Aquatic Mammals 2003, **29.1,** 88–98

Patterns in the mortality of common dolphins (*Delphinus delphis*) on the Portuguese coast, using stranding records, 1975–1998

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Abstract

Spatial and temporal patterns of distribution of common dolphins (*Delphinus delphis*) off the Portuguese continental coast were examined using a stranding database, for the period 1975 to 1998. Information on sex and size composition of the strandings and by-catch events was analysed to elucidate the social organization of this species. Studies were based on 294 stranded specimens and 124 confirmed by-catches. The annual number of dolphins stranded increased during the study period, probably as a result of a higher observer effort. Stranding records suggested that common dolphins are present off the Portuguese coast in all seasons and months of the year and occur in all the regions. However, geographic distribution of mortality was not homogeneous—larger numbers of strandings were recorded in the northern and central areas of the country. Three factors may be responsible for this pattern: differences in the distribution and/or abundance of the species, oceanographic conditions, and/or topographic features of each area. Significant differences were found in the number of strandings per season, with 37% occurring in the spring and 33% in the winter months, which may be a consequence of the severe weather conditions at this time of the year. Sex ratio of the stranding and by-catch records was significantly biased towards males in all geographic areas and seasons. Similarly, a significantly higher proportion of immature individuals were found both in the stranding and by-catch datasets. These results could suggest either the existence of differential mortality by sex and maturity, or the occurrence of age and sex segregation in the population. Stranding data also suggest that fishery interactions could be responsible for up to 44% of mortalities for this population.

Key words: common dolphin, strandings, by-catch, distribution, occurrence, sex composition, Portuguese coast, *Delphinus*.

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Introduction

There has been much debate on the usefulness of stranding data to infer spatial distribution, seasonal movements, population structure, and trends in abundance of cetacean species (Addink & Smeenk, 1999; Sequeira, 1996; Van Waerebeek *et al*., 1999). This occurs because stranding events are sensitive to factors that affect beaching and carcass detection. Both short- and long-term environmental factors, such as coastal currents, wind speed, sea state, and water temperature, influence stranding events. Similarly, the coast characteristics (e.g., orientation, nature of substrate, horizontal profile, among many others) influence the way a carcass is cast and maintained on the shore. Species occurring in inshore or along coastal waters are more likely to be brought ashore than pelagic cetaceans. Furthermore, factors influencing stranding detection include carcass size and exposure to potential observers. As a result, the probability of detecting a stranding event varies among species, and will not be consistent within a single species. It is therefore difficult to establish a direct relationship between the spatial and temporal distribution and abundance of cetaceans at sea, and the number of animals found stranded upon the coasts.

In spite of these problems, analysis of stranding data has been widely used since they often constitute the sole source of information for a given population, species, or geographic area. This is the case for Portuguese waters, where apart from a few opportunistic sighting cruises, no systematic surveys have ever been conducted. As a result, very little is known about the spatial and temporal patterns of the distribution of cetacean species in this area of the northeastern Atlantic. The lack of systematic survey data for Portuguese waters precludes a comprehensive analysis of cetacean distribution patterns within a broader geographical context.

The largest source of data on cetacean occurrence off the Portuguese coast consists of stranding records. These records were compiled into a national database, maintained by the Instituto da Conservação da Natureza, and to which all relevant institutions contribute (port administrations, aquaria, museums, nongovernmental organizations, universities, fisheries institutions, and individuals). In the absence of alternative data, these provide the best available information on the occurrence and distribution of several cetacean species.

A preliminary analysis of this database showed that common dolphin (*Delphinus delphis*) strandings constituted the bulk of the records. Thus, in this paper we present these records and analyse the possible implications regarding spatial and temporal patterns of distribution and social organization of common dolphins along the Portuguese coast.

Materials and Methods

The study area covers the entire continental coastline of Portugal. The western coast of Portugal extends approximately 700 km along the 9°W meridian between 37°N and 42°N. The southern coast totals about 250 km and runs along the 37°N parallel, between 7°20′W and 9°W (Fig. 1). Along the western coast, the dominant winds vary between northerly and northwesterly, whereas on the southern coast the prevalent winds are westerly (Fiúza *et al*., 1982).

Data on common dolphin strandings presented in this study were obtained from the stranding database at Instituto da Conservação da Natureza. Organizations involved in the stranding network are provided with marine mammal identification guides and information packages about stranding events. Network members receive training on species and sex identification, and data collection. To ensure standardization of data, cetacean and pinniped stranding report forms are distributed to network participants. Photographs of stranded animals also are taken, so species and sex identification can be confirmed later. Incidental catches were reported directly by fishermen, or by port administrations and maritime authorities. Although the dataset includes some information on stranding events from as early as the sixteenth century, only records subsequent to 1975 (when data started to be collected systematically) were used in this analysis.

