

Impact of fisheries on the tucuxi (*Sotalia fluviatilis*) and rough-toothed dolphin (*Steno bredanensis*) populations off Ceará state, northeastern Brazil

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Abstract

Incidental catches of cetaceans in fishing gear have been reported worldwide as a major cause of mortality. Two species, the tucuxi (*Sotalia fluviatilis*) and the rough-toothed dolphin (*Steno bredanensis*) have been adversely impacted by fishery interactions in northeast Brazil, an area where few marine mammal studies have been conducted. This paper reports the fishery-related mortality of these species along the coast of Ceará state, northeast Brazil, commenting on the possible conservation implications for the species local populations. From January 1992 to December 1998, the occurrence and mortality of *S. fluviatilis* and *S. bredanensis* was investigated through surveys of sightings and strandings on 21 municipalities distributed on four state geographic zones. A total of 89 dolphin (76 *S. fluviatilis* and 13 *S. bredanensis*) strandings occurred along the coast. Incidental catches per year ranged between 7–13, except during 1996 when 31 animals were recorded. Most animals were recovered at state geographic zones II and III where finfish fisheries and stranding survey efforts were highest. Seasonally, incidental catches were more frequent during the austral spring (October–December). Preliminary population data suggest estimates of only a few hundred individuals of *Sotalia fluviatilis* along the coast of Ceará. Sightings of *Steno bredanensis* were few due to their slightly offshore distribution. The small number of individuals in conjunction with long gestation and nursing periods, suggest

that an increased mortality due to dolphin-fisheries interactions could severely impact local populations of both species.

Key words: fisheries by-catch, strandings, cetaceans, tucuxi, rough-toothed dolphin, Brazil.

Introduction

Incidental catches of cetaceans in fishing gear, are reported worldwide as a major cause of mortality (Northridge, 1984; Perrin, 1994). The problem has been reviewed for both the North (Lien, 1994; Bloch *et al.*, 1996) and South Atlantic (Crespo *et al.*, 1994; Siciliano, 1994). Recently, a note on cetacean bycatch in pelagic driftnetting off southern Brazil, reported the interactions of ten species with the driftnet fisheries (Zerbini & Kotas, 1998). Two species of small cetaceans, the tucuxi (*Sotalia fluviatilis*) and the rough-toothed dolphin (*Steno bredanensis*), were adversely affected by fishery interactions in northeast Brazil (Monteiro-Neto, 1993; Oliveira *et al.*, 1995; Alves-Jr *et al.*, 1996), an area where few long term marine mammal studies have been conducted. Catches of both species were reported in the gillnet fisheries at Ceará state, NE Brazil.

The tucuxi occurs in the Amazon river system (da Silva & Best, 1996), and coastal marine waters of the western Atlantic, from the state of Santa Catarina, south Brazil (27°35'S, 48°34'W) (Simões-Lopes, 1988) to Nicaragua (14°35'N, 83°14'W) (Carr & Bonde, in press). Marine and freshwater forms were identified by Borobia *et al.* (1991) based on skull dimensions and body size. Recent DNA studies confirmed the distinction of these two forms (Furtado-Neto, 1998). Incidental catches of tucuxi

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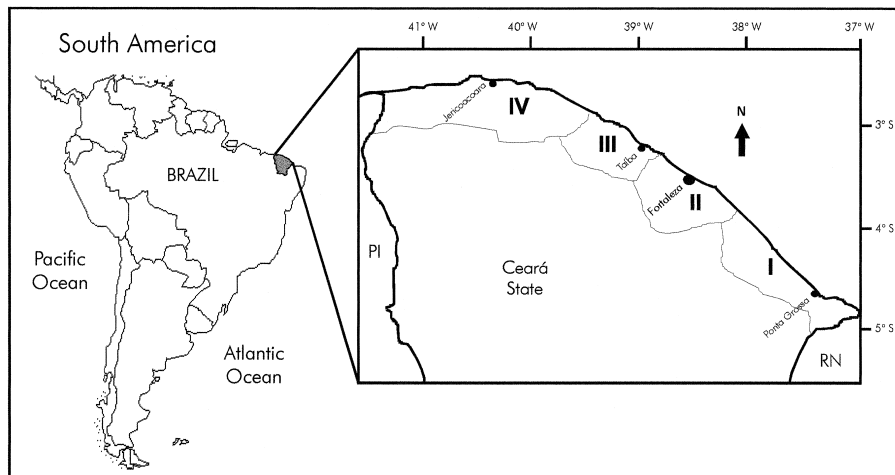


