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Cetacean strandings on the coast of Ceará, north-eastern Brazil (1992–2005)

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This study reviews and updates information on cetacean strandings in the state of Ceará, Brazil (02°30′S 41°15′W – 04°30′S 36°45′W), comprising 573 km of coastline. In the years 1992–2005, there were 252 cetacean stranding events, representing 19 species: three species of Balaenopteridae, three Physeteridae, two Kogiidae, two Ziphiidae and 11 Delphinidae. Three species comprised the majority (78.9%) of stranding events: estuarine dolphin, Sotalia guianensis *(61.9%); sperm whale,* Physeter macrocephalus *(10.3%); and rough-toothed dolphin,* Steno bredanensis *(6.7%). There was an increasing trend in the number of cases reported in the first five years with a highest frequency achieved in 1996. Stranding events occurred throughout the year, with the lowest frequency occurring in the autumn (March–May). Approximately 4% of the events were attributed to natural causes while 24.6% were human-related, mainly incidental captures. Meat removal for human consumption or bait was recorded in 6.7% of events. In the study area,* Sotalia guianensis*,* P. macrocephalus *and* Steno bredanensis *were the most abundant cetacean species, whereas* Lagenodelphis hosei*,* Pseudorca crassidens*,* Orcinus orca*,* Kogia sima*,* Mesoplodon europaeus*,* Balaenoptera acutorostrata *and* Balaenoptera bonaerensis *are probably rare in the area.*

Keywords: cetacean strandings, incidental capture, Ceará, north-eastern Brazil

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INTRODUCTION

Stranding of cetaceans occurs worldwide due to several reasons. Natural factors, such as diseases (Dhermain *et al.*, 2002), navigational error (Bompar, 1996), abnormalities in the Earth's magnetic field (Klinowska, 1991), oceanographical or climatic events (Perrin & Geraci, 2002), escaping predators (Nores & Perez, 1988), pursuing prey (Casinos & Vericad, 1976), and anthropogenic causes, such as boat collisions (Laist *et al.*, 2001; Jensen & Silber, 2003), pollution (Kannan *et al.*, 1993) and entanglement in fishing gear (Read *et al.*, 2003) are the main reported causes of these strandings.

Stranding events provide useful information for determining species occurrence, distribution and abundance (Berrow, 2001). They are also sources of information about the causes of deaths in cetaceans and provide baseline data for management and conservation actions (Mignucci-Gianonni *et al.*, 1999; Norman *et al.*, 2004).

On the Brazilian coast, cetacean stranding events have been reported since the 1970s (Carvalho, 1975; Gianuca & Castello, 1976), but it was only in the 1980s that the first census of species that stranded along the coast became available (Bittencourt, 1984; Geise & Borobia, 1987; Ximenez *et al.*, 1987). Nevertheless, little attention was given to the events that occurred in north-eastern Brazil. An effort to collect this information in the state of Ceará began in 1992 with creation of AQUASIS, a non-governmental organization that promotes research and actions for the conservation of marine mammals in the region. The first report on the cetacean species stranded in the state was published by Alves-Júnior *et al.* (1996). The present paper aims to review and update the information available from strandings on species diversity, temporal and geographical distribution, sex and age-class of the stranded animals and possible causes of strandings and deaths.

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MATERIALS AND METHODS

Study area

The study area included the 573 km coastline of the state of Ceará, Brazil (02°30′S 41°15′W–04°30′S 36°45′W) (Figure 1). The region is characterized by low primary productivity, high biodiversity and low abundance of aquatic organisms. Prevailing trade winds drive the surface currents nearly parallel to the coast in a north-westerly direction. Current intensity is high from July to November, reaching velocities above 4 m/s. The oceanic waters are influenced by the north-westerly branch of the Brazilian Current. Average sea surface temperatures range from 27 to 29°C. The continental shelf width