The information recorded and stored in the database includes the stranding location, date, species, biometry, sex, types of biological samples collected, and indication of the cause of death. All measurements of common dolphins were taken according to Norris (1961). Variability and inconsistency of measurements taken by different persons or by the same person on different occasions were not accounted for. As most animals were too decomposed to be necropsied, reproductive condition was inferred from total body length. Females less than 190 cm and males smaller than 200 cm length were considered to be sexually immature (Silva, 1996). The following traumatic criteria were used to diagnose by-catch in fishing gear among stranded carcasses: (i) skin lesions or incisions apparently produced by net material or a sharp instrument; (ii) amputated fins or flukes; (iii) removed blubber and/or musculature from the flanks, and (iv) rope marks around the tail stock or head (Kuiken, 1996). Other external injuries (e.g., bone fractures, propeller marks, wounds caused by fire guns or harpoons) and signs (e.g., fuel) were also noted and photographed. To test for the existence of geographic variations in the stranding pattern, data were grouped into three arbitrary areas of equal length of coastline (northern, central, and southern) (Fig. 1). The northern and central areas are located along the Portuguese western coast. About one-third of the southern area is oriented to the west and the remaining to the south.

Numbers of common dolphin strandings per year were too small to test for annual differences in mortality. Therefore, data were pooled into 5-year periods to examine the influence of temporal variables on the stranding pattern. Seasons were defined as: spring (March–May), summer (June–August), autumn (September–November), and winter (December–February).

Chi-square tests were used to compare the number of strandings of common dolphins among geographic areas, seasons, and temporal periods. Association between variables was examined with chi-square tests on two-dimensional or three-dimensional contingency tables. The Fisher exact test was used in the case of 2×2 contingency tables. Differences on the average length of male and female dolphins were analysed with *t*-tests, and differences in the length distribution between stranded and incidentally caught dolphins were tested using the Kolmogorov–Smirnov test. Statistical procedures followed Zar (1996).

Results

Causes of mortality

Between 1975 and 1998, 593 dead common dolphins were reported, of which 38 (6%) were hunted, 124 (21%) were incidentally captured during fishing activities, and 294 (50%) were found stranded on the beaches. The latter do not include an additional 137 (23%) stranded dolphins that exhibited physical signs of entanglement in fishing. For most of these animals, it was not possible to determine if the interaction that caused the lesions was responsible for the death of the individual or if the lesions were produced after death. Moreover,

