J. Mar. Biol. Ass. U.K. (2005), **85**, 209–212
Printed in the United Kingdom

Group characteristics of marine tucuxis (*Sotalia fluviatilis*) (Cetacea: Delphinidae) in Guanabara Bay, south-eastern Brazil

Alexandre F. Azevedo*†‡, Simone C. Viana†, Alvaro M. Oliveira† and Monique Van Sluys*

*PPGB/IBRAG, Departamento de Ecologia, Universidade do Estado do Rio de Janeiro (UERJ), Rua São Francisco Xavier 524, Maracanã, Rio de Janeiro, 20550-013, RJ, Brazil. †Projeto Mamíferos Aquáticos, Departamento de Oceanografia, UERJ, Brazil. ‡Corresponding author, e-mail: azevedo.alex@uol.com.br

Thirty-six boat surveys were conducted in Guanabara Bay, south-eastern Brazil, from October 2002 to June 2004 in order to investigate marine tucuxi group characteristics. The average and the range of tucuxis group size in the Guanabara Bay are similar with areas where small group sizes have been recorded. Group size ranged between one and 40 individuals (13.0 ±9.5; median=10.0). Groups of two to ten dolphins were the most common (53.9% of observations). Group size and the maximum number of dolphins sighted in each survey day did not vary between seasons (Kruskal–Wallis test, $H_{3,36}$=3.249; P=0.355). Spatial geometry varied with group size and mixed groups were the largest (Kruskal–Wallis test, $H_{3,218}$=57.149; $P<0.001$). The presence of calves had a great effect on group size, and nursery groups (mean =14.3 ±9.1; median=13.0) were twice as large than non-calf groups (mean=7.1 ±5.2; median=6.0). It is suggested that larger groups may aid in the calves development and learning. Group size changed frequently, resulting in 82.2% of observations with no constant size. Group size of marine tucuxi was not affected by the dolphins' behaviour (Kruskal–Wallis test, $H_{2,215}$=5.626, P=0.06) neither by water depth (R^2=0.012; $F_{1,219}$=2.82; P=0.094).

INTRODUCTION

Marine tucuxis (*Sotalia fluviatilis* Gervais, 1853) are small delphinids, which inhabit coastal waters in South and Central Americas, from southern Brazil to Nicaragua, with possible records in Honduras (Flores, 2002). Despite its near-shore distribution, the marine tucuxi has many ecological and biological parameters poorly known, including group characteristics. The species was included in the category 'Data Deficient' by the International Union for the Conservation of Nature and Natural Resources (IUCN – The World Conservation Union).

Recently, observations about group characteristics, especially group size, have been reported. There is a wide variation in marine tucuxi group sizes due to environmental differences and to different definitions of a group, since only a few number of researchers have standardized behavioural data collection. In Brazilian waters, group size from different areas is variable and marine tucuxi have been reported in groups of one to hundreds of individuals. For instance, groups up to 400 individuals are reported in south-eastern Brazil (Flores, 2002). A few other studies pointed out small group sizes ranging from two to 20 dolphins. In the Cananéia Estuary, south-eastern Brazil, observed mean group size was 12.4 (±11.4) individuals (Santos, 2004). In Guanabara Bay, some authors reported groups with modal number of two dolphins (e.g. Geise, 1989). However, other studies reported groups consisting mainly of six to 15 individuals, although they can form aggregations of up to 50 dolphins (e.g. Azevedo, 2000).

The presence of marine tucuxis in the Guanabara Bay is known since the end of the 19th Century. Despite being a highly degraded area, this bay supplies food and breeding grounds, and tucuxis are found year-round in this site (Azevedo et al., in press). The objective of this study was to report group characteristics of marine tucuxis in Guanabara Bay, and to analyse the influence of behavioural activity, calf presence and water depth, on group formation.

MATERIALS AND METHODS

Guanabara Bay (GB) (22°50′S 43°10′W), located in Rio de Janeiro State, south-eastern Brazil, has a total extension of 30 km, with an entrance 1.8 km wide and a total area of 371 km^2 (Figure 1). Main depth of GB is 5.7 m; but along the main channel, which follows the central south–north axis, depths reach an average of 20 m. This bay possesses features of an estuarine system and the freshwater contribution is derived from 35 rivers, which flow into the bay, and from sewage input (Perin et al., 1997). This bay is surrounded by a metropolitan complex and is highly degraded due to habitat loss, overfishing, harbour activities, inputs of metals and organochlorines, among others (Perin et al., 1997).

