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INTERACTIONS BETWEEN GILLNET FISHERIES AND SMALL CETACEANS IN NORTHERN RIO DE JANEIRO, BRAZIL: 2001-2002

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Abstract – In northern Rio de Janeiro (21º18'S-22º25'S), Brazil, gillnets are responsible for the by-catch of a number of small cetaceans. Franciscanas (*Pontoporia blainvillei*) and marine tucuxis (*Sotalia fluviatilis*) are the most impacted species. From November 2001 to October 2002 data on fisheries and mortality of small cetaceans were obtained through interviews with fishermen of 20% of the gillnet fleet. Seasons were grouped into spring-summer and autumn-winter and the region was divided into two fishing areas: Area I (Barra do Itabapoana to São Tomé Cape) and Area II (São Tomé Cape to Macaé). A total of 374 gillnet operations were recorded between 0.02-42.1n.miles from shore and in waters 5-67m deep. Gillnets were 3.1m in length and of 120mm mesh size. The fishing effort for the entire fleet (n= 50 boats) was estimated at 7,161.8km of net and the total number of small cetaceans caught was 225. The CPUE was 0.031 animal × (km of net × day)$^{-1}$. Fisheries and by-catches did not show seasonal differences. Fishing trips were more prevalent in Area I, whereas the by-catch of franciscanas and marine tucuxis was higher in Area II. Fisheries were distributed uniformly in areas close to shore (first 10n.miles) and beyond. In Area I they occurred predominantly within the 30-m isobath. The by-catch of franciscanas and marine tucuxis also occurred within these limits, suggesting that 30-m isobath may constitute the offshore limit of their distribution along the coast. The variability in the width of the continental shelf in Areas I and II may explain the differences in the magnitude of the by-catch of small cetaceans in these areas. Gillnet fisheries may adversely impact the coastal populations of small cetaceans. In northern Rio de Janeiro, particularly between 22º00'S and 22º25'S where the 30-m isobath is found close to shore, fisheries operating within the first 10n.miles from shore can pose substantial threat to dolphins. Due to the distribution of their preferred prey, franciscanas may be at greater risk of by-catch in areas near the Paraíba do Sul river mouth. It is thus proposed that these areas be closed to gillnet fisheries year round, so that the impact on coastal dolphins is minimised.

Resumo – No norte do Rio de Janeiro (21º18S'-22º25'S), Brasil, redes de espera são responsáveis pela captura acidental de vários pequenos cetáceos. Franciscanas (*Pontoporia blainvillei*) e tucuxis marinhos (*Sotalia fluviatilis*) são as espécies mais impactadas. Entre novembro de 2001 a outubro de 2002 dados sobre pescarias e mortalidade de pequenos cetáceos foram obtidos através de entrevistas com pescadores de 20% da frota pesqueira de rede de espera. As estações do ano foram agrupadas em primavera-verão e outono-inverno e a região foi dividida em duas áreas de pesca: área I (Barra do Itabapoana ao Cabo de São Tomé) e área II (Cabo de São Tomé a Macaé). Ao todo, 374 operações com rede de espera foram registradas entre 0,02-42,1 milhas da costa e 5-67m de profundidade. As redes de espera tinham 3,1km de comprimento e 120mm de tamanho de malha. O esforço de pesca para toda frota (n= 50 barcos) foi estimado em 7.161,8km de rede e o número total de pequenos cetáceos capturados foi de 225. A CPUE foi de 0,031 animal × (km of rede × dia)$^{-1}$. Pescarias e capturas acidentais não apresentaram diferenças sazonais. Operações de pesca prevaleceram na área I, enquanto a captura de franciscanas e tucuxis marinhos foi mais alta na área II. Pescarias se distribuíram uniformemente em áreas próximas da costa (primeiras 10 milhas náuticas) e além desse limite. Na área I elas ocorreram predominantemente até a isóbata de 30m. A captura de franciscanas e tucuxis marinhos também ocorreu dentro desses limites, sugerindo que a isóbata de 30m pode representar o limite de sua distribuição ao longo da costa. A variação na largura da plataforma continental entre as áreas I e II pode explicar as diferenças na magnitude da captura de pequenos cetáceos. Pescarias com rede de espera podem afetar adversamente as populações costeiras de pequenos cetáceos. No norte do Rio de Janeiro, particularmente entre 22º00'S e 22º25'S onde a isóbata de 30m está localizada próximo da costa, operações pesqueiras nas primeiras 10 milhas náuticas de distância da costa podem causar ameaça substancial aos golfinhos. Devido a distribuição de suas presas preferenciais, as franciscanas podem apresentar maior risco de captura em áreas próximas da foz do rio Paraíba do Sul. Dessa forma, propõe-se que as pescarias com rede de espera sejam proibidas nessas áreas durante todo o ano, a fim de minimizar o impacto sobre os golfinhos costeiros.