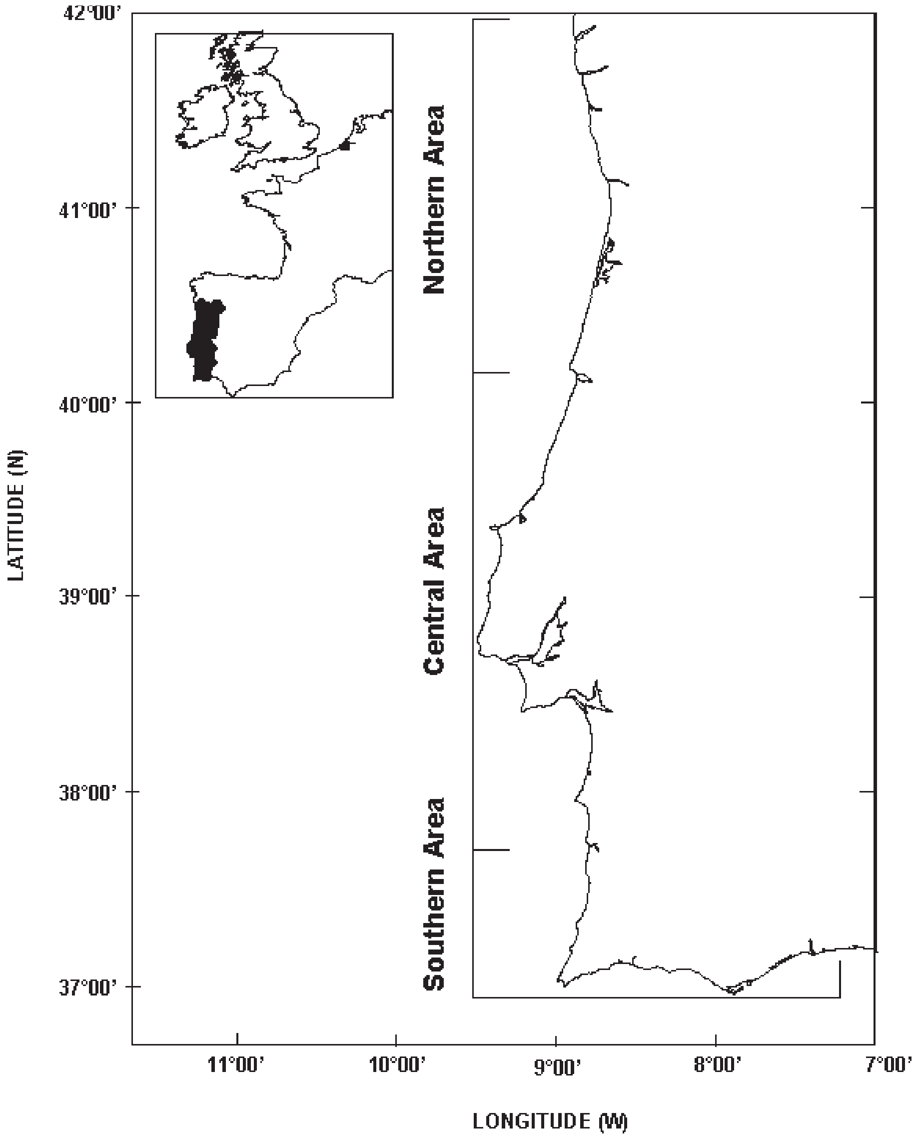

Figure 1. Map of the Portuguese mainland coast showing the demarcation of the three geographic areas considered.

marine mammals are known to exhibit lesions caused by entanglement episodes from which they have managed to escape alive (Kraus, 1990). Therefore, animals exhibiting signs of by-catch that were found stranded were not included in the analysis, due to the difficulty in determining the cause of their death.

In Portugal, small cetaceans were hunted until 1981, when a law granting full protection to all marine mammals was passed. Data from hunted dolphins were not analysed since they are not representative of the natural mortality of the population and for most of the animals information on capture location, sex and length was not available.

Strandings

Temporal and geographical distribution of mortality —Figure 2 presents the annual number of common dolphins stranded on the Portuguese coast between 1975 and 1998, and its percentage in relation to

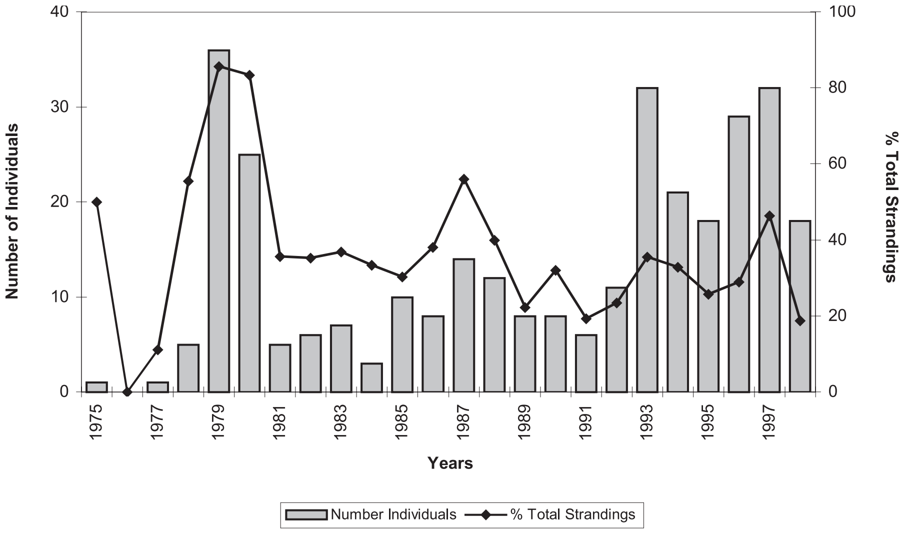

Figure 2. Annual distribution of common dolphin strandings on the Portuguese coast and its percentage in relation to total cetacean strandings (1975–1998).