Figure 1. Map of Ceará state, Brazil, showing the 4 zones (I–IV) of the State coast, where *Sotalia fluviatilis* and *Steno bredanensis* mortalities were investigated by the Ceará Cetaceans Study Group (GECC) from January 1992 to December 1998. In each zone the town with the highest dolphin mortality is shown.

in Brazilian waters were reported for both forms (Monteiro-Neto, 1993; Barros & Teixeira, 1994; Siciliano, 1994; da Silva & Best, 1996). The International Whaling Commission report on the mortality of cetaceans in passive fishing nets and traps stated that approximately 90 tucuxis are killed every year in the passive gillnet fisheries along the Brazilian coast (Perrin, 1994). This species is placed under the category of ‘insufficiently known’ by The World Conservation Union (IUCN, 1991) and is listed on Appendix I of CITES. International protective legislation is not available for *S. fluviatilis*, but all cetaceans are protected in Brazilian waters under the Federal Law 7643 (Siciliano, 1994; Lodi & Barreto, 1998).

The rough-toothed dolphin is found worldwide in tropical and temperate seas, without being known to be numerous in any particular area (Northridge, 1984). Sightings and strandings were reported from the Indian, Atlantic and Pacific Oceans (Leatherwood & Reeves, 1983) and the Mediterranean Sea (Watkins *et al.*, 1987). In Brazil, this species apparently has a more coastal distribution than elsewhere in the world (Flores & Ximenes, 1997; Lodi & Hetzel, 1998). They occur from Fortaleza, Ceará state (3–4°S) (Themotheo-Sobrinho, 1992) to the southern portion of Rio Grande do Sul state (30–31°S) (Pinedo, 1994; Ott & Danilewicz, 1996). This distribution increases their risk to interact with coastal fisheries. There are records of *S. bredanensis* net entanglements in Rio de Janeiro (Hetzel & Lodi, 1993) and Ceará (Themotheo-Sobrinho, 1992). The species is placed under the category of ‘insufficiently known’ by The

World Conservation Union (IUCN, 1991), is listed on Appendix II of CITES, and it is said to be protected by the general legislation of a number of countries.

This paper reports fishery-related mortality of *Sotalia fluviatilis* and *Steno bredanensis* along the coast of Ceará state, northeast Brazil, commenting on the possible conservation implications for the local populations.

Materials and Methods

From January 1992 to December 1998, the occurrence and mortality of *S. fluviatilis* and *S. bredanensis* along the coast of Ceará state were investigated through surveys of sightings and strandings, conducted on 21 municipalities distributed on four State Geographic Zones (GZ), defined by the State’s Coastal Zone Management Program, along the 573 km coastline (Fig. 1).

From 1992 to 1995, field surveys along the coast were conducted opportunistically and did not follow any sampling strategy.

From 1995 to 1998, about one field trip per month, to one or several municipalities along the coast, was conducted by the Ceará Cetacean Study Group (Grupo de Estudo de Cetáceos do Ceará—GECC). In every visit, local fishermen were interviewed to assess species occurrence, incidental catches and fishery-related mortality. We followed reports provided by various sources (tourists, fishermen, police), of live strandings or dead animals at various stages of decomposition. Stranding

