between 1997 and 2003 (Table 1, Figure 2). Data were defined as 'on effort' when the following conditions applied: (1) daylight and good visibility; (2) sea state $\leqslant 1$ Douglas with no swell (including either completely flat sea, flat sea with capillary waves or wavelets less than 10 cm high with no foam or breaking crests); (3) at least two experienced observers scanning the sea surface in search of dolphins; (4) eye elevation of approximately 2 m for both observers; and (5) survey speeds between 28 and 36 km h^{-1}. All the daily surveys started from the port of Episkopi (island of Kalamos, Figure 1) and returned there. Although routes varied depending on weather conditions and other factors, an attempt was made to provide an even coverage of the study area (Figure 2).

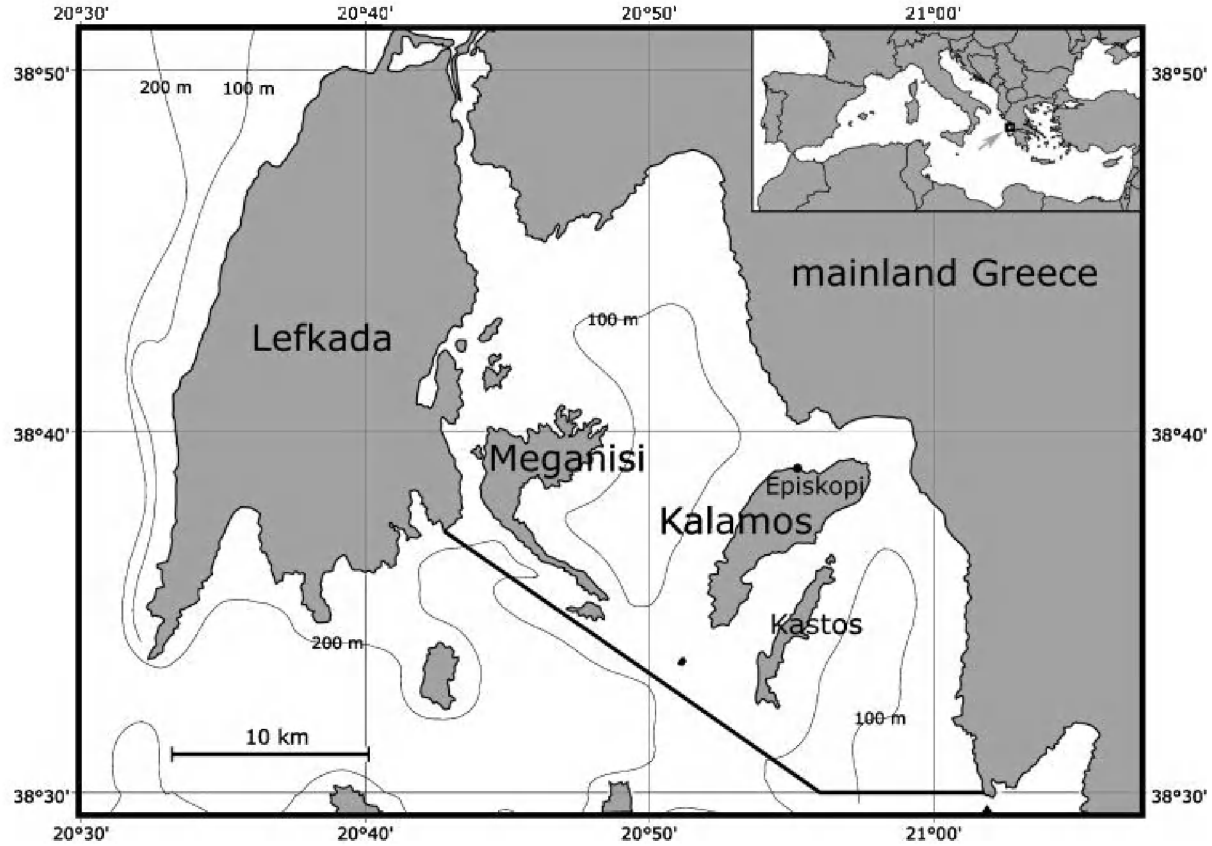

Figure 1. Study area (delimited by bold line) showing the locations cited in the text and bathymetric contour lines. The location of the study area in the Mediterranean Sea is shown in the inset.

The main study area was subdivided into a total of 222 cells of $1' \times 1'$ (1852×1460 m). Encounter rates were calculated for each year by the ratio n/L, where n is the total number of sightings and L is the total number of kilometres spent on effort. This is equivalent to computing the weighted mean of the encounter rates (n_i/l_i) recorded within each cell, where n_i and l_i are respectively the number of sightings and the number of kilometres spent on effort in each cell, and the weights are given by the ratio l_i/L. The sampling variance of the encounter rate was then calculated using the formula (Buckland *et al*., 1993)

$$\mathrm{Var}(n/L) = \frac{\sum_{i=1}^{k} \frac{l_i}{L}\left(\frac{n_i}{l_i} - \frac{n}{L}\right)^2}{k-1}$$

where k is the number of cells surveyed.

Cells that received a total survey effort lower than a cell's diagonal (2358 m) in any given year were excluded from the analysis of encounter rates for all years (Figure 2).

