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SIGHTINGS OF DOLPHINS DURING SEISMIC SURVEYS ON THE COAST OF BAHIA STATE, BRAZIL

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Grant Geophysical Inc. performed 2-D seismic surveys in transition zones on the coast of Bahia State, Brazil, from January to May 2002. The surveys were conducted between Boipeba Island and Barra Grande Beach (Figure 1), where depths range from 12 to 55m. During seismic activities, the occurrence of cetaceans was detected in the surveyed area. The aim of this note is to report sightings of all species of dolphins recorded during seismic surveys conducted in the region.

In order to obtain the appropriate license to operate in Brazilian waters, seismic surveying companies are required by the Brazilian Institute for the Environment and Natural Renewable Resources (IBAMA) to carry out an environmental monitoring program while seismic activities are being conducted. This program was subdivided into two parts, marine and terrestrial monitoring.

Marine monitoring consisted in recording the occurrence of marine organisms from two distinct boats, the gun boat (GB) and the environmental monitoring boat (EMB). The GB was responsible for shooting four 2200-PSI airguns (one shooting cycle / 16s) and had a permanent observer on the top of its cabin, who tried to record the presence of those organisms when airguns were either turned on or off ('blind' observation). The EMB had no seismic source onboard; however, an observer was present, with the role of monitoring the operation boundaries to record the presence of marine organisms. Each observer was equipped with a pair of reticule binoculars (red-lens compact Bushmaster 10x25mm) in order to improve his sightings. The GB observer was obligated to stop the seismic surveys whenever either a cetacean or a sea turtle was detected less than 500m far from the seismic source of the GB (the safety zone was arbitrarily estimated by the observer).

While the operation was set, for example, as cables were being deployed, the EMB moved away from the surveying site to record the occurrence of marine organisms in the vicinity and / or to place a third observer on land, who was responsible for monitoring the coastline. Once airguns started working, no boat, except the GB, could have its engine on near the surveying site, to avoid interference with the seismic data registering process (performed by a third boat, which recorded the information obtained through the sound-wave reflection on the sea bottom). Hence, the EMB had to keep a distance of at least 1.0nm (ca 1.8km) from the shooting line during seismic surveys.

Approximately 6km of coastline were surveyed daily, in searching for stranded animals. The position of the airgun shooting line was taken into account to establish the area that would be roamed, and whenever a line was completed, the monitored area changed following the location of the next line to be shot. As strandings were not expected to occur immediately after the GB operation, there was an overlap in the monitored areas in order to optimize monitoring efforts. Thus, one specific site could be monitored during subsequent days after the conclusion of the corresponding shooting line.

Marine monitoring lasted a total of 1225h, during 112 days (mean = 10.9h / day, SD = 2.8h / day, range of 4.0 to 13.8h / day – including days without sightings of cetaceans and periods with airguns turned on or off), around three different sites: Boipeba Island, Pratigi Beach and Barra Grande Beach. The daily mean time of airguns turned on was 5.1h / day (SD = 1.9h / day, range of 0.2 to 9.0h / day), hence, despite the large daily variation, the mean monitoring efforts with airguns turned on and off ('blind' observations) were, respectively, about 5.1h / day (SD = 1.9h / day, range of 0.2 to 9.0h / day) and 5.8h / day (SD = 1.7h / day, range of 3.3 to 8.2h / day).

Sightings of two dolphin species were recorded, the marine tucuxi (*Sotalia fluviatilis*), and the bottlenose dolphin (*Tursiops truncatus*). Although the field identification of these species can be confusing (Jefferson *et al.*, 1993), they are distinguishable by the longer and narrower snout and the more triangular shape of the dorsal fin of *S. fluviatilis*, compared to the shorter and more robust snout and the highly falcate dorsal fin of *T. truncatus* (Hetzel and Lodi, 1993). Whenever the identification of the cetacean species was doubtful, dolphins were classified as 'unidentified dolphin' (Table 1). The occurrence of marine tucuxis and bottlenose dolphins in Bahia State, as well as of other 13 cetacean species, had already been reported (Lodi *et al.*, 1990; Hetzel and Lodi, 1993; Reis and Queiroz, 1994[4]; Batista *et al.*, 1998[5]; Sampaio