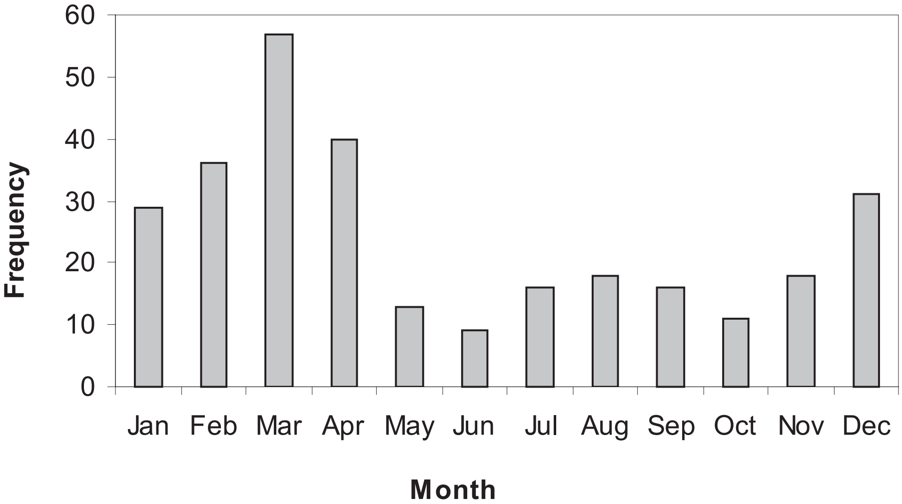

Figure 3. Monthly distribution of common dolphin strandings on the Portuguese coast (1975–1998).

total cetacean strandings. In the early period (1975–1980) the relative frequency of strandings of common dolphins varied considerably (0–85%) from year to year. After 1980, strandings of this species comprised between 19% and 68% of the total number of strandings per year, with an average value of 34%. In general, the number of strandings of common dolphins increased from 1975 to 1998, although there were some important yearly variations, and a few pronounced peaks emerged from the regular pattern (e.g., in 1979, 1980, 1993 and 1997).

Strandings did not occur randomly in the three areas considered ($\chi^2=39.9$, $df=2$, $P<0.00001$). The central area comprised 46% ($n=135$) of the total number of strandings, whereas the southern area was the poorest accounting for only 49 (17%) of the 294 records. Monthly distribution of common dolphin strandings suggested a regular pattern, showing an increase starting in December, reaching a pronounced peak in March and decreasing again in April (Fig. 3).

When data were pooled, there were significant differences in the number of strandings per season

Table 1. Number and mean length of stranded and incidentally caught common dolphins by sex.

	Body length (cm)							
	Females				Males			
Cause of death	*n*	Mean	SD	Min–Max	*n*	Mean	SD	Min–Max
Strandings	57	178.1	21.9	137–220	99	187.4	29.7	97–250
By-catches	17	162.2	40.9	96–227	39	182.5	19.5	108–230

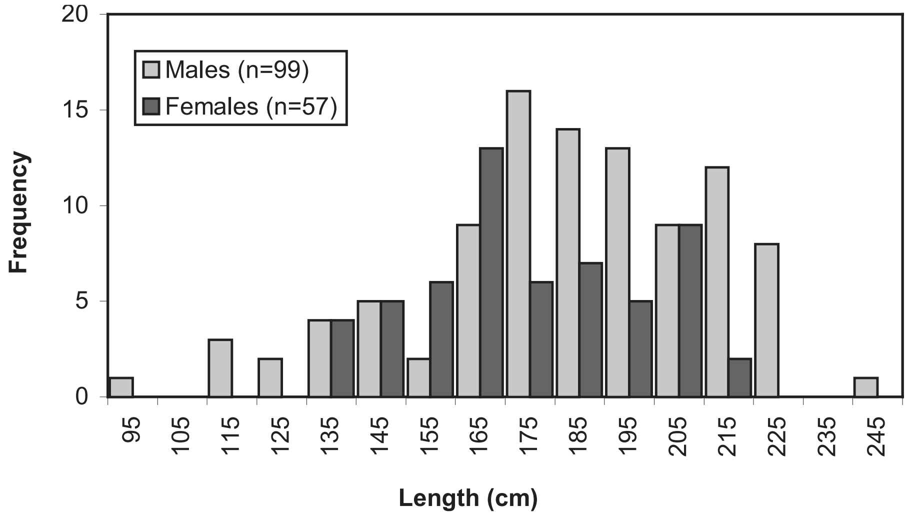

Figure 4. Length distribution of male and female common dolphins stranded on the Portuguese coast (1975–1998).

(χ^2=48.7, *df*=3, *P*<0.00001), with 37% (*n*=110) occurring during the spring and 33% (*n*=96) during the winter. Summer and autumn seasons had exactly the same number of strandings (*n*=44, 15%). The number of strandings in each geographic area was independent of the season (χ^2=11.9, *df*=6, *P*>0.05), suggesting that seasonal factors affecting stranding location acted equally in all the areas considered. There was however, a significant association between stranding location and temporal periods considered (5-year periods: χ^2=42.2, *df*=8, *P*<0.00001). Between 1975 and 1989, more than 67% of common dolphin strandings in the three 5-year periods considered occurred in the central area of the country, whereas after 1990 the northern area registered the majority of the stranding records (47%).