Group size and individual photo-identification

The sizes of 428 common dolphin and 235 bottlenose dolphin groups observed in 1993–2003 were estimated in the field by means of independent counts performed by different crew members over

Table 1. Survey effort in 1993–2003: number of daily surveys and total sightings per species (above) and kilometres surveyed 'on effort' (below). The boxed subset indicates the survey effort on which encounter rates were computed

Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Subtotal	Sightings[a]	
									Dd	Tt
Daily surveys										
1993			2	13	11	10		36	15	4
1994			7	15	18	18	2	60	26	6
1995				6	13	8		27	9	4
1996			3	18	22	17	8	68	36	25
1997	4	17	25	22	23	23	11	125	89	25
1998	7	15	17	22	21	26	4	112	76	23
1999			16	23	22	22	2	85	52	31
2000			22	23	24	21		90	54	26
2001		1	21	20	22	18		82	35	28
2002		2	19	16	24	11		72	17	32
2003	9		18	11	19	21		78	19	31
Total	20	35	150	189	219	195	27	**835**	**428**	**235**
Kilometres surveyed 'on effort'										
1993			41	236	290	273		841		
1994			157	371	296	269	38	1131		
1995				131	334	263		727		
1996			32	413	823	465	203	1936		
1997	11	230	626	522	428	581	375	2773		
1998	158	328	361	597	543	545	74	2606		
1999			549	548	689	662	13	2461		
2000			831	511	896	699		2937		
2001		1	472	552	934	478		2438		
2002		50	529	451	1021	454		2504		
2003	448		1059	783	1205	921		4416		
Total	617	609	4657	5133	7460	5610	704	**24771**		

[a] Dd: *Delphinus delphis*; Tt: *Tursiops truncatus*.

protracted observation sessions. Groups were defined as 'dolphins observed in apparent association, moving in the same direction and often, but not always, engaged in the same activity' (Shane, 1990). Members of the focal group usually remained within approximately 100 m of each other and were all potentially photo-identifiable. The number of dolphins in the group and their major age classes were assessed visually *in situ*, and corrected a posteriori whenever photo-identification analyses provided additional information, e.g. when the number of individuals photo-identified was larger than the group size estimated in the field. Groups were followed for an average of 129 min (June–September subset; SD = 76.86, SE = 3.18, $n = 586$, range 1–495; median = 120, IQR = 103). When a group split, one of the daughter groups was followed, based on a random choice that was independent of group size and/or activity (Mann, 1999). A change in group size and/or composition occurred on average every 59 min (SD = 52.22, SE = 1.56, $n = 1142$, range 3–354; median = 42, IQR = 57). The size (and behaviour) of a focal group was sampled at 3 min intervals throughout the duration of the sighting. Yearly mean group sizes were then obtained by extracting from the database a group size sample every 60 min (i.e. at 7:00, 8:00, 9:00, etc.), i.e. an arbitrary time interval greater than the mean duration of

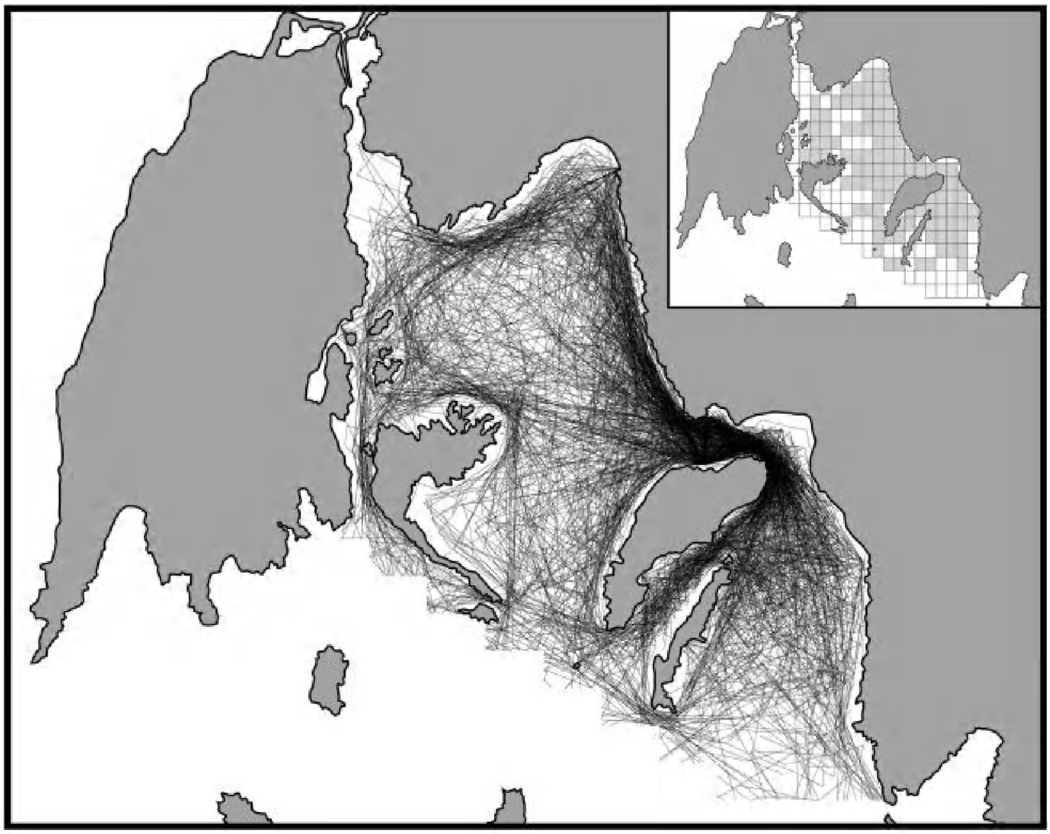

Figure 2. Survey effort in the study area between 1993 and 2003. Cells used for the analysis of encounter rates (see Methods) are shown in the inset.