Thirty-six boat surveys were conducted in Guanabara Bay from October 2002 to June 2004, in order to record behavioural activities of marine tucuxis. All surveys were carried out under adequate weather conditions (Beaufort sea state ≤2), in small (4.5–6.0 m) outboard-powered boats, usually between 0700 and 1800. Instantaneous

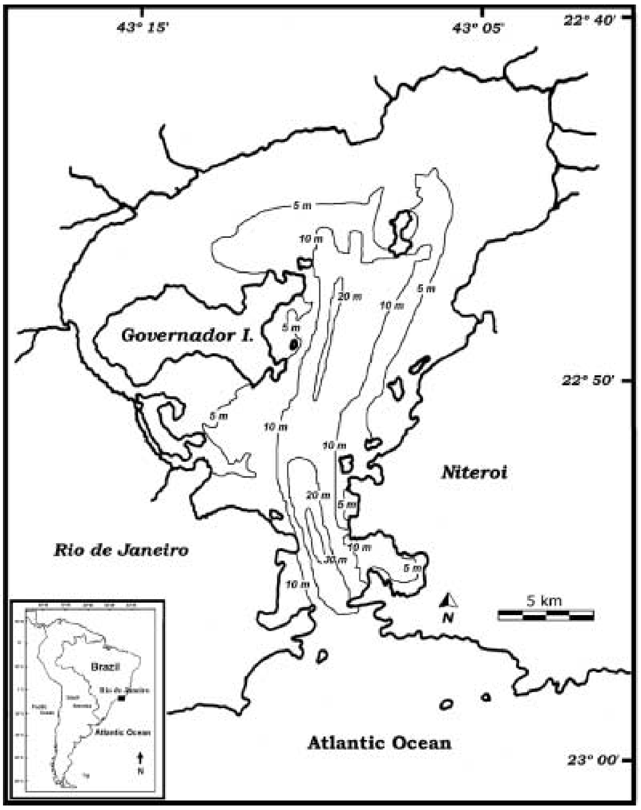

Figure 1. Map of Guanabara Bay (22°50′S 43°10′W), south-eastern Brazilian coast.

sampling focal-group behavioural data (*sensu* Altmann, 1974) were collected every five minutes. Focal-groups were solitary animals and aggregations of two or more dolphins in apparent association within 30 m from each other. Each focal-group had a recognizable dolphin, with natural marks on its body so that the animal could be distinguished from all other individuals. Photo-id techniques have been applied in studies with tucuxi from GB since 1995 (Azevedo et al., in press). Some individuals have prominent natural marks on the body (cut on back, half tail fluke, great marks on dorsal fin, anomalous pigmentation, and others), which allowed us to recognize some dolphins by the naked eye.

Observations of focal-group activities began when animals were considered to become habituated to the presence of the boat (Karczmaski & Cockcroft, 1999). Observations of group size, composition, spatial geometry, surface behaviour, location and water depth were made. The location of each focal-group was obtained by the use of a Global Positioning System (GPS), and water depth was estimated from the nautical chart (DHN no. 1501) of the Brazilian Navy.

Group composition was determined by visual observation of body size and categorized into adults/juveniles and calves. Calves were individuals with 2/3 or less of an adult body size, regularly accompanying a larger animal. Spatial geometry observations followed Shane (1990). Shane (1990) defined four distinct bi-dimensional geometry related to distance between group members: *tight*, when dolphins were less than one body length apart; *loose*, when dolphins separation was greater than one and less than five body lengths; *widely* dispersed, when group members were more than five body lengths apart; *mixed*, when dolphins were spaced into more than one category. Surface behaviour was the predominant activity of the majority of group members. When the focal group split, we followed the group with the focal animal. Surface behaviour was classified into five broad categories: travelling, foraging/feeding, socializing, resting (*sensu* Shane, 1990) and unknown.

Trying to maximize data representativeness, we avoided oversampling groups along the survey. So, each focal-group was followed for a maximum period of two hours and then another group was sampled. Additionally, we changed the boat course in each survey in order to cover different sites of GB, at different times of the day.

Consecutive sampling of the same group could lead to non-independence of data. Trying to minimize this problem, we randomly chose one focal group activity observation per hour to perform statistical analysis.

RESULTS AND DISCUSSION

Approximately 159 hours were spent in direct observations. A total of 219 focal group activity observations was randomly chosen.