Sex and age class composition of mortality—For 121 (41%) individuals, sex could not be determined due to the advanced stage of decomposition or mutilation of the carcass. Of the remaining dolphins, 109 (63%) were males and 64 (37%) were females, yielding a male to female sex ratio of 1.7:1, which was significantly different from parity (χ^2=11.7, *df*=1, *P*<0.001). Average length of males and females was significantly different (*t*=2.0, *df*=154, *P*<0.05) (Table 1). Length distribution of male and female stranded dolphins is shown in Figure 4. Individuals classified as sexually immature (62%, *n*=96) occurred more frequently than mature animals (χ^2=8.3, *df*=1, *P*<0.005) and comprised 59% of male and 65% of female dolphins stranded. To investigate whether the male-biased pattern occurred only in a particular season or temporal period, a three-dimensional contingency table was used to test for mutual independence of sex, season, and 5-year periods. There was no association between the three variables (χ^2=32.6, *df*=31, *P*>0.05) and the sex ratio was biased towards males in all the analyses performed. Similarly, reproductive class, season, and 5-year periods were mutually independent (χ^2=18.6, *df*=31, *P*>0.05).

Table 2. Number of by-catch events recorded and number of dolphins killed by type of fishing gear (1975–1998).

Fishing gear	Number of events	Number of dolphins killed
Gill nets	23	84
Beach seine nets	4	14
Trawl nets	2	12
Pelagic trawl nets	2	5
Tram nets	1	1
Octopus trap	1	1
Undetermined	6	7
Total	39	124

By-catches

One hundred and twenty-four common dolphins were caught in 39 separate fishing events, representing 77% of all cetaceans killed in fishing operations. Six different types of fishing gear were involved in the by-catch events analysed in the present study (Table 2). Gill nets were responsible for the largest number of occurrences ($n=23$, 59%) and captured more than 67% ($n=84$) of the dolphins. Beach seine nets and trawling operations killed 11% and 9%, respectively, of the individuals, with the former being only involved in four of the 39 by-catch events. Approximately 79% of the by-catch events were recorded in the central area, 13% in the northern, and only 3 (8%) occurrences took place in the southern area. About 85% ($n=106$) of the mortality caused by fishing operations occurred during the 1970s and 1980s, and since 1990 only 18 confirmed cases have been registered. Most of the by-catch events were recorded during spring ($n=15$) and summer ($n=15$) months (autumn, $n=6$; winter, $n=3$).

Sex and age class composition of mortality—Of the 124 confirmed by-catches, 42 were males, 18 were females and for the remaining 64 sex was not determined. The sex ratio of the by-catch sample was 2.33:1, which was significantly different from unity ($\chi^2=9.6$, $df=1$, $P<0.005$). Average length of male and female common dolphins incidentally caught was significantly different ($t=2.5$, $df=54$, $P<0.05$) (Table 1; Fig. 5). Sixty-eight (55%) dolphins incidentally caught were not measured so reproductive condition could not be inferred from total body length. The ratio of immature to mature dolphins was 4.6:1, which was significantly different from unity ($\chi^2=23.1$, $df=1$, $P<0.0001$). Maturity was independent of sex (Fisher-test, $P>0.05$), with sexually immature dolphins comprising 87% of male and 71% of female by-catches. Differences in the length distribution of stranded and incidentally caught dolphins were statistically significant among males (Kolmogorov–Smirnov Test, $D=0.3$, $n=97$, $P<0.025$) but not among females ($D=0.4$, $=54$, $P>0.10$).

Thirteen by-catch events involved more than a single animal. Although the individuals caught may not represent the whole school at time of capture, and despite the sample size, analysis of school composition in these events was used to test hypotheses regarding group segregation. On five