associations and smaller than the mean time taken to encounter a new group (Whitehead, 2004). Groups other than the focal group observed at a distance (i.e. dolphins in sight *sensu* Bearzi *et al.* (1997)) were not considered. Only groups observed between June and September were considered, to allow for consistency with encounter rate analyses and eliminate any variability potentially caused by seasonal changes in mean group size. Groups observed outside the study area (Figure 1) were excluded from the analysis.

Individual photo-identification was performed consistently throughout 1993–2003, based on long-term natural marks, such as nicks and notches on the dolphins' dorsal fins (Würsig and Jefferson, 1990). For some individual common dolphins the identification was based on a combination of natural marks and dorsal fin pigmentation patterns (Neumann *et al.*, 2002). Only individuals having obvious long-term marks on their dorsal fins were included in the catalogue. Photographs suitable for photo-identification analyses were obtained for a total of 575 days, using AF reflex cameras equipped with 80–200 mm f2.8 APO lenses. This effort produced a catalogue of 18 547 common dolphin and 8245 bottlenose dolphin images. Excluding non-adult size classes (i.e. newborns, calves and juveniles), an average of 48% of all common dolphins and 59% of all bottlenose dolphins encountered were positively identified.

Non-parametric multiple comparisons followed Zar (1984).

RESULTS

Encounter rates

Encounter rates of common dolphin groups showed a significant decrease between 1997 and 2003 (Kruskal–Wallis rank test, $H=29.61$, df = 6, $P<0.001$; Figure 3). Common dolphin encounter rates declined continuously during the course of this study, from a mean of 2.18 groups/100 km recorded in 1997 to a mean of 0.40 groups/100 km in 2003. Encounter rates of bottlenose dolphin groups ($\text{mean}_{1997\ 2003}=0.61$ groups/100 km) did not show significant variations (Kruskal–Wallis rank test, $H=8.36$, df = 6, $P=0.213$; Figure 4).

Group size

Common dolphin group sizes showed significant differences among years 1993–2003 (June–September subset; Kruskal–Wallis rank test, $H=102.84$, df = 10, $P<0.001$). Non parametric multiple comparisons ($P<0.001$) showed that group sizes recorded in years 1993–1994 were significantly higher than those recorded in 1997–2001. Group sizes in 1995–1996 were significantly higher than in 1997 and 1999. Moreover, group sizes in 1999 were significantly lower than in all other years except 1997 and 2000–2001. The mean group size was 13.1 between 1993 and 1996 (SD = 9.28, SE = 0.62, $n=223$, range 2–40; median = 10, IQR = 12), 7.2 in 1997–2001 (SD = 4.70, SE = 0.20, $n=555$, range 1–26; median = 6, IQR = 6) and 9.2 in 2002–2003 (SD = 4.65, SE = 0.51, $n=83$, range 1–23; median = 8, IQR = 6; Figure 5).

Bottlenose dolphin group sizes also showed significant differences among years 1993–2003 (Kruskal–Wallis rank test, $H=65.61$, df = 10, $P<0.001$). However, no consistent longitudinal trend was apparent (Figure 6). Group sizes in the years 1994 and 2003 were significantly higher than those recorded in both 1996–1998 and 2000–2002 (non-parametric multiple comparisons, $P<0.001$). The mean size of bottlenose dolphin groups observed in 1993–2003 was 6.8 (June–September subset; SD = 4.16, SE = 0.22, $n=364$, range 1–24; median = 6, IQR = 5).

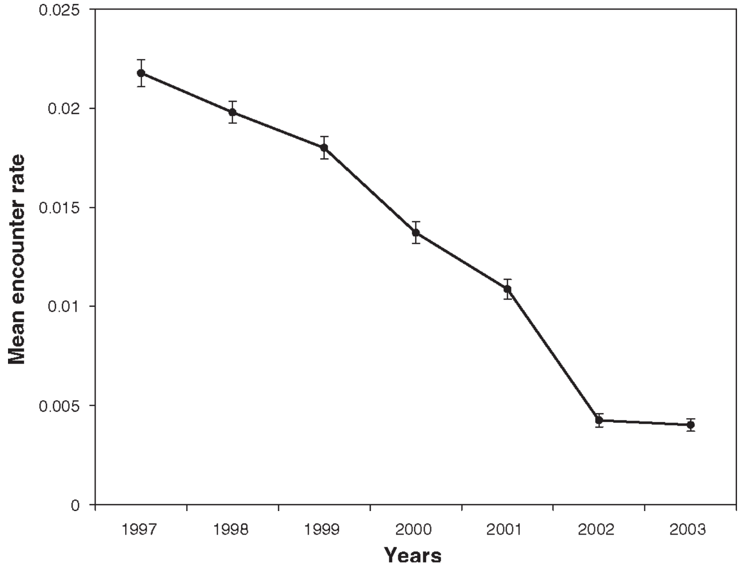

Figure 3. Common dolphin mean encounter rate by year, 1997–2003. Error bars represent 95% confidence intervals.