Keywords: gillnet fishery, small cetaceans, by-catch, *Pontoporia blainvillei*, *Sotalia fluviatilis*, southeastern Brazil.

Introduction

In northern Rio de Janeiro State, southeastern Brazil, passive gillnets are the only fishing gear known to incidentally catch small cetaceans. Seven species have already been recorded: franciscana (*Pontoporia blainvillei*), marine tucuxi (*Sotalia fluviatilis*), bottlenose dolphin (*Tursiops truncatus*), Atlantic spotted dolphin (*Stenella frontalis*), rough-toothed dolphin (*Steno bredanensis*), long-beaked common dolphin (*Delphinus capensis*) and false killer whale (*Pseudorca crassidens*) (Lodi and Capistrano, 1990; Di Beneditto *et al*., 1998; Di Beneditto, 2001).

Among these cetaceans the former two species represent about 95% of the records and the by-catch is restricted to the first 10n.miles from shore, or the 30m isobath (Di Beneditto *et al*., 2001*a*). Due to their mostly inshore distribution, franciscana and marine tucuxi are more vulnerable to coastal fishing operations. This trend has also been for other areas where these two species occur (Corcuera *et al*., 1994; Siciliano, 1994; Secchi *et al*., 1997; Monteiro-Neto *et al*., 2000; Ott *et al*., 2002).

The main purpose of this paper is to describe the gillnet fisheries in northern Rio de Janeiro and quantify their interactions with small cetaceans, particularly the franciscana and the marine tucuxi.

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Material and Methods

This study took place in the northern coast of Rio de Janeiro, Brazil. The boundaries of the study area were Barra do Itabapoana (21º18'S) to the north, and Macaé (22º25'S) to the south, as well as the continental shelf break along the 100m-isobath. The two major river runoffs of Rio de Janeiro (Itabapoana and Paraíba do Sul rivers) are located in this area (Muehe and Valentini, 1998). The village of Atafona (21º37'S) encompasses the most representative harbour in terms of gillnets fishing effort, from which around 50 boats operate (Di Beneditto *et al*., 2001*a*) (Figure 1).

From November 2001 to October 2002, gillnet fisheries were monitored through weekly interviews with the skipper of 10 boats based in Atafona, corresponding to 20% of the gillnet fleet. Boat selection was done randomly each week, with no particular boat being continuously monitored during the entire period. Information requested from the fishermen included: (1) gillnet dimensions, (2) days of fishing operations, (3) gillnet position at sea (fishing area, distance from shore and depth), and (4) small cetacean mortality data. The unit effort was expressed as linear kilometres of net immersed per day of fishing operations. Total fishing effort was based on the data obtained weekly. Catch per unit effort (CPUE) of small cetaceans was expressed as the number of animals captured per linear kilometre of net x day. The cetacean species were identified through full carcasses or any remains (*e.g*. head or fins) brought to shore by fishermen.

In order to analyse the seasonality of gillnet fishing operations and of the by-catch data, seasons were grouped into spring-summer (October to March) and autumn-winter (April to September). These seasons include the highest and lowest recorded values of temperature and rainfall, respectively (Martin *et al*., 1998; Muehe and Valentini, 1998).