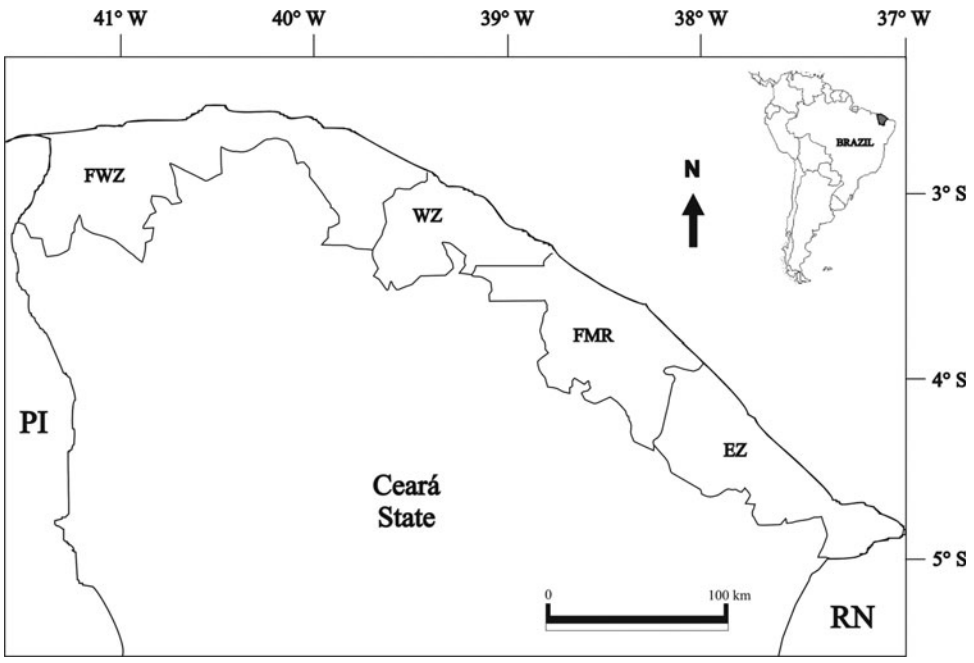

Fig. 1. Map of the study area, showing the National Coastal Zone Management in four region divisions: FWZ, Far Western Zone; WZ, Western Zone; FMR, Fortaleza Municipality Region; EZ, Eastern Zone.

ranges from 41 km on the eastern coast, widening towards the west and reaching 101 km (Campos *et al.*, 2003).

Following the National Coastal Management Plan (Brazil, 1997), the coastline was divided into four zones: Far Western (FWZ), Western (WZ), Fortaleza Metropolitan Region (FMR), and Eastern (EZ) (Figure 1). This sub-division was used for grouping data and stranding records, in order to evaluate possible spatial distribution patterns.

Surveys

From July 1996 to December 1999, one field trip per month was conducted to one or several municipalities along the coast. During these surveys, awareness campaigns were implemented in the communities in order to promote a collaboration network and improve strandings reports. Information obtained on cetacean strandings in Ceará from 1992 to June 1996, was reported by Alves-Júnior *et al.* (1996) and is also considered in this study. In this earlier period, and from 2000 to 2005, no systematic surveys were performed. Stranding records were obtained through opportunistic surveys and reports from fishermen, government officials and tourists, most of them as part of the collaboration network established during previous surveys.

Data collection

Data on stranding locality and zone, species, total length and sex of the animals were collected at each stranding event. Species were identified according to Jefferson *et al.* (1993). Taxonomy is that of Reeves *et al.* (2003), except for the estuarine dolphin, which follows Caballero *et al.* (2006). Protocols for attending strandings, evaluating carcasses and collecting samples followed Geraci & Lounsburry (1998) and IBAMA (2005). When possible, detailed external examination of specimens was carried out to assess parameters related to the event and to elucidate cause of death. Necropsy was also performed on fresh and moderate decomposed animals to gather information on potential causes of death.