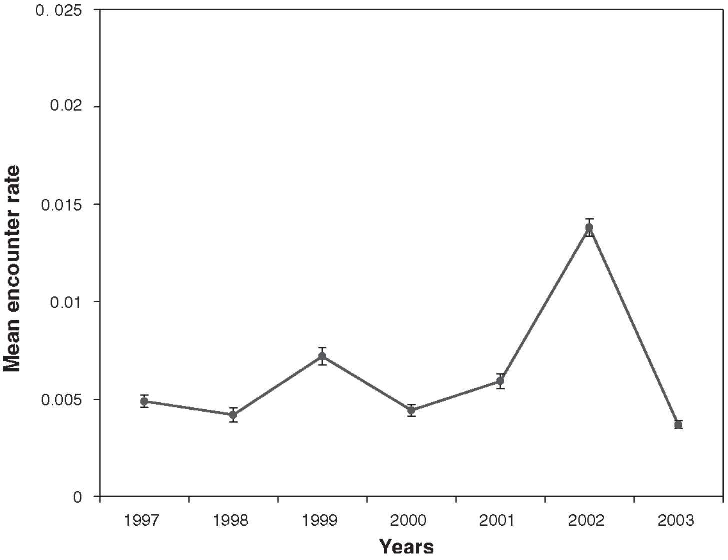

Figure 4. Bottlenose dolphin mean encounter rate by year, 1997–2003. Error bars represent 95% confidence intervals.

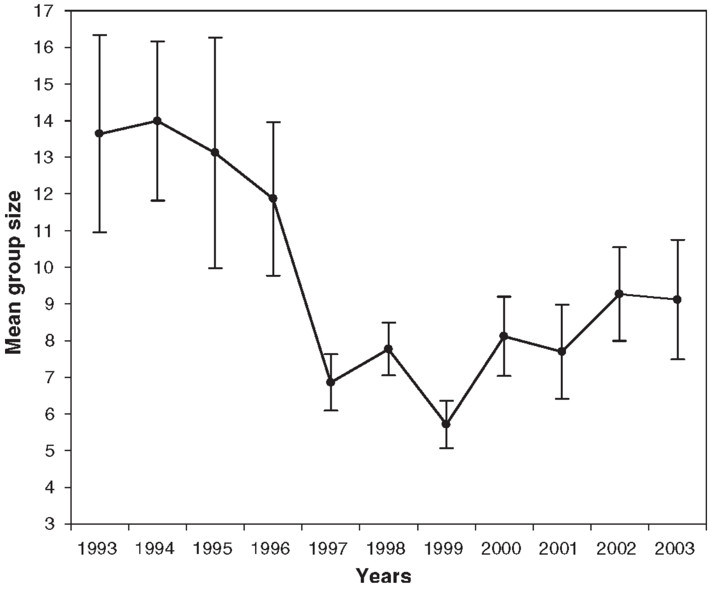

Figure 5. Mean group size by year, 1993–2003: common dolphins. Error bars represent 95% confidence intervals.

There was no correlation between the number of kilometres surveyed on effort before sighting any dolphin group and the size of the group sighted, both for common dolphins (Spearman's $r=0.048$, $n=202$, $P=0.493$) and for bottlenose dolphins (Spearman's $r=0.152$, $n=104$, $P=0.123$), indicating that the capability of detecting dolphins in the study area was independent of the number of individuals comprising a group.

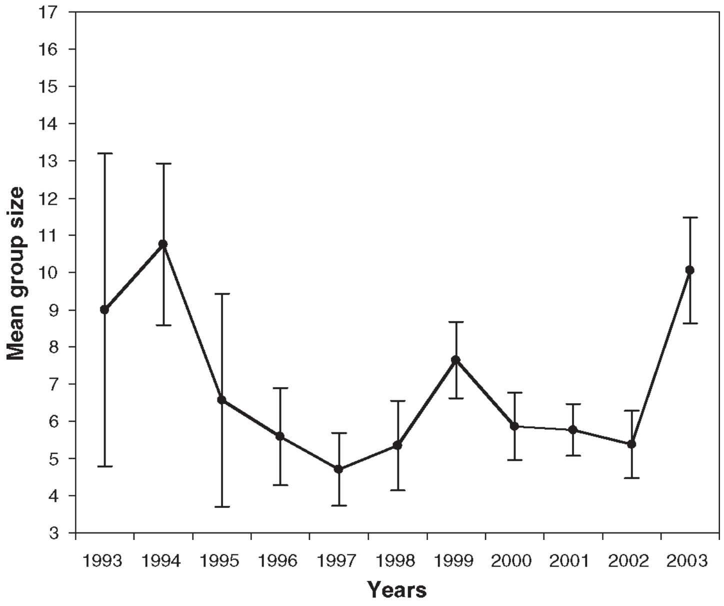

Figure 6. Mean group size by year, 1993–2003: bottlenose dolphins. Error bars represent 95% confidence intervals.