The average and the range of tucuxis group size in GB are similar with areas where small group sizes have been recorded. Group size ranged from one to 40 individuals (13.0 ±9.5; median=10.0). Solitary dolphins were seen in 0.9% of the observations. Groups composed of two to ten dolphins were the commonest, totalling 53.9% of observations. Groups larger than 30 individuals were rare (Figure 2). Mean group size may be a function of resources provided by the environment. Guanabara Bay is the most degraded area along the marine tucuxi distribution and its poor environmental conditions seem to limit resources for *Sotalia fluviatilis*, thus affecting group size.

Maximum number of tucuxis sighted in a single day was about 50 individuals (mean=40.1 ±7.2; median=40.0) and it did not vary between seasons (Kruskal–Wallis test, $H_{3,36}=3.249$; $P=0.355$). This same pattern was observed for group sizes (Kruskal–Wallis test, $H_{3,219}=1.575$; $P=0.665$). Fluctuations in group size throughout the year can be related to variation in dolphin abundance among seasons. Information about seasonal variation of group size in marine tucuxis is scarce, but our findings are in agreement with recent studies that did not find seasonal differences in group size of tucuxis (e.g. Santos, 2004).

In general, no spatial geometry was significantly predominant (Cochran's Q test; Q=10.790; df=3; $P=0.013$). Group formation varied with group size (Kruskal–Wallis test, $H_{3,218}=57.149$; $P<0.001$). Mixed groups were larger than all other spatial geometries (Figure 3). Spatial geometry was also associated with behaviour and during socializing tight groups were more common than all other three spatial geometries (Cochran's Q test; Q=27.818; df=3; $P<0.001$). Travelling groups were reported in tight and loose formations and both categories were reported at the same time. Loose, widely dispersed and mixed of these two geometries were usual during feeding activities. Tight feeding groups were less frequent

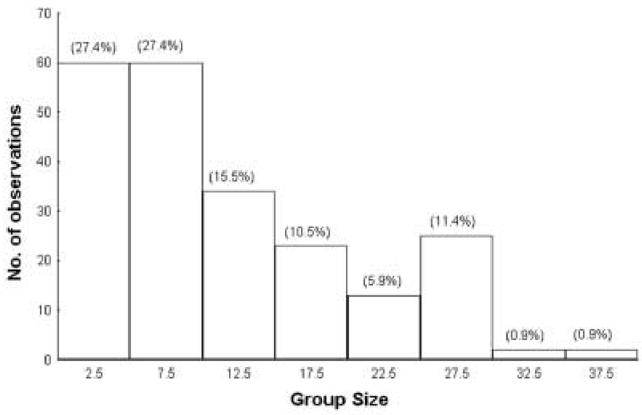

Figure 2. Distribution of group size of marine tucuxis in Guanabara Bay (Brazil), between October 2002 and June 2004.

(15.6%) such as widely dispersed travelling groups (14.5%). The relationship between spatial geometry and behavioural activity have already been reported for other dolphin species, such as *Tursiops truncatus* in western Florida (Shane, 1990) and *Sousa chinensis* in South Africa (Karczmarski & Cockcroft, 1999). In GB, feeding groups were commonly seen in dispersed formations, which seem to help in co-operative search for food. In contrast, during travelling, marine tucuxis were frequently sighted in non-dispersed geometries, probably to decrease the risk of separation of a member of the group and improve the investigation of the area being travelled (Karczmarski & Cockcroft, 1999).

Groups with calves were seen in all surveys and the number of calves per group ranged from zero to five (mean = 1.2 ±1.1; median=1.0). Groups with one or more calves were larger (14.3 ±9.1; median=13.0) than those comprising adults/juveniles (7.1 ±5.2; median=6.0) (Mann–Whitney test, U=2310.5; N=219; P<0.001). Previous studies in GB reported calves in groups of three or four individuals (e.g. Geise, 1989). Our results indicate calves occurring in larger groups. The presence of calves had a great effect on group size, and nursery groups were, in general, twice the size of non-calf groups. This pattern has already been documented on other dolphin species, such as *S. chinensis* (Karczmarski, 1999). It is suggested that larger groups provide better individual protection, sensory integration and co-operative foraging, which may aid in the calves' development and learning (Karczmarski, 1999).

Marine tucuxis were seen in waters of 3.5 to 34 m in depth and there was no relation between group size and water depth (R^2=0.012; $F_{1,219}$=2.82; P=0.094). Group size changed frequently, resulting in 82.2% of observations with no constant size. The dolphins preferably used water deeper than 10 m and usually formed aggregations of up to 50 individuals spread out in small groups within a large area. These small groups moved in the same general direction almost all the time and frequently groups were observed to split and join one another.