Data analysis

To analyse spatial distribution of strandings, records were grouped into the four previously defined state zones. The Chi-square (χ^2) statistical test was used to verify univariate significant differences in the frequency of strandings between zones. For temporal analysis, stranding events were categorized by year, month and seasons. We used two seasonal categories for comparisons. The first followed the usual four austral seasons classification (summer: January–March; autumn: April–June; winter: July–September; spring: October–December). The second scheme followed the rainy (January–June) and dry (July–December) seasons. Chi-square (χ^2) statistics were also used to test differences in stranding frequencies between years, months and both seasonal categories.

Sex and age-class definitions were based on observation during necropsy dissection and the available information from the literature for each given species. Carcass condition was classified in: live animal; fresh carcass; moderated decomposition; advanced decomposition; and mummified or skeletal remains (Geraci & Lounsbury, 1998). The cause of death or stranding followed the categories proposed by Mignucci-Giannoni *et al.* (1999): (a) natural—illness, dependent calf; (b) human-related—direct capture, incidental captures, ingestion of debris; and (c) undetermined.

RESULTS AND DISCUSSION

A total of 252 cetacean strandings were recorded in Ceará from January 1992 to October 2005. There were no records

of mass strandings. Nineteen species of cetaceans were reported, including 11 Delphinidae, one Physeteridae, two Kogiidae, two Ziphiidae and three Balaenopteridae. Three species comprised the majority (79%) of stranding events: estuarine dolphin, *Sotalia guianensis* (62%); sperm whale, *Physeter macrocephalus* (10.3%); and rough-toothed dolphin, *Steno bredanensis* (6.7%). Strandings of *S. guianensis* from 1992 to 2005 were analysed by Meirelles *et al.* (2006). As previously reported by Monteiro-Neto *et al.* (2000), the artisanal fishery in Ceará has a negative impact on this species, with 32% of the reported specimens displaying entrapment marks.

The first report of cetacean strandings at Ceará state (Alves-Júnior *et al.*, 1996) documented 14 cetacean species. Another five species were recorded after 1996, including northernmost records of the Gervais' beaked whale, *Mesoplodon europaeus* (Martins *et al.*, 2004) and Antarctic minke whale, *Balaenoptera bonaerensis* (Meirelles &

Table 1. Delphinidae specimens (not including *Sotalia guianensis*) stranded in the state of Ceará from 1992 to 2005.