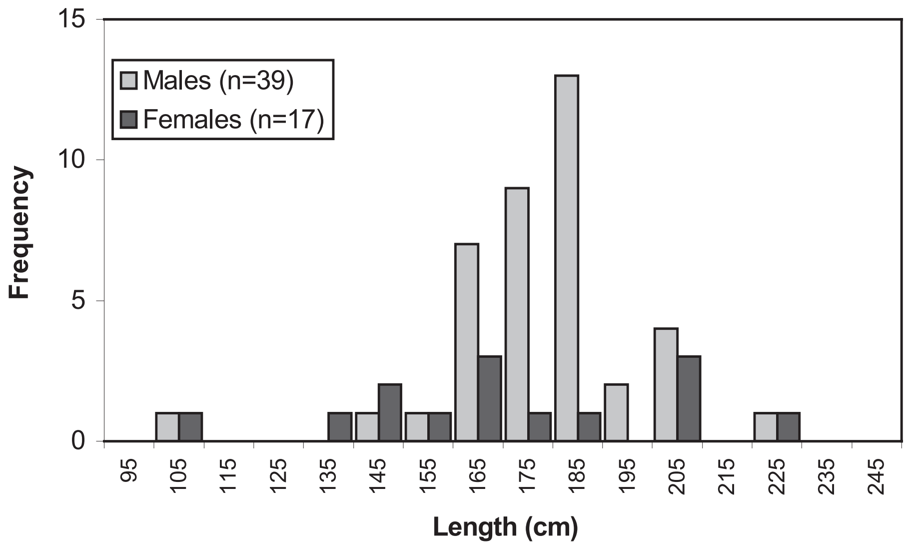

Figure 5. Length distribution of male and female common dolphins incidentally caught in fishing operations off the Portuguese coast (1975–1998).

occasions, the groups captured were entirely composed of immature males; in three events pregnant and lactating females were caught together with very young animals (between 96 and 110 cm length) of both sexes; a mixed group of immature males and females (with a marked predominance of the former), and mature males comprised five groups incidentally caught.

Discussion

This paper documents mortality of common dolphins on the Portuguese coast from 1975 to 1998 based on stranding records. The results reported here represent an unknown percentage of total mortality, since many carcasses never reach shore, and others are not detected or reported to the authorities. However, the current data suggest certain trends worthy of further investigation.

Results from the present study suggest that common dolphins are the most abundant cetacean species off the Portuguese coast. Indeed, common dolphin strandings comprised 46% of all the records contained in the database and accounted for more than one-third of the average annual strandings. However, this figure could be a conservative estimate because of the large percentage of small delphinids that remain unidentified, the majority of which probably consists of common dolphins.

Annual variations in mortality

Although the number of strandings of common dolphins increased from 1975 to 1998, this does not necessarily reflect an increasing mortality of the species. More likely this pattern is the result of a higher percentage of the strandings being reported to the authorities, which in turn indicates an increased public awareness on the issue. It is possible however, that some of the specific peaks in strandings correspond to years of unusual oceanographic events or mortality episodes. This could be the case of the peak observed in 1979–1980, which seems to be the result of a peak in the number of common dolphin strandings. In 1993, 1996 and 1997, strandings of common dolphins reached higher values than in previous years; yet, this species accounted for only a moderate percentage of overall cetacean strandings. Furthermore, strandings of other species, such as harbour porpoises (*Phocoena phocoena*), bottlenose dolphins (*Tursiops truncatus*) and striped dolphins (*Stenella coeruleoalba*), followed a similar yearly pattern. This suggests that the larger number of strandings of common dolphins was not the result of a mortality outbreak in this species but could probably be the consequence of severe weather and sea conditions, unusual oceanographic patterns or biological or anthropogenic events (e.g., oil spills, red tides).

Geographical distribution

The geographic distribution of strandings of common dolphins was not homogeneous along the Portuguese continental coast. Almost half of the strandings were recorded in the central area of the country, whereas the southern area comprised less than 17% of the events. The geographic pattern observed was independent of the season, but when data were pooled into 5-year periods there was a significant association between stranding location and periods considered. This indicates that factors influencing the stranding location were not consistent throughout the years. Until 1989, the highest percentage of strandings was recorded in the central area of the country, whereas the northern area accounted for most of the mortality from 1990 onwards. This shift in the mortality pattern most certainly reflects the distribution of observer effort and not the true distribution of common dolphins. Before 1990, the Portuguese stranding network was focused mainly in the central area of the country, where most of the organizations involved were located. After that, and particularly with the beginning of Beached Bird Surveys in 1990, observer effort was more evenly distributed within and among areas. The same pattern was also evident in the stranding records of other cetacean species. From 1975 to 1989, strandings in the central area comprised between 46% and 51% of the overall strandings (after removing the strandings of common dolphins). From 1990 onwards, 34% of the strandings occurred in the northern area and 47% in the central area of the country.