Individual photo-identification

The rates at which individual dolphins were identified during the study are shown in Figures 7 and 8. The curve with the rate of discovery for common dolphins evened out by 1997, indicating that most of the potentially identifiable individuals had been catalogued by that year, and that rates of immigration were low. The continued discovery of a few individuals each year long after the curve has flattened is to be expected even in the absence of immigration. Individuals previously present in the study area can become photo-identifiable as they develop natural marks on their dorsal fins (e.g. in the case of sub-adults as they grow older; Bearzi *et al.*, 1997). Conversely, there was a continuous discovery of bottlenose dolphins across the study period (Figure 8), indicative of a high proportion of transient individuals. The alternative hypothesis of a closed but very large community was rejected based on further evidence provided by photo-identification data (see below).

A total of 72 common dolphins with natural marks on their dorsal fins suitable for reliable, long-term identification were catalogued. Most individual common dolphins were consistently resighted across the study period, although there was a progressive reduction in the number of animals sighted in the second half of the study (Figure 9). Bottlenose dolphins showed a remarkably different pattern. Of a total of 48 bottlenose dolphins catalogued, only about 12 individuals were found consistently in the study area, whereas most others were seen sporadically or only once.

The total number of individual common dolphins identified each year decreased after 1996 (low numbers in 1993–1995 reflect poor effort in those years). Conversely, more bottlenose dolphins were identified in the last years of this study (Figure 9).

DISCUSSION

This study highlights a continuous decline of common dolphins since 1997, which is consistently shown by (1) decreasing encounter rates (Figure 3); (2) decreasing mean group sizes, indicating that decreasing

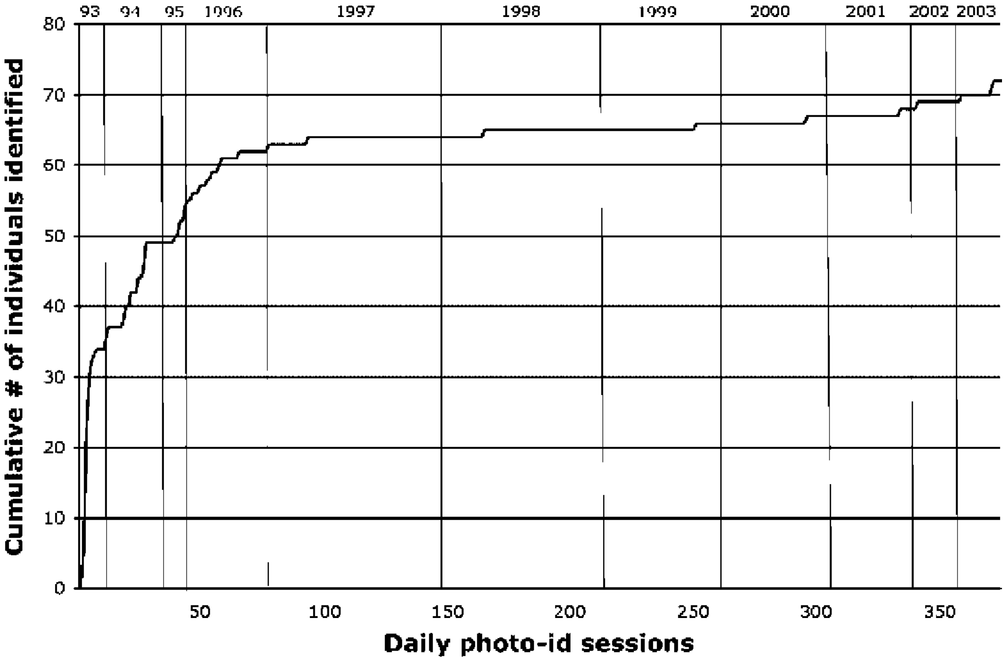

Figure 7. Discovery curve for common dolphins in 1993–2003.