Species	Date	Sex	Size (m)	Age-class	Status	Observations	Source
Steno bredanensis	March 1992	I	NI	NI	Death		Alves-Júnior *et al.*, 1996
	January 1993	F	2.02	Subadult	Death		Alves-Júnior *et al.*, 1996
	April 1993	F	2.69	Adult	Death	Incidental capture	Alves-Júnior *et al.*, 1996
	April 1993	M	1.80	Subadult	Death	Incidental capture	Alves-Júnior *et al.*, 1996
	May 1993	I	NI	NI	Death		Alves-Júnior *et al.*, 1996
	January 1994	I	NI	NI	Death		Alves-Júnior *et al.*, 1996
	November 1995	M	1.30	Calf	Death	Incidental capture	Alves-Júnior *et al.*, 1996
	December 1995	I	NI	NI	Death		Alves-Júnior *et al.*, 1996
	December 1995	F	1.43	Calf	Alive	Incidental capture	Alves-Júnior *et al.*, 1996
	February 1996	F	2.60	Adult	Death	Incidental capture	Alves-Júnior *et al.*, 1996
	October 1997	M	1.53	Calf	Death	Incidental capture	This paper
	November 1997	F	2.48	Adult	Death		This paper
	November 1999	F	1.45	Calf	Death		This paper
	December 1999	M	1.59	Calf	Death		This paper
	September 2000	F	2.44	Adult	Death		This paper
	June 2001	M	2.62	Adult	Alive	Plastid ingestion	Meirelles & Barros, 2007
	October 2005	M	2.35	Adult	Death	Incidental capture	This paper
Tursiops truncatus	January 1992	I	NI	NI	Death		Alves-Júnior *et al.*, 1996
	January 1994	M	3.10	Adult	Alive	Shark bites	Alves-Júnior *et al.*, 1997
	December 1995	I	NI	NI	Death		Alves-Júnior *et al.*, 1998
	March 1996	I	3.10	Adult	Death		Alves-Júnior *et al.*, 1999
	December 1996	M	1.38	Calf	Death		This paper
	September 1998	M	2.90	Adult	Death		This paper
	June 2000	I	2.58	Adult	Death		This paper
	October 2000	I	1.82	Subadult	Death	Meat, eyes and fins removed	This paper
	February 2005	I	NI	NI	Death		This paper
Stenella longirostris	March 1998	M	1.70	Adult	Death	Meat removed	This paper
	February 2003	F	1.91	Adult	Alive	Pregnant	This paper
	April 2003	M	1.94	Adult	Alive		This paper
	April 2003	M	1.79	Adult	Alive		This paper
	April 2003	M	1.13	Calf	Alive		This paper
	April 2003	M	1.91	Adult	Death	Meat removed	This paper
Stenella clymene	March 1993	I	1.90	Adult	Death	Incidental capture	Alves-Júnior *et al.*, 1996
	November 2002	F	1.74	Adult	Alive		This paper
	October 2003	M	1.60	Subadult	Alive	Fractures in both jaws	This paper
Stenella frontalis	April 1996	M	1.66	Adult	Death	Intentional capture	Alves-Júnior *et al.*, 1996
	June 1996	I	NI	NI	Death	Skull	Alves-Júnior *et al.*, 1996
	December 1997	I	NI	NI	Death	Skull	This paper
	February 2001	F	1.43	Subadult	Death		This paper
Lagenodelphis hosei	May 1999	M	2.35	Adult	Alive	Died after 9 days in treatment	Barros *et al.*, 2001
Peponocephala electra	May 1994	M	2.30	Subadult	Alive	Died	Alves-Júnior *et al.*, 1996
	April 1996	F	2.33	Adult	Alive	Incidental capture	Alves-Júnior *et al.*, 1997
	January 1997	I	2.28	Subadult	Alive	Died	This paper
	March 1998	I	NI	NI	Alive	Died	This paper
	February 1999	F	2.04	Subadult	Death		This paper
	May 2003	F	2.45	Adult	Alive	Released	Motta & Silva, 2005
Globicephala macrorhynchus	January 1993	I	4.50	Adult	Death	Meat, fins and teeth removed	Alves-Júnior *et al.*, 1996
	March 1993	I	5.00	Adult	Death	Meat and teeth removed	Alves-Júnior *et al.*, 1996
	March 2001	I	NI	NI	Death		This paper
	August 2002	I	NI	Adult	Death	Skull	This paper
	July 2003	F	3.30	Adult	Alive	Stranded death	This paper
Pseudorca crassidens	July 2000	M	3.03	Subadult	Alive	Died	Alves *et al.*, 2002
Orcinus orca	March 1999	M	6.73	Adult	Death		This paper

Furtado-Neto, 2004) in the south-western Atlantic, the first record of the Fraser's dolphin, *Lagenodelphis hosei*, in north-eastern Brazil (Barros *et al.*, 2001), and the first strandings of *B. acutorostrata* (Meirelles *et al.*, in press), pygmy sperm whale, *Kogia breviceps*, killer whale, *Orcinus orca*, and spinner dolphin *Stenella longirostris* (this paper) in Ceará.

Detailed information on other stranded species can be observed in Table 1 (family Delphinidae), Table 2 (families Kogiidae and Physeteridae), Table 3 (family Ziphiidae) and Table 4 (family Balaenopteridae).