There are several possible explanations for the higher mortality in the northern area, including differences in the spatial distribution or abundance of dolphins, oceanographic conditions and coastal topography of the area. Due to the lack of systematic cetacean surveys, it is not possible to verify the validity of the first hypothesis with at-sea data on distribution and abundance of common dolphins. However, examination of stranding data of other dolphin species (Sequeira, 1996; Sequeira *et al.*, 1996) failed to provide a consistent pattern, as would be expected if only observer effort, oceanographic conditions or topographic features were responsible for the results obtained. Usually, distribution and movements of small delphinids closely matched those of their preferred prey (Clarke, 1986). The spatial pattern of distribution and relative abundance of common dolphins observed in this study seems to follow this general rule. In Portuguese waters, common dolphins are known to feed on a variety of epipelagic and mesopelagic shoaling fishes, but sardine (*Sardina pilchardus*), blue whiting (*Micromesistius poutassou*) and snipefish (*Macroramphosus* spp.) seem to be the most important components of their diet (Silva, 1999). Patterns in the abundance of these prey species along the Portuguese coast agree with the stranding pattern described, with greater numbers of prey in the northern and central areas and much lower abundance on the south coast of Portugal (Cunha, 1989; Serrão, 1989). Therefore, distribution of common dolphin strandings along the Portuguese coast could partly reflect the distribution of the species at sea. Yet, care must be taken when interpreting data at small geographic scales, as the stranding location strongly depends on post-mortem drifting.

Furthermore, these results are certainly affected by oceanographic conditions and topographic features of the areas. The more sheltered position of the southern coast with respect to dominant N and NW winds (Granadeiro & Silva, 1993) could help explain the lower mortality recorded on the southern area. In addition, the northern area is characterized by a larger continental platform with gentle slopes. Thus, carcasses have a higher probability of being retained, and because these are easily accessible beaches, dolphin strandings could be easier to detect.

Therefore, it seems plausible that all three factors—spatial patterns of distribution/abundance of dolphins, oceanographic and climate conditions, and coastal topography—interact to produce the observed stranding pattern of common dolphins. Differences in the number of strandings between the northern or central and the southern area could be mainly caused by differences in the distribution and/or abundance of the species and in oceanographic conditions, whereas distribution/abundance and topographic features could have a strong influence in the variations within the western coast.

Seasonal variations in mortality

Common dolphin strandings were recorded in all months, indicating that the species is present off the Portuguese continental coast all year round. However, the stranding frequency varied greatly throughout the year, exhibiting pronounced peaks in March, April and February. When data were pooled into seasons, a higher number of strandings was recorded during spring, followed by winter and autumn. Seasonal differences in the frequency of strandings could result from variations in oceanographic and climate conditions, indicate local changes in distribution and/or abundance, or result from the combination of both factors. The seasonal pattern of mortality shown in the present study is in agreement with those described for the species elsewhere (Berrow & Rogan, 1997; Collet, 1981; Duguy & Wisdorff, 1988), as well as with the general pattern of cetacean strandings on the Portuguese coast (Sequeira *et al*., 1996, 1997). This suggests that oceanographic factors may be the main driving force for the seasonal distribution of strandings. In fact, the extreme weather and sea conditions experienced during winter and early spring not only tend to push carcasses to shore, but also could contribute to the death of weak, injured, or young animals. In contrast, during the summer (especially from July to September), upwelled waters occupy the surface layers over the whole western shelf and part of the upper slope of Portugal, and their areal extent pulsates onshore-offshore (Fiúza, 1983). This phenomenon could also contribute to the lower number of strandings in the summer by preventing some of the carcasses from washing ashore. Although acknowledging the influence of oceanographic factors, Collet (1981) also suggested that an offshore seasonal displacement could contribute to the low number of summer strandings of common dolphins on the French Atlantic coast. In comparison, Tomilin (1967) was able to detect a decrease in the percentage of females in the Black Sea catch composition during spring and summer, which he suggested was caused by a summer offshore migration of females to open seas in order to calve. If the same phenomenon occurs on the Portuguese coast, we would expect the male-biased mortality patterns to be even more pronounced during the summer months, which was not the case. Instead, the male-biased mortality was more obvious during winter and spring months, particularly from January to April. Furthermore, by-catch data indicate that pregnant and lactating females accompanied with very young calves were incidentally caught in beach seine nets during the summer months. The offshore seasonal displacement of common dolphins could be related to the movements of their prey. Unfortunately, there is no reliable information on the seasonal movements of prey along the Portuguese coast. However, no significant differences were found in the diet of common dolphins stranded in winter and summer seasons (parameters investigated were prey diversity, relative proportion of fish and cephalopods in the diet, percentage weight and length of sardines consumed) (Silva, 1999). This could mean that there are no seasonal differences in prey distribution or abundance, or that common dolphins are indeed following the movements of their preferred prey.