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[4] Reis, M.S.S. and Queiroz, E.L. (1994) *Ocorrência de* Stenella *cf* S. clymene *Gray, 1850 (Cetácea, Delphinidae) para o litoral norte do Estado da Bahia, Brasil*. Page 142 *in* Abstracts, VI Reunião de Trabalho de Especialistas em Mamíferos Aquáticos da América do Sul, 24-28 October, Florianópolis, Brazil.
[5] Batista, R.L.G., Santos, U.A. and Reis, M.S.S. (1998) Registros de cetáceos no litoral de Ilhéus-Bahia, Brasil. Page 22 *in* Abstracts, VIII Reunião de Trabalho de Especialistas em Mamíferos Aquáticos da América do Sul and II Congresso da Sociedade Latinoamericana de Especialistas em Mamíferos Aquáticos, 25-29 October, Olinda, Brazil.

and Reis, 1998[6]; MAMA, 2004). Therefore, the small number of dolphin species identified in the present work does nor reflect the diversity of cetaceans for this region, especially as other cetacean species (*e.g.*, *Kogia* sp. and *Steno bredanensis*) have also been recorded during subsequent seismic surveys performed two years later in the same area during longer periods (Araújo, pers. comm.).

Dolphins were sighted in 26% of the days monitored (46 sightings), and observations of *S. fluviatilis* were much more frequent than those of *T. truncatus* (87% and 0.04%, respectively, see Table 1). The fact that marine tucuxis were more often sighted than bottlenose dolphins can simply reflect the inshore distribution of the species. Marine tucuxis occur typically near the coast (Borobia *et al*., 1991), while bottlenose dolphins can have either coastal or oceanic habits in Brazil (Barreto, 2000). The distribution of these species could make it easier to sight the former than the latter, since seismic activities were conducted in shallow waters.

Group size of marine tucuxis varied from one to 12 animals, and groups of up to four dolphins were recorded in 65% of the sightings (Table 1). Higher frequencies of small groups of *S. fluviatilis* were also reported for Ceará State, northeastern Brazil (Oliveira *et al*. 1995), but much larger aggregations of tucuxis have been observed in Rio de Janeiro State, southeastern Brazil (Simão *et al.* 2000; Lodi, 2003). Calves of *S. fluviatilis* [identified following Ramos *et al.* (2000), whose results were later corroborated by Di Beneditto and Ramos (2004)] were present in 4.4% of the sightings of the species.

Occurrence of marine tucuxis was higher near Boipeba Island (Figure 1). This observation can be biased by the higher sampling effort close to the Boipeba Island (29 groups sighted / 600h of survey) in comparison to those next to Pratigi Beach (eight groups sighted / 312h) and Barra Grande Beach (three groups sighted / 312h). One should also consider that food availability could have influenced dolphins' distribution, since the largest variety of ecosystems, *e.g.*, mangroves, sandy and coral reefs, is found in Boipeba Island. Barros and Wells (1998) stated that distribution and movement of prey influence