The northern Rio de Janeiro coast was divided into two fishing areas: Area I, from Barra do Itabapoana to São Tomé Cape (22º00'S), and Area II, from São Tomé Cape to Macaé. Area I is strongly influenced by Itabapoana and Paraíba do Sul rivers runoffs, while in Area II the effects of the Central Water of South Atlantic (CWSA) up-welling are present, specially during spring-summer months (Valentin and Monteiro-Ribas, 1993; Muehe and Valentini, 1998). According to the Nautical Charts nº 1.403 and 1.500 from the Hydrograph and Navigation Department/Brazilian Navy, the 30m-isobath is located around 30-35 n.miles from the coastline in Area I, while the same isobath is situated about 7-14n.miles from shore in Area II (Figure 1).

Differences among seasonality, fishing grounds and small cetaceans by-catch proportions were tested by a normal approximation of the chi-square test (Zar, 1996), using *Statistica for Windows vs. 5.5* program procedures.

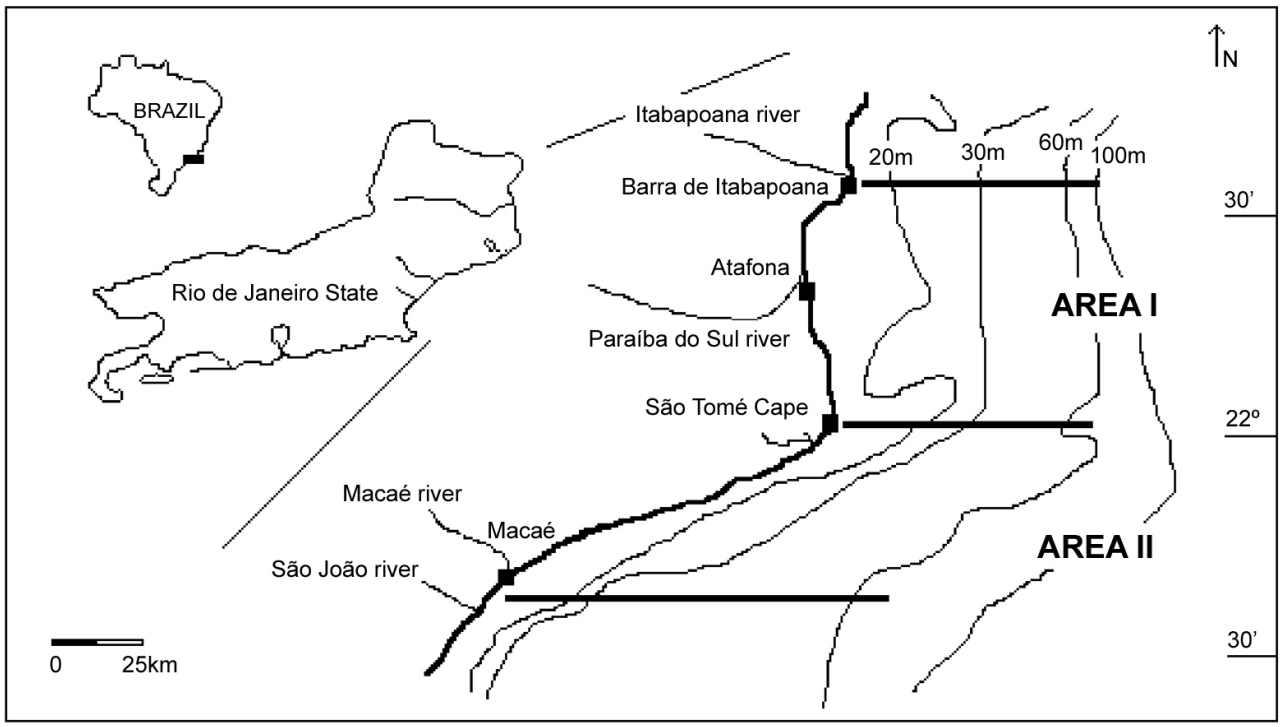

Figura 1. Map of Rio de Janeiro State with the geographis limits of the northern coast, the major rivers runoffs, the village of Atafona, the São Tomé Cape, the bathymetric characteristics and the fishing grounds (Area I and II).