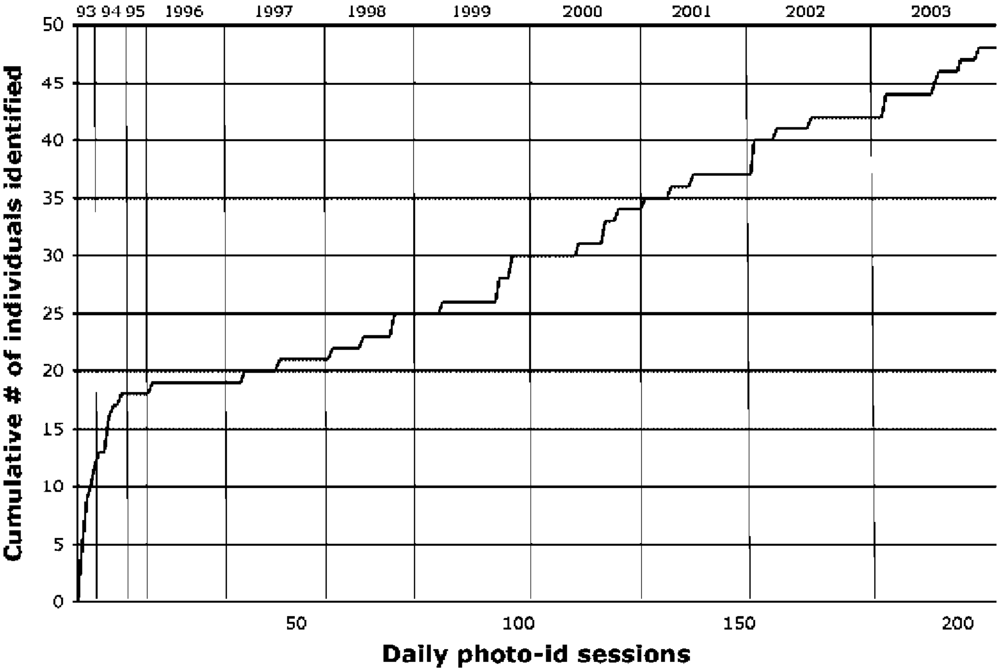

Figure 8. Discovery curve for bottlenose dolphins in 1993–2003.

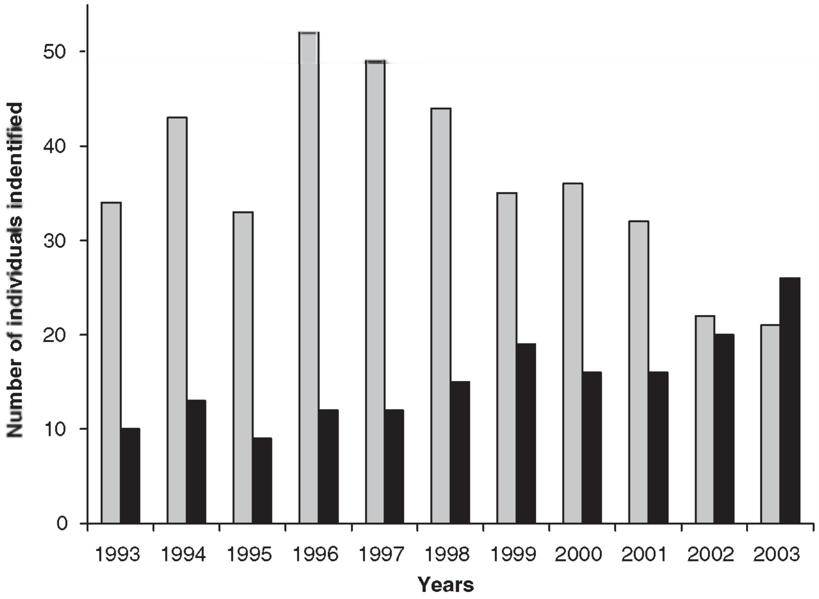

Figure 9. Number of individual common dolphins (light grey) and bottlenose dolphins (black) photo-identified in 1993–2003.

encounter rates resulted from the rarefaction of dolphins in the study area rather than from their aggregation in progressively larger groups (Figure 5); (3) a decreasing total number of recognizable individuals encountered each year (Figure 9); and (4) a flattening of the rate of discovery curve since 1997, indicative of very low rates of immigration (Figure 7). At the beginning of the study, common dolphins were encountered at high densities and resighting rates between years were high. However, during the course of the study, some individuals either died or abandoned the study area, and others were seen much less regularly than before, suggesting that they were utilizing a wider geographical area.

No obvious temporal changes in encounter rate (Figure 4) and group size (Figure 6) were recorded for bottlenose dolphins, which were present at low but relatively stable densities throughout this study. Politi *et al.* (2000) noted signs of emaciation in a high proportion of bottlenose dolphins photo-identified in the eastern Ionian Sea, and this was tentatively attributed to a scarcity of prey caused by intensive trawling. Such fishing activity was demonstrated, *inter alia*, to have depleted the local stock of European hake *Merluccius merluccius* (Papaconstantinou *et al.*, 1985). However, no evidence of a decline in bottlenose dolphins was recorded across this study. Bottlenose dolphins are resilient animals, and they often manage to survive under unfavourable circumstances (e.g. see Bearzi *et al.* (2004a)), largely owing to adaptive strategies involving a high degree of flexibility of diet, social organization and behaviour (Shane *et al.*, 1986; Shane, 1990; Bearzi *et al.*, 1999; Blanco *et al.*, 2001), including opportunistic foraging behind trawlers (Bearzi *et al.*, 1999) or near fish farm cages, as observed in eastern Ionian Sea coastal waters (Bearzi *et al.*, 2004b). Only around 25% of the bottlenose dolphins identified were found consistently in the study area across the study period, whereas most others appeared to be transient, as indicated by their resighting patterns and by the discovery curve (Figure 8). This predominantly transient pattern differs from that of bottlenose dolphins studied in northern Adriatic Sea coastal waters, where higher degrees of site fidelity were observed for most community members (Bearzi *et al.*, 1997).