Temporal and spatial distribution

There is a significant difference in the number of strandings per year ($\chi^2 = 48.22$; $P < 0.05$), with an increasing trend in the number of cases reported in the first five years with a highest frequency achieved in 1996 (Figure 2A). This increase was not necessarily related to an increase in the death rate of cetaceans, but may be a response from the coastal communities to the awareness campaigns conducted by AQUASIS during the period. Campaigns not only informed the public about the needs of protecting cetaceans, but also compelled communities to report strandings. Although the educational campaigns also occurred between 1997 and 1999, there was no increase in the number of reports in these years.

Stranding events occurred in all months (Figure 2B), but monthly frequencies were quite variable and showed no significant differences ($\chi^2 = 16.88$; $P > 0.05$), even when related only to live or fresh carcasses ($\chi^2 = 10.88$; $P > 0.05$). Also, the difference between rainy and dry seasons was non-significant analysing all strandings ($\chi^2 = 2.30$; $P > 0.05$), and only live and fresh animals ($\chi^2 = 0.72$; $P > 0.05$); but there were significant differences between the four seasons ($\chi^2 = 10.19$; $P < 0.05$), with the lowest frequency occurring in the autumn (Figure 2C).

Most of species have more stranding records in summer and autumn months, while species such as *Sotalia guianensis* and *K. sima*, and *Steno bredanensis*, *Stenella clymene* and *Megapetra novaeangliae*, stranded more in winter and autumn, respectively.

According to Norman *et al.* (2004), whether cetacean strandings are recorded usually depends upon factors such as: (1) presence of the public at the coast; (2) abundance of certain species during a certain period; and (3) oceanographic features (e.g. wind speed and direction, and currents). In the study area, the increase of human presence at the beaches occurs in July (winter) and from December to February (spring–summer). There is no information on cetacean species abundance in the state of Ceará, but information on migratory species indicates the presence of *Physeter macrocephalus* mainly from December to May (spring–summer–autumn) (Ramos *et al.*, 2001), and Balaenopteridae species from June to November (winter–spring—calving and breeding seasons) on the Brazilian north-eastern coast (Stewart & Leatherwood, 1985). In the region, coastal upwelling occurs most frequently from July to November (winter–spring), when it is promoted

Table 2. Kogiidae and Physeteridae specimens stranded in Ceará from 1992 to 2005.

Species	Date	Sex	Size (m)	Age-class	Status	Observations	Source
Kogia breviceps	March 1999	M	2.17	Subadult	Death	Meat removed	This paper
Kogia sima	July 1992	NI	2.00	Subadult	Alive		Alves-Júnior *et al.*, 1996
	July 1998	M	2.80	Adult	Death	Crescentic scars	This paper
	February 2001	F	2.12	Adult	Alive	Intentional capture	This paper
	January 2005	NI	NI	NI	Alive	Intentional capture Meat consumption	This paper
Physeter macrocephalus	May 1993	NI	15.00	Adult	Death		Alves-Júnior *et al.*, 1996
	March 1994	NI	NI	NI	Death		Alves-Júnior *et al.*, 1997
	February 1995	NI	8.00	NI	Death		Alves-Júnior *et al.*, 1998
	February 1995	NI	NI	NI	Death		Alves-Júnior *et al.*, 1999
	May 1995	M	3.10	Calf	Alive	Died in treatment	Alves-Júnior *et al.*, 2000
	October 1995	NI	NI	NI	Death		Alves-Júnior *et al.*, 2001
	January 1996	M	5.68	Subadult	Death		Alves-Júnior *et al.*, 2002
	January 1996	NI	4.50	Calf	Death		Alves-Júnior *et al.*, 2003
	January 1996	F	8.10	Adult	Death		Alves-Júnior *et al.*, 2004
	March 1996	NI	10.00	Adult	Death		Alves-Júnior *et al.*, 2005
	March 1996	NI	NI	NI	Death		Alves-Júnior *et al.*, 1996
	August 1996	M	17.00	Adult	Death		Barros, 2001
	December 1997	NI	15.00	Adult	Death		Barros, 2001
	1997	NI	9.00	NI	Death		Barros, 2001
	March 1998	NI	NI	NI	Death		Barros, 2001
	January 1999	NI	3.90	Calf	Death		Barros, 2001
	January 1999	NI	7.20	NI	Death	Teeth removed	Barros, 2001
	March 1999	NI	3.70	Calf	Death		Barros, 2001
	May 1999	M	9.70	Subadult	Alive	Released	Barros, 2001
	December 1999	F	9.40	Adult	Death		This paper
	March 2000	F	3.53	Calf	Alive	Died in treatment	This paper
	September 2001	M	18.10	Adult	Death		This paper
	January 2004	NI	8.60	NI	Death		This paper
	March 2004	NI	NI	NI	Death		This paper
	September 2004	M	16.00	Adult	Death		This paper
	April 2005	NI	NI	NI	Death		This paper