Results

During the study period 374 gillnet operations were recorded. Passive gillnets were made of monofilament and varied from 1.3-4.9km in length (mean = 3.1; SD = 0.6); 1.9-6.0m in height (mean = 4.2; SD = 1.2); and 100-300mm stretched size mesh (mean = 120; SD = 10). The fishing boats were 10-12m in length and had load capacity of approximately 2-4 tons.

Fishing trips took place 2-4 weeks per month, or 2-6 days a week. The nets were deployed at sea 1-8 times each week, with soaking time being about 12 hours in each net setting. Poor weather conditions (*e.g.* strong winds), present in all seasons, accounted for the variability in the local fisheries data. These conditions constrained the fisheries during a few weeks/year or forced the boats to return earlier to the harbour. Throughout the entire fishing ground (21°18'S-22°25'S), the gillnet operations were conducted from 0.02 to 42.1n.miles from shore (mean = 15.2; SD = 12.1) and from 5 to 67m of depth (mean = 26.8; SD = 15.9).

Fishing effort for all monitored boats was 1,432.4km per year, with an average of 119.4km per month (SD = 31.2). Extrapolating it to the entire fleet, the effort was about 7,161.8km per year, with an average of 596.8km per month (SD = 155.8). Figure 2 represents the monthly effort along the studied period.

Forty-five small cetacean species were recorded: franciscana (22), marine tucuxi (20), Atlantic spotted dolphin (2) and one (1) unidentified dolphin (Table 1). Assuming a constant probability of by-catch to the entire gillnet fleet, the yearly number of small cetaceans caught in gillnets was 225: 110 franciscanas, 100 marine tucuxis, 10 Atlantic spotted dolphins and 5 unidentified dolphins. The CPUE estimate was about 0.031 animal × (km of net × day)$^{-1}$; franciscana and marine tucuxi values were 0.015 and 0.014, respectively.

Gillnet fisheries, as well as the by-catch of franciscana and marine tucuxi, did not show significant differences between the seasons of spring-summer and autumn-winter ($p > 0.05$). Gillnet fisheries were more prevalent in Area I than in Area II ($p = 0.0000$), while the by-catches were more prevalent in Area II for the franciscana ($p = 0.0000$) and the marine tucuxi ($p = 0.0002$). The number of fishing trips in all fishing ground was similar in the first 10n.miles from shore (47.6%) and beyond this limit (52.4%) ($p = 0.1897$). On the other hand, in Area I the fisheries occurred mainly in waters ≤ 30m deep (81.9%) ($p = 0.0000$). The by-catch of franciscana occurred mainly within the first 10n.miles from shore (100%) and in waters ≤30m deep (95.5%). A similar pattern was recorded for the marine tucuxi, with 85% of the captures occurring up to 10n.miles from shore and 100% of them in waters ≤ 30m deep (Table 2).

Discussion

In northern Rio de Janeiro the gillnet fisheries are carried out all year round and these fisheries extend to 40n.miles from shore and into waters 60m deep, as recorded in this and other studies (Lodi and Capistrano, 1990; Di Beneditto, 2001). We have, however, detected changes in net dimensions through time. According to the above authors, from 1987 to 1999 the most commonly-used gillnet measured 2.3km in length and 140mm in stretched-mesh size. These values are 35% shorter and 15% larger than the present length and mesh size, respectively. Smaller mesh size generally result in a catch of predominantly immature specimens of the same target species (Garcia-Mellado *et al.*, 2002; Carlson and Cortés, 2003). Consequently, this mesh size change could cause an overexploitation of the target species (Norse, 1993). Gillnet dimensions currently in use in northern Rio de Janeiro could result in a gradual collapse in the local fishing activity.