Both bottlenose dolphins and common dolphins were mostly seen in small groups. A mean group size of seven for bottlenose dolphins is typical in coastal Mediterranean waters, where the species is typically found in groups of 5–10 individuals (Bearzi *et al.*, 1997; Notarbartolo di Sciara and Demma, 1997). Conversely, common dolphin groups observed in the eastern Ionian Sea were unusually small. Common dolphins worldwide are among the most gregarious of all cetaceans (Evans, 1994; Reeves *et al.*, 2002), with average school sizes ranging between 50 and 400 animals, and maximum school sizes of 650–4000 (Acevedo-Gutiérrez, 2002). In the Mediterranean, common dolphins are mostly found in groups of 50–70 animals with aggregations of 100–600 animals recorded occasionally (Notarbartolo di Sciara *et al.*, 1993; Forcada and Hammond, 1998; Cañadas *et al.*, 2002; Bearzi *et al.*, 2003). Although relatively smaller group sizes can be expected in coastal habitats with low predation pressure (Acevedo-Gutiérrez, 2002), the small mean sizes of groups observed in the eastern Ionian Sea (decreasing from about 13 individuals in 1993–1996 to seven to nine individuals in 1997–2003) suggest that the common dolphins in our study area may be facing some degree of social disruption.

Bearzi *et al.* (2003) reviewed the status of Mediterranean common dolphins and concluded that the factors potentially contributing to their generalized decline in the region included: (1) reduced availability of prey caused by overfishing and habitat degradation; (2) contamination by xenobiotic chemicals, resulting in immunosuppression and reproductive impairment; (3) environmental changes, such as increased water temperatures, affecting ecosystem structure or dynamics; (4) incidental mortality in fishing gear, especially gill nets. These and other hypotheses may also explain the decline observed in the eastern Ionian Sea. However, some of the potential threats should be regarded as minor or unlikely causal factors.

The current study recorded no evidence (e.g. carcasses with telltale signs on their bodies) to suggest that dolphins in our study area are being killed deliberately or are dying from entanglement in fishing gear. Although organochlorine levels in common dolphins sampled around Kalamos were relatively high (Fossi *et al.*, 2003), there is no evidence that contaminant levels are higher in the eastern Ionian Sea than in the few Mediterranean areas where common dolphins are still abundant. On the contrary, eastern Ionian Sea coastal waters are considered to be relatively unpolluted (Pitta *et al.*, 1998), and no evidence exists that local contaminant levels have increased significantly in recent years. Although exposure to xenobiotic contaminants is a potentially important threat (Fossi *et al.*, 2003), it is unlikely to be a primary cause for the recent decline in common dolphins recorded in our study area.

Changes in oceanographic parameters can have large-scale impacts on the marine environment, and the distribution of common dolphins may be related to shifting environmental conditions, such as sea temperature (Gaskin, 1968; Forney, 1999; Neumann, 2001). These kinds of fluctuation affect dolphin distribution and/or abundance primarily by influencing the availability of their prey (Selzer and Payne, 1988). It is difficult, therefore, to discriminate between the effects of climate change and other factors affecting dolphin prey, such as overfishing. In the study area, sea-surface temperatures recorded by us across the 11 yr of study did not show any obvious trend (Tethys Research Institute, unpublished data), and gradual or small-scale environmental fluctuations would in any event not be especially good candidates for explaining the rapid decline of common dolphins in the eastern Ionian Sea.

Whether the observed common dolphin decline is simply a consequence of migratory behaviour or long-range movements by some or most community members is not known, and this hypothesis certainly deserves further investigation. To date, several surveys conducted outside the study area between 1997 and 2003 have provided no evidence to suggest that the core of this community has shifted elsewhere.

The patterns observed in the eastern Ionian Sea are consistent with the hypothesis of decreased availability of key prey. As stressed by Chapman and Reiss (1999) 'the lack of sufficient food to maximise reproductive potential may be the most important regulator of population size in animals'. Dispersion over a wider foraging range and reduced group sizes represent behavioural strategies typically adopted by animal communities when food resources are declining and/or distributed in small and low-density patches (Norris and Dohl, 1980; Würsig, 1986; Chapman and Chapman, 2000). Common dolphins in the study area have a particularly fluid fission–fusion social system (Bruno, 2001; Bruno *et al.*, 2004) that was likely promoted by levels of predation that may be assumed as low, and by patchy prey resources (Shane *et al.*, 1986; Würsig, 1986; Shane, 1990; Clapham, 1993). Although such a social system allows for a certain degree of flexibility, living in progressively smaller and scattered groups (e.g. as a response to decreasing prey resources) may bring the community to a point of social collapse (Slooten *et al.*, 1993; Bruno, 2001). This problem may be particularly acute in a promiscuous species such as the common dolphin, for which sperm competition (Stockley and Purvis, 1993) is likely a central feature of its reproductive strategy (Cockcroft, 1993; Murphy *et al.*, 2004). The importance of living in groups of an appropriate size has been highlighted in the nearby Gulf of Corinth, Greece, where Frantzis and Herzing (2002) found a high occurrence of mixed groups that included common dolphins, striped dolphins *Stenella coeruleoalba* and Risso's dolphins *Grampus griseus*. Those authors suggested that common dolphins increasingly associated with striped dolphins when they could no longer find enough conspecifics to form large single-species groups.