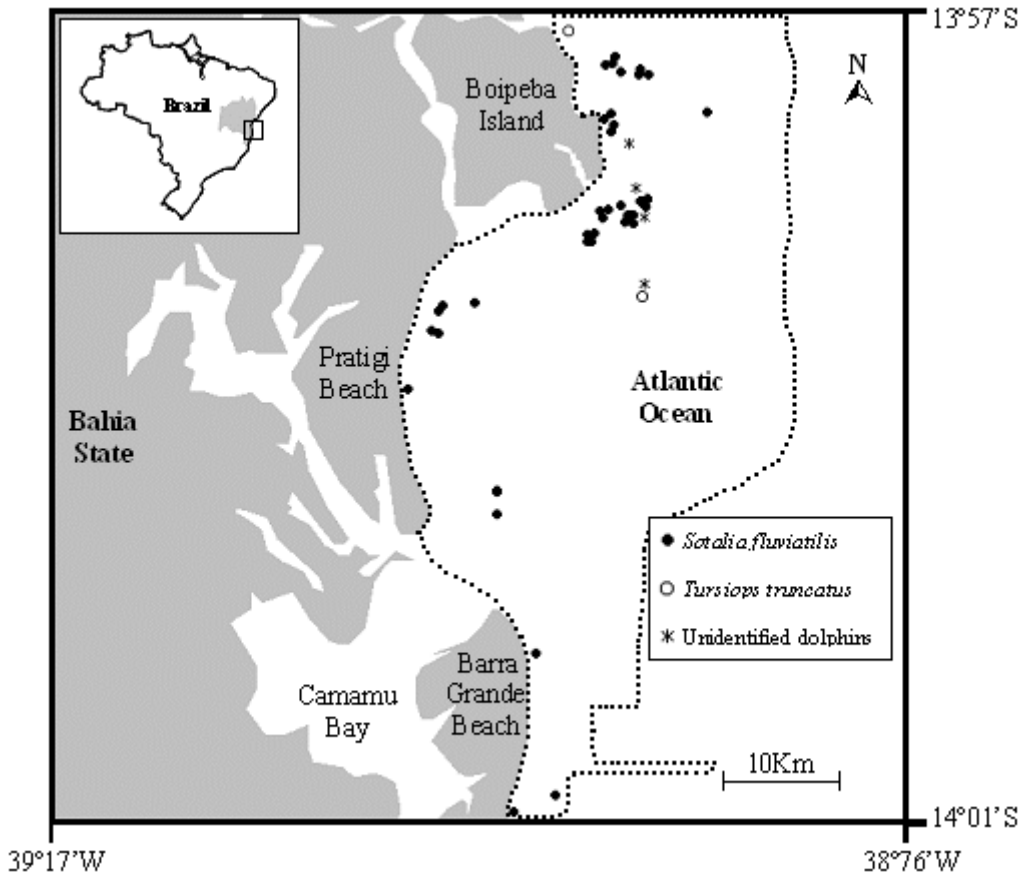

Figure 1. Sightings of dolphins in the area where seismic surveys occurred.

[6] Sampaio, C.L.S. and Reis, M.S.S. (1998) *Registros de cetáceos na costa nordestina*. Page 187 *in* Abstracts, VIII Reunião de Trabalho de Especialistas em Mamíferos Aquáticos da América do Sul and II Congresso da Sociedade Latinoamericana de Especialistas em Mamíferos Aquáticos, 25-29 October, Olinda, Brazil.

distribution and movement patterns of cetaceans on spatial and temporal scales. Around Pratigi Beach, some *S. fluviatilis* individuals were sighted near shrimp trawling boats, suggesting some degree of interaction with this kind of fishery.

Bottlenose dolphins were sighted exclusively near Boipeba Island, in two different days (Figure 1). On 25 February 2002, six *T. truncatus* specimens (four adults and two calves) were observed at 13º34'95"S; 38º54'50"W, and, on 7 March 2002, 10 individuals (eight adults and two calves) were sighted at 13º36'22"S; 38º52'45"W (Table 1).

Seismic surveys were never interrupted, since no marine organism was sighted by the GB observer in the safety zone while airguns were turned on. This situation could suggest that, at least apparently, dolphins avoided the noise produced by the airguns; unfortunately, we cannot confirm this statement because no dolphin with suggestive avoiding behavior to airguns was observed. However, it is known that some cetacean species avoid being close to seismic sources. Goold (1996), though using a different methodology, reported that common dolphins, *Delphinus delphis*, tended to keep a distance from seismic activities when airguns were active.

While seismic activities lasted, neither an injured nor a stranded dolphin was found, and just one dead individual was recorded (on 22 February 2002). The animal could not be identified to species due to the condition of the carcass, which was floating, trapped in a long-line (Table 1). We were not able to conclude whether the dolphin was entangled or not prior to its death, but this kind of observation suggests interaction with fishing activities and no association with the usage of airguns can be made. Although relatively uncommon, incidental catches of small cetaceans in long-lines have been recorded in northeastern Brazil (Siciliano, 1994). Even though some authors reported negative effects of seismic activities on dolphins (Finneran *et al.*, 2002; Gordon *et al.*, 2003), our results do not allow further comments about this topic.

Table 1. List of sightings of dolphins recorded.