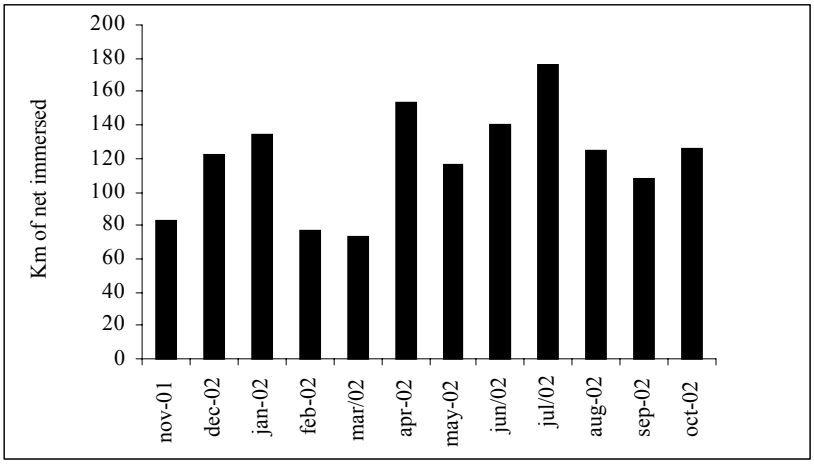

Figure 2. Monthly fishing effort of 20% of the gillnet fleet (n= 10 boats) based at the village of Atafona, northern Rio de Janeiro State, from November 2001 to October 2002.

Table 1. Characteristics of the by-catch of small cetaceans in northern Rio de Janeiro State, Brazil: 2001-2002.

SPECIES		CAPTURE DATE	FISHING AREA	CAPTURE COORDINATES	DISTANCE FROM SHORE (n.miles)	CAPTURE DEPTH (meters)
Franciscana (*Pontoporia blainvillei*)	1	01/11/01	II	22º17'S; 41º25'W	4.3	20
	2	01/11/01	II	22º17'S; 41º25'W	4.3	20
	3	01/11/01	II	22º17'S; 41º25'W	4.3	20
	4	01/11/01	II	22º20'S; 41º37'W	4.8	18
	5	24/01/02	II	22º21'S; 41º26'W	9.7	33
	6	19/02/02	I	21º55'S; 40º57'W	2.2	14
	7	19/02/02	I	21º55'S; 40º57'W	2.2	14
	8	19/02/02	I	21º55'S; 40º57'W	2.2	14
	9	20/02/02	II	22º10'S; 41º08'W	4.3	13
	10	20/02/02	II	22º10'S; 41º08'W	4.3	13
	11	14/04/02	II	22º08'S; 41º08'W	2.2	10
	12	14/04/02	II	22º08'S; 41º08'W	2.2	10
	13	26/04/02	II	22º07'S; 41º03'W	4.3	12
	14	26/04/02	II	22º07'S; 41º03'W	4.3	12
	15	21/05/02	I	21º55'S; 40º57'W	2.2	14
	16	31/05/02	I	21º55'S; 40º52'W	6.5	19
	17	09/07/02	II	22º08'S; 41º08'W	2.2	10
	18	09/07/02	II	22º08'S; 41º08'W	2.2	10
	19	24/07/02	II	22º12'S; 41º24'W	0.5	6
	20	30/08/02	I	22º00'S; 41º58'W	1.6	7
	21	30/08/02	II	22º14'S; 41º24'W	3.2	16
	22	31/08/02	II	22º13'S; 41º24'W	2.2	16
Marine tucuxi (Sotalia fluviatilis)	1	03/11/01	II	22º17'S; 41º26'W	4.8	15
	2	03/11/01	II	22º17'S; 41º26'W	4.8	15
	3	12/11/01	II	22º19'S; 41º25'W	6.5	22
	4	12/11/01	II	22º19'S; 41º25'W	6.5	22
	5	12/11/01	II	22º19'S; 41º25'W	6.5	22
	6	20/12/01	II	22º21'S; 41º15'W	12.9	30
	7	10/01/02	II	22º08'S; 41º15'W	0.2	5
	8	05/02/02	II	22º05'S; 41º03'W	2.2	10
	9	05/02/02	II	22º05'S; 41º03'W	2.2	10
	10	26/06/02	I	21º44'S; 40º44'W	16.1	24
	11	09/07/02	II	22º08'S; 41º08'W	2.2	10
	12	10/07/02	I	22º00'S; 40º58'W	1.0	7
	13	17/08/02	I	21º37'S; 40º33'W	25.9	27
	14	30/08/02	I	22º00'S; 40º58'W	1.6	7
	15	30/08/02	I	22º00'S; 40º58'W	1.6	7
	16	30/08/02	II	22º14'S; 41º24'W	3.2	16
	17	15/10/02	II	22º12'S; 41º08'W	6.5	17
	18	18/10/02	II	22º15'S; 41º08'W	9.7	23
	19	18/10/02	I	21º37'S; 41º00'W	0.2	7
	20	25/10/02	I	21º37'S; 40º57'W	3.2	13
Atlantic spotted dolphin (Stenella frontalis)	1	28/12/01	I	21º37'S; 40º55'W	4.3	15
	2	10/03/02	II	22º07'S; 41º03'W	4.3	12
Unidentified	1	10/10/02	II	22º43'S; 41º47'W	32.4	60