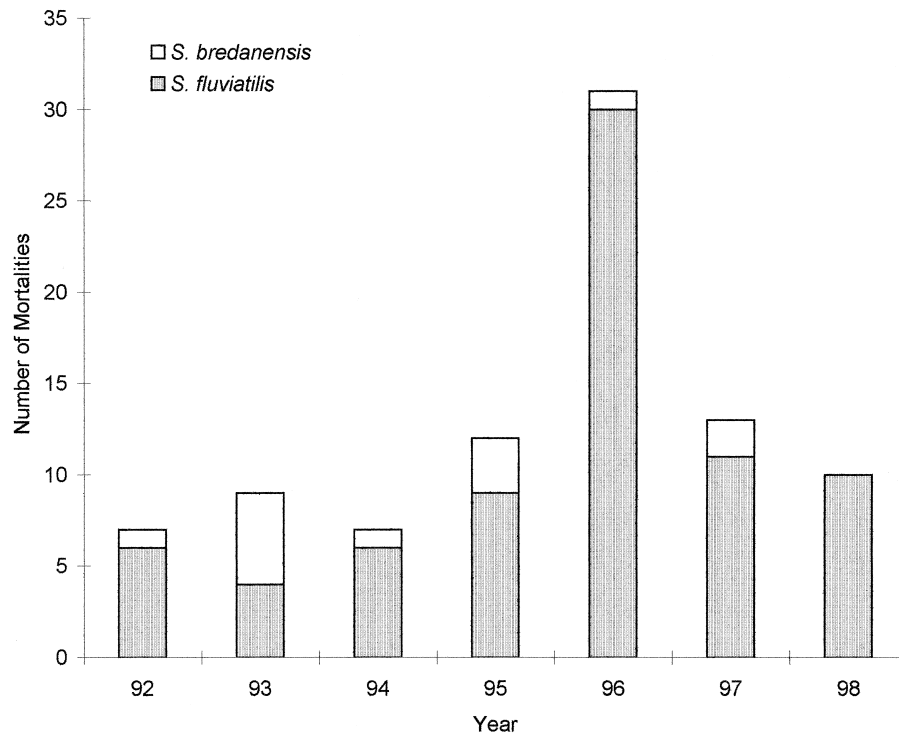


Figure 2. Mortality of *Sotalia fluviatilis* and *Steno bredanensis* in Ceará state recorded by year (1992–1998).

localities were recorded, together with size (total length) and sex of the animal. Necropsy was performed on fresh animals to gather information on possible causes of death.

Strandings of live and dead animals were identified based on Pinedo *et al.* (1992) and Jefferson *et al.* (1993).

Skeletons and other tissues were deposited at the GECC's collection at the Marine Science Institute of the Federal University of Ceará (LABOMAR-UFC). Observations of single individuals or pods of both species were made in different localities along the coast by the research team, and species were identified according to Leatherwood & Reeves (1983).

Results

A total of 89 dolphin (76 *S. fluviatilis* and 13 *S. bredanensis*) strandings occurred along the coast of Ceará State from January 1992 to December 1998 (Tables 1 and 2). Animals usually showed conclusive evidences of fishery interactions such as cuts, bruises and net marks. *S. fluviatilis* was the most common species throughout the survey. The magnitude of this bycatch is one of the highest

among small cetaceans throughout the Brazilian coast, surpassed only by franciscanas, *Pontoporia blainvillei* (Siciliano, 1994; Pinedo, 1994). Mortality for both *S. fluviatilis* and *S. bredanensis* here recorded is of concern because preliminary surveys suggest small population sizes for this area. For instance, pod sightings for *S. fluviatilis* did not exceed 8 to 10 individuals at a time (Oliveira *et al.*, 1995), and often only one or two individuals are sighted.

Incidental catches per year ranged between 7–13, except during 1996 when 31 animals were recorded (Fig. 2). This pattern shows a strong correlation with the implementation of a marine mammal conservation awareness program in 1995–96. During that period, the number of calls from the public for strandings increased considerably, affecting the total number of animals recorded (Tables 1 and 2; Fig. 2). Stranding awareness efforts were not as strong in subsequent years.

Most animals were recovered at state geographic zones II and III, more specifically at Fortaleza, the state capital and GECC's headquarters, and Taiba, a small fishing village (Figs. 1 and 3). Seasonally, incidental catches were more frequent during the austral spring (October–December) (Fig. 4).

Table 1. Total length (TL) sex, date (dd/mm/yy), stranding site and State Geographic Zone (GZ) where *Sotalia fluviatilis* individuals were found dead along the coast of Ceará state, between January 1992 and December 1998.