Table 3. Ziphiidae specimens stranded in Ceará from 1992 to 2005.

Species	Date	Sex	Size (m)	Age-class	Status	Observations	Source
Ziphius cavirostris	March 1994	NI	5.50	Adult	Death		Alves-Júnior *et al.*, 1996
	January 1997	NI	5.50	Adult	Death		This paper
	November 1998	M	2.35	Calf	Alive		This paper
	January 2001	NI	5.37	Subadult	Death		This paper
	March 2005	NI	NI	NI	Death		This paper
Mesoplodon europaeus	February 2002	NI	NI	Adult	Death		Martins *et al.*, 2004

by strong north-westerly winds (Campos *et al.*, 2003), the period when carcasses have more chance to come ashore. Thus, these factors apparently could influence the stranding records mostly in spring, summer and winter months.

Melon-head whale stranded only in summer–autumn months, and most of the animals stranded alive. In Ceará, the rainy season lasts from January to June, with highest average rainfall values in April and May (Campos *et al.*, 2003). In this period, the increase in primary productivity and consequently in food availability, can lead this whale group to come closer to the coast for foraging and this may increase the probability of a sick animal to come ashore.

Sperm whales stranded mainly from January to May (summer–autumn). There is no information on the occurrence of sperm whales in low latitudes of the south-western Atlantic. However, the presence of this whale is well known in low latitudes of the South Pacific Ocean, mainly off the Galapagos Islands, where breeding and calving can be observed during summer–spring austral months (Whitehead *et al.*, 1989). Thus, sperm whales probably use the area for breeding and calving during summer–autumn, when most strandings were recorded. This hypothesis can be supported by the strandings of two live newborns in Ceará.

Humpback whales stranded during winter–spring months, when this species migrates to lower latitudes for mating and calving. In Ceará, strandings of *M. novaeangliae* were not recorded before 1997. New reports of humpback whale sightings and strandings in low latitudes have been related to a re-occupation of a historical occurrence area, since it is inferred from the literature that 1542 humpback whales were taken off Paraiba Whaling Bases (COPESBRA) and they were commonly in those areas (Paiva & Grangeiro, 1965; Stevick *et al.*, 2004; Zerbini *et al.*, 2004).

A highly significant difference in the frequency of strandings was observed among the four zones ($\chi^2 = 209.08$; $P < 0.01$). The majority of strandings events were reported for FMR (64.3%). Only 9.5% of all records were reported for the FWZ (Figure 3). Number of strandings per km was also higher in FMR (1.55), and the lowest value was observed in FWZ (0.12). These results may be a consequence of AQUASIS monitoring and rescue efforts, and not necessarily indicate that more animals strand in FMR. The institution that rescues animals and recovers carcasses is located in Fortaleza Metropolitan Region, the most densely populated area along the coast. Therefore, stranding events have a higher probability to be reported in this zone than in any other area of the state. In the other state coastal zones the absence of coastal communities in some regions, the least accessible sites, limits the number of reports from those areas.

Analysing species strandings related to zones, it can be observed that most of them have more stranding records in FMR. However, species such as *K. sima* stranded exclusively in the WZ, and *P. macrocephalus* stranded more both in the FMR and FW Zones.