Table 2. Comparisons among seasonality, fishing grounds (areas, coastline distance and depth) and small cetaceans by-catch proportions in northern Rio de Janeiro, by a normal approximation of the chi-square test.

PARAMETERS	SEASONALITY		FISHING AREA		DISTANCE FROM SHORE		DEPTH	
Gillnet fisheries (374= 100%)	Spring-summer	Autumn-winter	Area I	Area II	First 10 n. miles	Beyond 10 n. miles	Until 30m of depth	Beyond 30m of depth
	N= 167	N= 207	N= 259	N= 115	N= 178	N= 196	N= 277	N= 97
	44.7%	55.3%	69.3%	30.7%	47.6%	52.4%	74.1%	25.9%
	p= 0.0559		*p*= 0.0000 *		*p*= 0.1897		*p*= 0.0000 *	
Fisheries – Area I (259= 100%)	N= 115	N= 144			N= 115	N= 144	N= 212	N= 47
	44.4%	55.6%			44.4%	55.6%	81.9%	18.1%
	p= 0.1117				*p*= 0.1117		*p*= 0.0000 *	
Fisheries – Area II (115= 100%)	N= 53	N= 62			N= 63	N= 52	N= 65	N= 50
	46.1%	53.9%			54.8%	45.2%	56.5%	43.5%
	p= 0.2263				*p*= 0.1308		*p*= 0.0701	
Franciscana by-catch	N= 167 (100%)	N= 207 (100%)	N= 259 (100%)	N= 115 (100%)	N= 178 (100%)	N= 196 (100%)	N= 277 (100%)	N= 97 (100%)
	N= 10 animals	N= 12 animals	N= 6 animals	N= 16 animals	N= 22 animals	N= 0	N= 21 animals	N= 1 animal
	6.0%	5.8%	2.3%	13.9%	12.4%	0.0%	7.6%	1.0%
	p= 0.9349		*p*= 0.0000 *		*p*= 0.0000 *		*p*= 0.0142 *	
Marine tucuxi by-catch	N= 167 (100%)	N= 207 (100%)	N= 259 (100%)	N= 115 (100%)	N= 178 (100%)	N= 196 (100%)	N= 277 (100%)	N= 97 (100%)
	N= 13 animals	N= 7 animals	N= 7 animals	N= 13 animals	N= 17 animals	N= 3 animals	N= 20 animals	N= 0
	7.8%	3.4%	2.7%	11.3%	9.6%	1.5%	7.2%	0.0%
	p= 0.0612		*p*= 0.0002 *		*p*= 0.0006 *		*p*= 0.0078 *	

* Significant differences.