DATE	SPECIES	N	LOCATION		LOCAL DEPTH (m)	OBSERVER
			LATITUDE	LONGITUDE		
29 January 2002	*Sotalia fluviatilis*	2	13°36'57"S	38°53'55"W	-	GB***
1 February 2002	*Sotalia fluviatilis*	2	13°37'38"S	38°53'47"W	5	EMB
4 February 2002	*Sotalia fluviatilis*	9	13°36'16"S	38°53'03"W	9	EMB
4 February 2002	*Sotalia fluviatilis*	2	13°41'15"S	38°53'34"W	6	EMB
5 February 2002	*Sotalia fluviatilis*	4	13°41'02"S	38°53'45"W	5	EMB
5 February 2002	*Sotalia fluviatilis*	6	13°36'13"S	38°52'36"W	16	EMB
6 February 2002	*Sotalia fluviatilis*	4	13°38'10"S	38°52'40"W	10	GB***
6 February 2002	*Sotalia fluviatilis*	12	13°34'49"S	38°53'59"W	-	EMB
7 February 2002	*Sotalia fluviatilis*	10	13°41'17"S	38°54'04"W	5	EMB
7 February 2002	*Sotalia fluviatilis*	6	13°35'57"S	38°53'16"W	-	EMB
10 February 2002	unidentified dolphin	2	13°43'09"S	38°53'23"W	-	EMB
14 February 2002	unidentified dolphin	1	13°38'29"S	38°52'41"W	-	EMB
14 February 2002	*Sotalia fluviatilis*	2	13°36'11"S	38°52'60"W	-	EMB
14 February 2002	*Sotalia fluviatilis*	1	13°36'11"S	38°52'60"W	-	EMB
14 February 2002	*Sotalia fluviatilis*	7	13°36'11"S	38°52'60"W	-	EMB
15 February 2002	*Sotalia fluviatilis*	3	13°40'51"S	38°55'84"W	4	GB***
15 February 2002	*Sotalia fluviatilis*	3	13°38'96"S	38°51'83"W	-	EMB
16 February 2002	unidentified dolphin	1	13°40'05"S	38°53'21"W	7	EMB
17 February 2002	*Sotalia fluviatilis*	1	13°43'62"S	38°57'73"W	-	EMB
19 February 2002	*Sotalia fluviatilis*	2	13°41'68"S	38°54'18"W	-	EMB
20 February 2002	*Sotalia fluviatilis*	2	13°40'59"S	38°53'17"W	15	GB***
21 February 2002	*Sotalia fluviatilis*	2	13°41'12"S	38°53'57"W	-	EMB
21 February 2002	*Sotalia fluviatilis*	7	13°40'45"S	38°53'12"W	-	EMB
22 February 2002	*Sotalia fluviatilis*	1	13°32'02"S	38°48'74"W	-	GB***
22 February 2002	unidentified dolphin	1**	13°33'41"S	38°48'23"W	40	EMB
24 February 2002	*Sotalia fluviatilis*	3	13°37'39"S	38°48'89"W	-	EMB

continued...

conclusion

DATE	SPECIES	N	LOCATION		LOCAL DEPTH (m)	OBSERVER
			LATITUDE	LONGITUDE		
25 February 2002	*Tursiops truncatus*	6*	13°34'95"S	38°54'50"W	10	EMB
25 February 2002	*Sotalia fluviatilis*	8	13°35'90"S	38°53'43"W	13	EMB
1 March 2002	*Sotalia fluviatilis*	8*	13°45'93"S	38°59'68"W	-	EMB
1 March 2002	*Sotalia fluviatilis*	6	13°50'23"S	38°56'95"W	7	EMB
1 March 2002	*Sotalia fluviatilis*	4	13°49'26"S	38°56'80"W	-	EMB
2 March 2002	*Sotalia fluviatilis*	2*	13°44'53"S	38°58'75"W	-	EMB
7 March 2002	*Tursiops truncatus*	10*	13°36'22"S	38°52'45"W	-	EMB
10 March 2002	*Sotalia fluviatilis*	3	13°40'01"S	38°56'32"W	-	EMB
11 March 2002	*Sotalia fluviatilis*	4	13º37'48"S	38°53'01"W	-	EMB
15 March 2002	*Sotalia fluviatilis*	3	13º40'27"S	38°56'25"W	-	EMB
17 March 2002	*Sotalia fluviatilis*	7	13º43'52"S	38°57'30"W	-	EMB
21 March 2002	*Sotalia fluviatilis*	2	13º43'60"S	38°58'62"W	6	EMB
23 March 2002	*Sotalia fluviatilis*	3	13º41'66"S	38°54'19"W	7	EMB
24 March 2002	*Sotalia fluviatilis*	4	13º41'39"S	38°55'06"W	-	EMB
25 March 2002	*Sotalia fluviatilis*	2	13º40'17"S	38°56'56"W	4	EMB
31 March 2002	*Sotalia fluviatilis*	3	13º41'23"S	38°57'30"W	-	EMB
13 April 2002	*Sotalia fluviatilis*	12	13º59'56"S	38°56'43"W	-	EMB
28 April 2002	*Sotalia fluviatilis*	10	13º54'42"S	38°55'36"W	12	EMB
4 May 2002	*Sotalia fluviatilis*	8	13º37'22"S	38°50'54"W	25	GB***
8 May 2002	*Sotalia fluviatilis*	3	13º41'39"S	38°54'54"W	-	GB***

Depths were determined by sonar. The GB had its own equipment and estimated depths on the EMB were obtained by requesting this information from the nearest boat equipped with a sonar. (*) presence of calves, (**) dead dolphin - entangled in a long-line, (-) no data available, (GB) Gun Boat, (EMB) Environmental Monitoring Boat, (***) airguns turned off.

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