Animal	TL (mm)	Sex	Date (dd/mm/yy)	Stranding site	GZ
01	—	—	?/03/92	Fortaleza	II
02	1040	F	13/05/92	Taíba	III
03	1600	—	17/07/92	Jericoacoara	IV
04	1770	F	09/11/92	Fortaleza	II
05	1800	—	04/12/92	Fortaleza	II
06	1870	M	27/12/92	Fortaleza	II
07	1900	M	31/01/93	Fortaleza	II
08	1920	M	21/04/93	Tabuba	II
09	2020*	—	12/08/93	Tabuba	II
10	1470	F	08/09/93	Fortaleza	II
11	1350	M	02/01/94	Pecém	III
12	1700	F	03/04/94	Icarai	II
13	2030	M	31/05/94	Icarai	II
14	1880*	—	?/10/94	Taíba	III
15	1200*	—	?/10/94	Taíba	III
16	1880*	—	04/12/94	Fortaleza	II
17	1870	M	19/01/95	Fortaleza	II
18	1350	F	22/01/95	Fortaleza	II
19	1610	—	01/08/95	Taíba	III
20	—	—	09/11/95	Praia Nova	IV
21	—	—	11/11/95	Tatajuba	IV
22	2000	F	11/12/95	Fortaleza	II
23	—	—	17/12/95	Pecém	III
24	1510	M	20/12/95	Fortaleza	II
25	—	—	21/12/95	Taíba	III
26	1740	F	05/01/96	Cumbuco	II
27	1770	F	05/01/96	Taíba	III
28	1280	F	26/01/96	Fortaleza	II
29	1900	M	04/03/96	Fortaleza	II
30	1280	F	09/06/96	Taíba	III
31	1500	F	21/06/96	Taíba	III
32	1850	M	22/06/96	Taíba	III
33	1780	M	22/06/96	Fortaleza	II
34	—	—	26/06/96	Paracuru	III
35	—	—	26/06/96	Paracuru	III
36	1820	F	01/07/96	Fortaleza	II
37	1800	M	31/07/96	Fortaleza	II
38	1650	M	31/08/96	Icarai Norte	IV
39	1940	—	31/08/96	Flexeiras	III
40	—	—	31/08/96	Flexeiras	III
41	—	—	31/08/96	Flexeiras	III
42	—	—	01/09/96	Mundaú	III
43	—	—	01/09/96	Mundaú	III
44	—	—	01/09/96	Mundaú	III
45	—	—	01/09/96	Mundaú	III
46	1860	F	02/09/96	Fortaleza	II
47	1680	M	04/09/96	Taíba	III
48	1650	M	14/09/96	Fortaleza	II
49	1820	F	15/09/96	Fortaleza	II
50	1895	M	23/09/96	Taíba	III
51	955	F	08/10/96	Taíba	III
52	1640	M	09/10/96	Fortaleza	II
53	—	—	13/10/96	Baleia	III

Continued

Table 1. *Continued.*

Animal	TL (mm)	Sex	Date (dd/mm/yy)	Stranding site	GZ
54	—	—	14/10/96	Baleia	III
55	1800*	M	14/10/96	Baleia	III
56	1870*	F	17/03/97	Fortaleza	II
57	1970	F	21/03/97	Fortaleza	II
58	—	—	02/05/97	Ponta Grossa	I
59	—	—	16/05/97	Pecém	III
60	—	—	21/05/97	Fortaleza	II
61	—	—	28/05/97	Fortaleza	II
62	1950	F	02/06/97	Icarai	II
63	1900	—	26/09/97	Batoque	I
64	1810	F	08/10/97	Fortaleza	II
65	1800	M	20/11/97	Fortaleza	II
66	1900	F	22/11/97	Paracuru	III
67	1350	F	16/01/98	Fortaleza	II
68	1890	M	21/02/98	Fortaleza	II
69	2000	F	21/02/98	Fortaleza	II
70	1850	F	02/08/98	Fortaleza	II
71	1880	M	20/10/98	Fortaleza	II
72	1820	M	31/10/98	Tabuba	II
73	1300	M	15/11/98	Fortaleza	II
74	1100	M	06/12/98	Fortaleza	II
75	—	—	17/12/98	Apiques	III
76	1630	—	29/12/98	Cauipe	II

(*) Estimated total length.