About 69% of the gillnet operations are concentrated in Area I. We propose the following non-excluding factors to explain these disproportionate figures it: i) fishing areas are close to the Atafona harbour, where the boats are based, ii) boats avoid south São Tomé Cape region due to the intensive traffic of cargo vessels which can cause serious damage to their nets, and iii) the continental shelf is narrower in Area I and fishermen may prefer fishing in these waters.

Data on gillnet fishery in northern Rio de Janeiro from 1987-96 (Di Beneditto *et al.*, 1998) indicate that, during that period, approximately 60 boats used gillnets and the total effort each year was around 12,000 km of net. Since then, the number of gillnet boats has decreased to 50 and fishing effort each year (during 1997-99) was 9,700km of net (Di Beneditto and Ramos, 2001). Despite our data extrapolation to the fleet at-large, the fishing effort we report in this study (about 7,200 km of net) was obtained through systematic boat monitoring, and accounted for the variability in the fishing effort throughout the year due to poor weather conditions. This approach was not taken in the previous studies (Di Beneditto *et al.*, 1998; Di Beneditto and Ramos, 2001), as all boats were assumed to operate during 5 days/week and 4 weeks/month. As such, those values could have overestimated the local gillnet fishing effort (Table 3).

From 1987 to 1999, the annual number of small cetaceans by-caught in northern Rio de Janeiro ranged from 10 to 85, including all species (Di Beneditto, *unpublished data*). In the present study, the number recorded was 225, a figure substantially higher than the ones estimated for the previous years (Table 3). This large discrepancy may reflect biases in the sampling procedures during that time. The continuation of the gillnet fleet monitoring using the method standardised in the present study should be done in order to confirm the actual trend in the by-catch of small cetaceans in this region.

Nevertheless, the magnitude of the by-catch estimated here warrants concern, despite the lack of abundance estimates for the two main species involved. In the case of franciscana, there is evidence that the population in northern Rio de Janeiro might be more vulnerable than the population from southern Brazil, as the former shows relatively lower genetic variability (Secchi *et al.*, 1998).

Table 3. Annual fishing effort and by-catch of small cetaceans in northern Rio de Janeiro, Brazil, during 1987-96, 1997-99 and 2001-02.

PERIOD	ANNUAL FISHING EFFORT (km)	NUMBER OF SMALL CETACEANS BY-CATCH RANGE AVERAGE±SD	SMALL CETACEANS CPUE RANGE AVERAGE±SD
1987-96	12,000 [1]	16 - 85 [4] 50.8±22.7	0.001 - 0.007 [4] 0.004±0.002
1997-99	9,700 [2]	10 - 38 [4] 24.3±14.0	0.001 - 0.004 [4] 0.003±0.002
2001-02	7,200 [3]	225	0.031

(1) Di Beneditto *et al*. (1998); (2) Di Beneditto and Ramos (2001); (3) present study; (4) Di Beneditto, *unpublished data*.

Among the small cetacean species, by-catches of franciscana and marine tucuxi were the more representative. The strong correlation between the operation of coastal fisheries and the by-catch of small cetaceans has been reported elsewhere in the western South Atlantic (Praderi *et al*., 1989; Corcuera, 1994; Siciliano, 1994; Secchi *et al*., 1997). There are no CPUE estimates for marine tucuxi outside of northern Rio de Janeiro. On the other hand, CPUE of franciscana has been calculated for several areas (*e.g.* southern Brazil: Secchi *et al*. (1997) and Ott (1998); Uruguay: Praderi (1997) and Argentina: Perez-Macri and Crespo (1989) and Corcuera *et al*. (1994)). Recently, Ott *et al*. (2002) compiled information about interactions between the franciscana and fisheries throughout its range; Table 4 shows the comparison between their data and the present study. The CPUE value in northern Rio de Janeiro from 2001-02 was lower than those reported for southern Brazil (~29º-32ºS) and Argentina (~35º-40ºS), a possible reflection of differences in the franciscana population size, dynamics of the gillnet fleets, gillnet dimensions and their operational characteristics, differences in sampling procedures or a combination of these factors.