Sex and age-class

Sex was not determined for 42.9% of the stranding specimens, due to the carcass decomposition or, in case of large cetaceans, the animal position. In specimens where sex was determined, 86 males (59.7%) and 58 females (40.3%) were recorded. This difference is significant ($\chi^2 = 5.44$; $P < 0.05$), and may be due to the fact that males are easier to identify, especially when the penis is exposed. Results like these were also observed in Puerto Rico and the Virgin Islands by Mignucci-Giannoni *et al.* (1999). Age-class was determined for 77.8% of the events. Of these, 64% were adults, 22% were subadults and 14% were calves.

Condition of carcass and cause of death

The carcass condition was registered in 77.8% of all cases. Of those for which condition was documented, 15.3% (N = 30) stranded alive, but the majority were in distress and died during rescue or treatment. Only two animals, a subadult male sperm whale and an adult female melon-headed whale were considered successfully released, since no reports of subsequent stranding events were registered. Dead animals were usually found in advanced state of decomposition (38.3%) or as

Table 4. Balaenopteridae specimens stranded in Ceará from 1992 to 2005.

Species	Date	Sex	Size(m)	Age-class	Status	Observations	Source
Megaptera novaeangliae	November 1997	M	5.80	Calf	Death		Furtado-Neto *et al.*, 1998
	August 2001	NI	NI	Adult	Death		This paper
	September 2001	F	4.68	Calf	Alive	Scapule fracture	This paper
	October 2004	M	5.75	Calf	Death		This paper
	April 2004	NI	NI	Adult	Death		This paper
Balaenoptera bonaerensis	October 2001	NI	~7.0	Adult	Death	Skull	Meirelles and Furtado-Neto, 2004
Balaenoptera acutorostrata	July 2005	NI	~6.70	Adult	Death	Shark bites	Meirelles *et al.*, in press

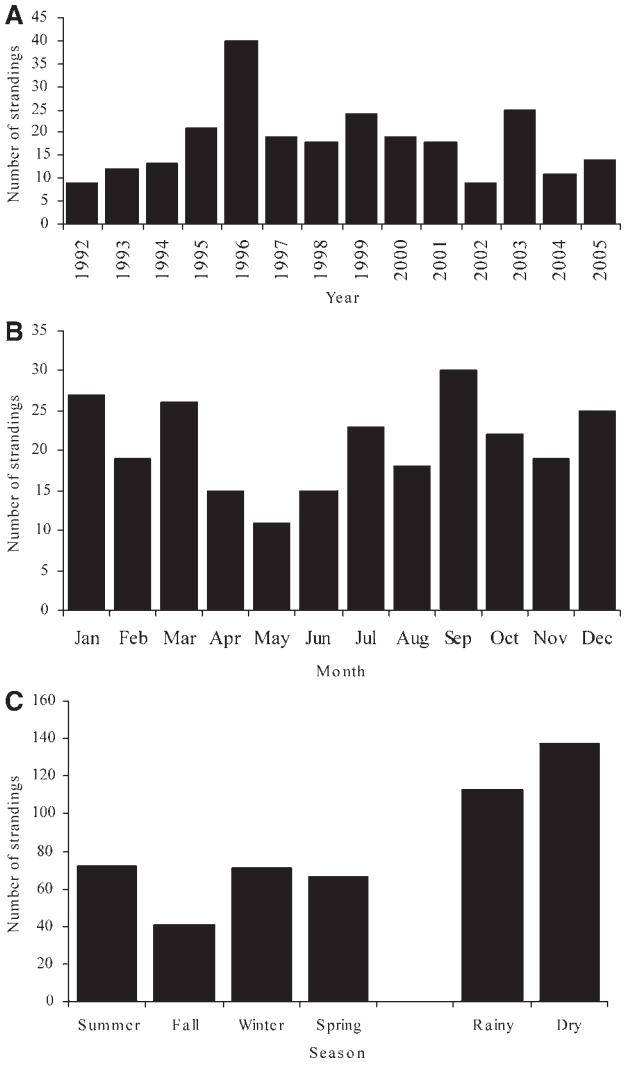

Fig. 2. Distribution of cetacean stranding records in Ceará per year (A), per month (B), per four season and two season classifications (C), from 1992 to 2005.