Table 2. Total length (TL) sex, date (dd/mm/yy), stranding site and State Geographic Zone (GZ) where *Steno bredanensis* individuals were found dead along the coast of Ceará state, between January 1992 and December 1998.

Animal	TL (mm)	Sex	Date	Stranding site	GZ
01	—	—	?/03/92	Fortaleza	II
02	2020	F	16/01/93	Fortaleza	II
03	2690	F	02/04/93	Fortaleza	II
04	1010	M	02/04/93	Fortaleza	II
05	1800	M	03/04/93	Fortaleza	II
06	—	—	07/05/93	Uruaú	I
07	—	—	14/01/94	Cofeco	II
08	1300	M	09/11/95	Taíba	III
09	—	—	16/12/95	Taíba	III
10	—	F	19/12/95	Pecém	III
11	2600	F	04/02/96	Iguape	II
12	1530	M	27/10/97	Fortaleza	II
13	2480	F	30/10/97	Fortim	I

Discussion

Fisheries operating off Ceará are essentially artisanal, conducted in nearshore waters, and use small wooden rafts called 'jangadas', or sail-rigged open boats. Gillnets are used at the bottom to catch spiny lobster (*Panulirus argus* and *P. laevicauda*) and near

the surface to catch pelagic fish, such as mackerel (*Scomberomorus brasiliensis* and *S. cavala*). Nets are made of monofilament nylon, with a mesh size of 14 cm stretch mesh and 300 m length. Several nets may be tied together up to 1.5 km. Dolphins caught on nets may be thrown overboard, or more often, used for human consumption or shark bait,

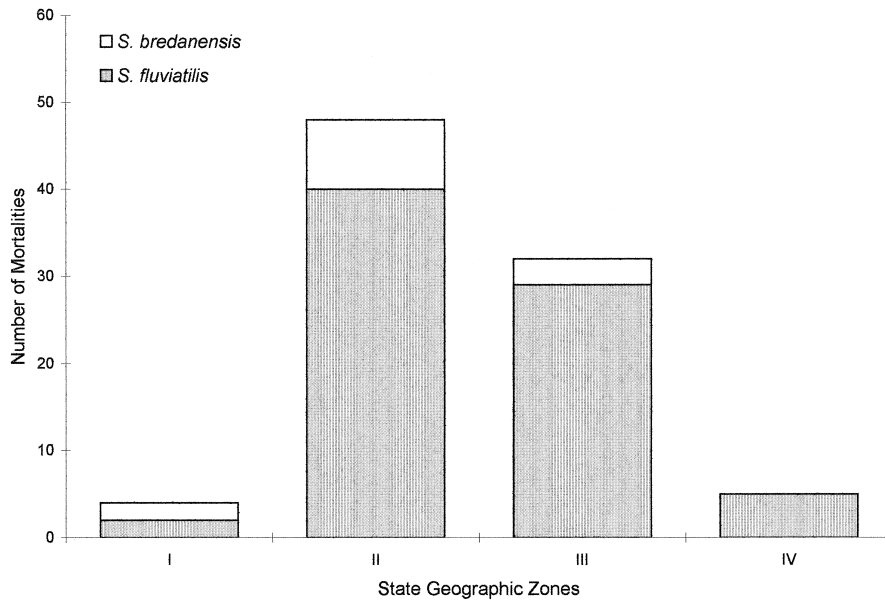


Figure 3. Mortality of *Sotalia fluviatilis* and *Steno bredanensis* in Ceará state by geographic zone (I–IV) between 1992 and 1998.