Sex and age class composition

In cases where sample size permitted statistical analyses, examination of the sex of common dolphins stranded in the Portuguese coast indicated a significantly male-biased ratio. This bias towards males was evident in immature, as well as mature dolphins. Sexually immature individuals comprised the majority of the stranding records on the

Portuguese coast, independently of the geographic area, temporal period and season considered. Although for a large percentage of the individuals recorded in this study sex and body size remained unknown, there is no reason to believe that this would consistently affect a single gender or maturity class.

Assuming that strandings reflect the natural mortality of the population, bias in the sex ratio of stranded common dolphins could be caused by an unequal sex ratio in the population, differential mortality rate, or differences in the distribution or behaviour between sexes.

Bias in sex ratio in strandings has been reported for several dolphin species and populations (e.g., Perrin & Reilly, 1984). There is also some evidence of unequal sex ratios at birth, with a higher tendency towards male-biased ratios detected in embryos (e.g., Tsalkin, 1940 cited in Tomilin, 1967), foetuses (e.g., Sergeant, 1962; Miyazaki, 1984), and neonates (e.g., Aguilar & Lockyer, 1987). Studies also show that the proportion of males can decrease with age; for older age classes, the sex ratio is usually near unity or biased towards females (Kasuya & Marsh, 1984; Perrin & Reilly, 1984). In the present study, male mortality increased from the immature to the mature class, but number of mature males incidentally caught equalled that of females, suggesting a sex ratio close to unity in older year classes.

Differential mortality appears to be common among several mammalian species, with the general tendency for higher mortality rates in males (Ralls *et al.*, 1980), the gender that usually exhibits a larger body size.

Age and/or sex segregation seems to occur in several dolphin species and populations (Cox *et al.*, 1998; Perrin & Reilly, 1984; Perryman & Lynn, 1994; Rogan *et al.*, 1997; Sergeant *et al.*, 1980) and authors often have used this phenomenon to explain uneven sex ratios observed in stranded and captured population samples. In this study, evidence for the existence of age and sex segregation among common dolphins is provided by the analysis of by-catch records. The analysis of the composition of multiple individual by-catch events suggests that immature dolphins either form separate groups or join mature males. Mature females were only found with very young calves. It is worth noting the complete absence of immature schools composed only of females and the pronounced bias towards immature males. These results are in agreement with information on school composition of striped dolphins (a closely-related species) caught in the drive fishery in Japan (Miyazaki & Nishiwaki, 1978), where a predominance of immature males was reported. The segregation hypothesis is further supported by observations of common dolphin schools incidentally caught in trawling operations off the northeast United States (Waring *et al.*, 1990). About 70% of the individuals sexed were males and a very large percentage was sexually immature.

In summary, analysis of the stranding and by-catch datasets could suggest the existence of differential mortality by sex, with immature and mature males suffering higher mortalities due to dispersal and competition. This does not exclude however, the hypothesis of an excess of immature males caused by uneven sex ratios at birth. This ratio would tend to balance with increasing age, as the male population was impacted by higher mortalities. Alternatively, age and sex segregation could occur in the population, as evidenced by the composition of by-catches, with females segregating to more offshore waters. Females might then have lower probabilities of either being washed ashore after death, or being affected by the interaction with coastal fishing operations. The predominance of immature individuals of both sexes in the by-catch dataset could also result from a greater susceptibility to entanglement owing to lack of experience.

According to the information contained in the stranding database, 124 common dolphins died as a result of interaction with fishing operations. In addition, 137 stranded animals exhibited physical evidence of interaction with fishing gear, although in most cases it was not possible to confirm if the interaction was responsible for the death of the individual. Assuming the worst scenario, these results suggest that 44% of the deaths recorded were caused by interaction with fisheries. Although it cannot be determined if current mortality levels pose a significant threat to the population inhabiting this geographic area, by-catch rates should be precisely assessed and carefully monitored, perhaps through the implementation of a coastal fisheries observer programme.

Acknowledgments

The present work would not have been possible without the collaboration of all persons and institutions that have voluntarily participated in the Portuguese stranding network. We acknowledge and thank those collaborators for collecting data on the stranded specimens. We are also thankful to António Teixeira (Instituto da Conservação da Natureza), Aldina Inácio (Aquário Vasco da Gama), and Francisco Reiner, who have been the promoters of the stranding network. We gratefully thank José Pedro Granadeiro, Alexandra Silva, Tara Cox and one anonymous reviewer for their valuable comments on an early draft of this manuscript.

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