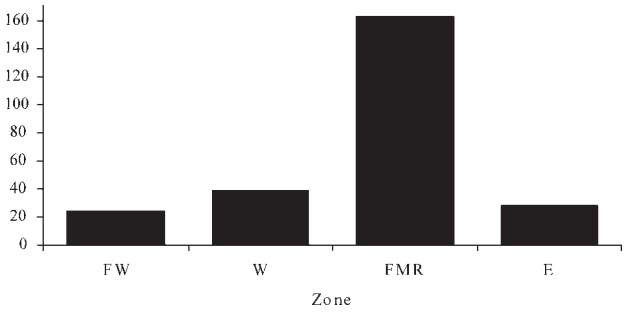

Fig. 3. Number of cetacean stranding records in each region of the Ceará coast from 1992 to 2005.

mummified/skeletal remains (21.4%). Animals found recently dead (10.2%) or moderately decomposed (14.8%) were not common.

Cause of death or stranding was determined in 28.3% of all reports. Natural causes accounted for 4% of the events, and human-related causes for 24.6%. The fact that 74.5% of the recovered carcasses were decomposed in a condition that did not allow adequate necropsy, explains the high incidence of undetermined cause of death.

Estuarine and rough-toothed dolphins were the species with more records of incidental captures, mainly in FMR, where the fishing activity is higher than in other zones. However, other species, such as *P. electra* and *S. clymene* were also recorded in this category.

Although the intentional capture of cetaceans has not been allowed in Brazil since 1987, species such as *Stenella frontalis* and *Kogia sima* were reported to be captured by fishermen in Ceará, to remove meat for human consumption and bait. Meat removal for human consumption or bait was observed in 6.7% of stranded animals, mainly *S. guianensis*. Interviews in coastal communities indicated that the meat can be dried with salt and then fried for consumption. The removal of eyes to be used as 'lucky charms' and the teeth, which are sold to artisans to make earrings, necklaces and bracelets were also recorded. Consumption of dolphin meat has already been reported in north-eastern Brazil (Meirelles *et al.*, 2006; Attademo, 2007; Tosi *et al.*, 2007), and this custom has been indicated as a social problem, as hunger is motivating the use of cetaceans as a protein source.

Stranding data on cetacean management

Data gathered from stranding events may facilitate cetacean management in several ways. According to Maldini *et al.* (2005), species stranding in a particular area are usually those found in surveys of live animals. Thus, stranding data can be a useful indicator of species composition in a region, when other data are not available. The abundance of stranding records in most cases also reflects the abundance of the free-living population in a particular region. Species that stranded only on one or two occasions may be designated as rare or occasional visitors to the area (Sergeant, 1979). Consequently, in Ceará, *Sotalia guianensis*, *Physeter macrocephalus* and *Steno bredanensis* are the most abundant cetacean species, whereas *L. hosei*, *P. crassidens*, *O. orca*, *K. sima*, *M. europaeus*, *B. acutorostrata* and *B. bonaerensis* are probably rare in the area.

Two out of 19 species recorded in Ceará are considered as Vulnerable by the IUCN (2007): *M. novaeangliae* and *P. macrocephalus*. Studies to identify the occurrence areas and the human impacts on these species in Ceará are very important, since they are considered to be facing a high risk of extinction in the wild. Another seven species (*Sotalia guianensis, Stenella clymene, S. frontalis, Steno bredanensis, Tursiops truncates, Mesoplodon europaeus* and *Ziphius cavirostris*) are listed as 'Data deficient'. Surveys on the ecology of these species (especially *S. guianensis* and *Steno bredanensis* that have coastal habitats) are very important to promote their conservation, and also to help to assess their category of real threat in the future.

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