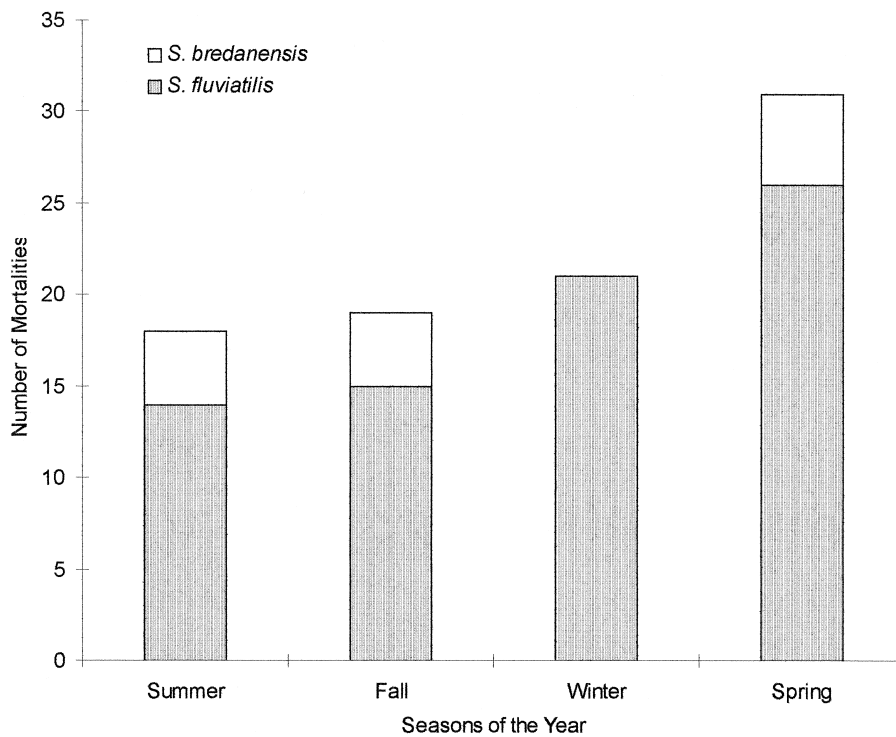


Figure 4. Mortality of *Sotalia fluviatilis* and *Steno bredanensis* in Ceará state by austral seasons of the year between 1992 and 1998.

violating strict regulations protecting marine mammals. This type of fishing gear ('jangada') has been implicated in *Sotalia fluviatilis* gillnet mortality elsewhere in northeastern Brazil (Barros & Teixeira, 1994).

Fortaleza and Taíba were the localities where most animals were recovered (Figs. 1 and 3). Incidental catches at Taíba were previously reported by Siciliano (1994), thus supporting our findings. Despite the fact that fishermen reported incidental catches at both, the lobster (bottom) and the finfish (surface) fisheries, dolphins interacted more frequently with the latter. Only four individuals (2 *S. fluviatilis*, 2 *S. bredanensis*) were reported from Geographic zone I (Fig. 3), traditionally a lobster fisheries area. Due to logistic problems (fewer telephone posts and, lack of roads restricting communication and access to coastal communities), stranding survey efforts are in zone IV not as intense as in zones I–III, thus yielding fewer records.

The results have indicated that incidental catches were more frequent during the austral spring (October–December) (Fig. 4). These findings do not reflect the same seasonal occurrence of *Sotalia fluviatilis* in the coastal waters of Praia de Iracema at Fortaleza (Oliveira *et al.*, 1995). In that study, conducted on a limited stretch of beach, sightings were greater in the austral summer (first quarter), declining towards the other seasons. These differences could be partly due to seasonal inshore-offshore movements of dolphins possibly following prey or seeking protected areas to mate, give birth and raise calves. For instance, pods at Praia de Iracema often have calves among individuals (Oliveira *et al.*, 1995). Dolphin longshore migrations from one geographic zone to another may decrease sightings at one area but increase incidental catches at another.

Further information is needed to estimate population sizes and movement patterns for both species. Preliminary data gathered from interviews with fishermen suggest estimates of only a few hundred individuals of *Sotalia fluviatilis* along the entire coast of Ceará. Groups of *S. bredanensis* were hardly observed during the study because of their slightly offshore distribution. Siciliano (1994) did not mention the species for the Northeast region on his review of small cetaceans and fishery interactions in coastal waters of Brazil.

The small number of individuals in each group, in conjunction with long gestation and nursing periods, suggests that an increased mortality due to dolphin-fisheries interactions could severely impact local populations of both species. We strongly recommend the implementation of permanent research and environmental education programs among the beach communities in the study area due to the vulnerability of these species.

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