Despite high levels of sympatry, associations between common dolphins and bottlenose dolphins were rarely observed and no evidence of mutual avoidance or mutual attraction was recorded over the course of this study. In 1365 h of observation, members of the two species were seen within 100 m of one another for a cumulative total of 180 min on four non-consecutive days (Tethys Research Institute, unpublished data). During those short periods when common and bottlenose dolphins either deliberately approached each other or just happened to be in the same area, close associations were recorded on only two occasions, one in which the animals were feeding together near the surface (6 min) and another in which they were swimming in a tight formation (6 min). Whether this was a consequence of different prey preferences, an attempt to reduce competition, or a combination of both factors is not known. However, systematic observations between 1997 and 2003 indicated that the two species have remarkably different behaviours and exhibit specialized feeding strategies to target different prey (Ferretti *et al.*, 1999). Bottlenose dolphins spent most of their time performing long dives (up to 8 min), apparently targeting demersal prey, whereas surface foraging was a rare event. Conversely, common dolphins typically performed dives shorter than 2 min and were often seen chasing epipelagic schooling fish near the surface. Analyses of floating fish scales collected after bouts of near-surface feeding by common dolphins showed that their prey included European anchovies *Engraulis encrasicholus* and sardines (European pilchard *Sardina pilchardus* and round sardinella *Sardinella aurita*) in similar proportions (Agazzi *et al.*, 2004).

Much of the fish fauna of the eastern Ionian Sea is reduced because of overfishing, and the potential exists for exploitative competition (Keddy, 1989) between common dolphins and local mid-water fisheries targeting their prey, particularly anchovies and sardines (Bearzi *et al.*, 2003; Agazzi *et al.*, 2004; Pusineri *et al.*, 2004). The mean trophic level of fishery catches in the eastern Ionian Sea coastal waters encompassing the study area has been decreasing over the past 20 years (Stergiou and Koulouris, 2000), indicating that the effect of fishing down the food web (Pauly *et al.*, 1998) is at play in this part of the Mediterranean. Since the mid 1980s, decreased total landings were recorded around Kalamos (Papaconstantinou *et al.*, 1988; Papaconstantinou and Stergiou, 1995; Stergiou *et al.*, 1997), an area that has been subjected to intensive bottom trawling (Papaconstantinou *et al.*, 1985). Furthermore, the available data for the entire Greek part of the Ionian Sea show that catch per day for both anchovies and sardines declined significantly ($P < 0.05$) during 1996–2001, despite the fact that the fishing effort (number of days at sea) remained constant across this period (Anonymous, 2001). Although prey overlap between cetaceans and fisheries does not necessarily mean that there is direct competition (Briand, 2004), it is reasonable to assume that such competition might occur when key dolphin prey are scarce and subjected to heavy exploitation (Trites *et al.*, 1997). It is also important to consider that prey *quality* is at least as important as *quantity* when evaluating the ecological interactions between fisheries and marine mammal populations (Trites and Donnelly, 2003).

Largely based on the local presence of relict common dolphin groups, the Greek Ministry of the Environment included the eastern Ionian area around the island of Kalamos in the Natura 2000 network ('Site of Community Importance') under the 9243 EEC Habitats Directive. However, this designation has not yet provided protection to this dolphin community. In light of the negative trends reported here, management strategies are urgently needed. In the absence of clear evidence on cause–effect relationships, action aimed at controlling overfishing is certainly a management obligation, as well as an appropriate precautionary measure to prevent a continued decline of common dolphins in this area. Fishery management measures aimed to reduce the heavy exploitation of epipelagic fish stocks would be likely to produce benefits. In particular, the stocks of European anchovy and European pilchard, representing important common dolphin prey, are heavily exploited by the local purse seiners, and catches are known to have declined dramatically in the study area in recent years. The use of networks of marine reserves encompassing common dolphin critical habitats and of no-take zones aimed at protecting resident and migratory fish stocks also represent appropriate management tools to improve the feeding situation for dolphins and to create the conditions for their recovery, while providing benefits for the adjacent fisheries and the marine environment at large (Agardy, 1997; Roberts *et al.*, 2001; Stergiou, 2002; Hooker and Gerber, 2004).

ACKNOWLEDGEMENTS

This work was co-funded by a Pew Marine Conservation Fellowship — a programme of the Pew Institute for Ocean Science. Further support was received by the *Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area* (ACCOBAMS), by The Whale and Dolphin Conservation Society (WDCS), and by ASMS OceanCare. Konstantinos I. Stergiou (University of Thessaloniki, Department of Zoology, Laboratory of Ichthyology) provided relevant information on fishery trends in Greece. We are grateful to John Harwood, Giuseppe Notarbartolo di Sciara, Randall R. Reeves, Simone Panigada, Maddalena Bearzi and an anonymous referee for their insightful comments on early drafts. John Harwood also helped us choose a method for the analysis of encounter rates. Roberto Gramolini developed a dedicated tool to ease ArcView GIS analyses. Thanks to Sabina Airoldi, Mauro Bastianini, Enrico Cabras, Sabrina Ferretti, Alexandros Frantzis, Joan Gonzalvo, Cristiana Miglio, Ada Natoli, Simone Panigada, George Paximadis, Giovanna Pesante, Chiara Piroddi, Francesco Quondam and Aviad Scheinin for contributing to field data collection and/or data analysis. Our gratitude also goes to all the volunteers who made this research possible through their financial contributions and help in the field. The Venice Natural History Museum and the Milan Civic Aquarium and Hydrobiological Station provided invaluable logistic support.

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