The lack of seasonality and the predominance of small cetacean by-catch in Area II were already noted for northern Rio de Janeiro (Lodi and Capistrano, 1990; Di Beneditto, 1997). According to the by-catch data, the 30-m isobath is the offshore limit of the franciscana and the marine tucuxi. Using the Nautical Charts nº1.403 and 1.500 from the Brazilian Navy, the potential distribution range of both species within 30-m isobath limit is around 3,960km^2 in the entire fishing ground, being 2,400km^2 in Area I (60.6%) and 1,560km^2 in Area II (39.4%). Although the gillnet effort was greater in Area I, the by-catch of small cetaceans was than that of Area II. Assuming that 30-m isobath defines the inshore distribution of these species, the differences in width of the continental shelf at those depths may influence the magnitude of the by-catch of small cetaceans in this area.

Table 4. Comparisons of CPUE data of franciscanas (*Pontoporia blainvillei*) in several areas of their distribution.

Locality	CPUE
Northern Rio de Janeiro State, Brazil (21º18'S - 22º25'S) 1987-99 2001-02	0.0002 to 0.002 [1] 0.015 [2]
Northern São Paulo State, Brazil (23º59'S - 24º20'S)	0.002 [3]
Northern Rio Grande do Sul State, Brazil (29º15'S - 29º58'S)	0.054 to 0.088 [3]
Southern Rio Grande do Sul State, Brazil (32º05'S)	0.010 [3]
Uruguay (33º45'S - 34º35'S)	0.0064 [3]
North Buenos Aires Province, Argentina (35º00'S - 38º08'S)	0.2161 to 0.4289 [3]
South Buenos Aires Province, Argentina (38º08'S - 40º30'S)	0.0734 [3]

(1) Di Beneditto and Ramos (2001); (2) present study;(3) Ott *et al*. (2002).

This hypothesis was considered by Secchi and Ott (2000) to explain the differences in the fishing effort and CPUE of the franciscana along Rio Grande do Sul State coast (~29º-32ºS), southern Brazil. The authors suggested that as the 30-m isobath is close to shore, the area available for franciscanas is limited, which in turn would result in the observed large densities and, consequently, higher by-catch rates.

The data on marine tucuxi by-catch in northern Rio de Janeiro indicate the 30-m isobath as its offshore limit and the occurrence of the species beyond this depth has never been recorded along its known range. I suspect that the inshore distribution of its preferred prey and the presence of potential competitors and predators might influence its distribution pattern in deeper waters.

The by-catch data on franciscanas, on the other hand, indicate that they might occur more commonly in the first 5-7n.miles from shore in Areas I and II, where the depths are 7-15m and 15-30m, respectively. During 1993-98, sightings of franciscanas in northern Rio de Janeiro were recorded in Di Beneditto *et al*. (2001*b*) and the observation effort included waters ≤ 60m deep. More than 90% of these sightings were obtained up to 5n.miles and up to 15m of depth. Siciliano *et al*. (2002) analysed the same dataset through geo-reference and verified that sightings of franciscana in Area I were strongly correlated to river runoffs.

Studies on franciscana feeding habits in northern Rio de Janeiro indicated that their diet was composed of juvenile squid and and croakers (sciaenids), in addition to anchovies (engraulids) and sardines (clupeids), mostly associated with estuaries and coastal areas near river mouths (Di Beneditto and Ramos, 2001). The occurrence and/or density of its preferred prey species may limit its distribution, especially in north São Tomé Cape region (Area I), as was also reported by Siciliano *et al*. (2002).

The by-catch data of the franciscana and the marine tucuxi showed that their distribution in northern Rio de Janeiro may be constricted by the bathymetric characteristics of the area. Human activities, such as gillnet fisheries, can cause serious impact on their populations, particularly if they are of small size. As such, gillnet fisheries should not operate within 10n.miles from shore between São Tomé Cape (22º00'S) and Macaé (22º25'S), as the 30-m isobath can be found very close to shore. In addition, fisheries operating near the Paraíba do Sul river mouth could adversely impact franciscanas, and pose a threat for the conservation of the species in the area.

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