The average group size was highest in socializing activity (Figure 4), but no significant differences were found among the three behaviours (Kruskal–Wallis test, $H_{2,215}$=5.626, P=0.06). Group variation was analysed during travelling, feeding/foraging and socializing, once resting and unknown were infrequent (N=2 for both). Larger groups of bottlenose dolphins in socializing activities have been seen on more occasions than in any other

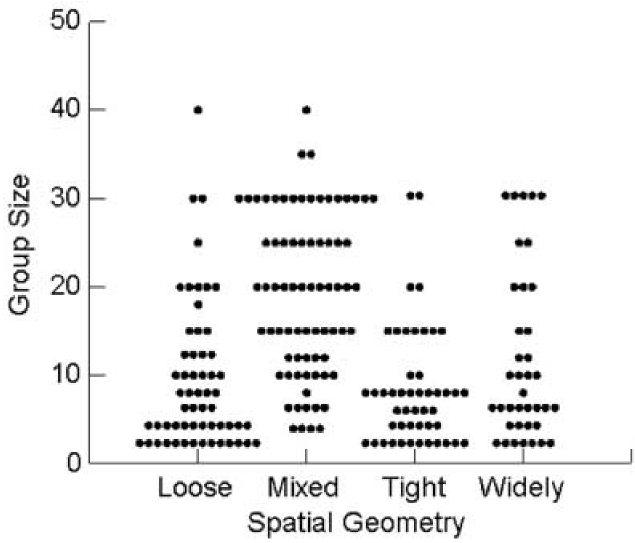

Figure 3. Marine tucuxis group size for each spatial geometry analysed in Guanabara Bay (Brazil) between October 2002 and June 2004. *Tight* (mean=8.4 ±6.6, median=8.0); *loose* (mean=9.6 ±8.1, median=6.5); *widely* (mean=11.8 ±9.3, median=7.5); *mixed* (mean=19.6 ±9.0; median=20.0).

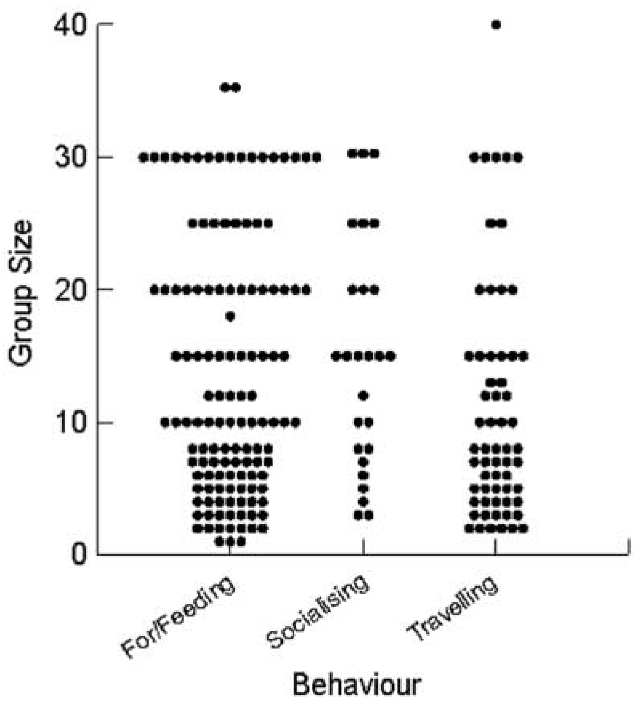

Figure 4. Marine tucuxis group size for the three behavioural categories analysed in Guanabara Bay (Brazil) between October 2002 and June 2004. Feeding/foraging (mean=13.7 ±9.6, median=10.0); travelling (mean=11.1 ±9.1, median=8.0); socializing (mean=15.0 ±8.6, median=15.0).

behavioural activity (e.g. Shane, 1990). However, our results are similar to those reported for humpback dolphins (Karczmarski & Cockcroft, 1999) in which group size does not depend on behavioural activity.

Our findings provided new information about group characteristics of marine tucuxis in GB. However, this is a short-term study, and further research concerning the social structure of *Sotalia fluviatilis* are needed for interpretation of individual relationships and different group functions.

This study was funded by the Instituto Biomas, Cetacean Society International, The Humane Society of the United States and PPGB (IBRAG, UERJ). We thank the two anonymous referees who made useful suggestions for improving the manuscript. José Lailson Brito Jr (Departamento Oceanografia, UERJ, Brazil) and Haydée Cunha (IB, UFRJ, Brazil) provided useful comments on the manuscript. We particularly thank the Departamento de Ecologia (IBRAG, UERJ), the Departamento de Oceanografia (IGEO, UERJ) and the Iate Clube Jardim Guanabara which provided logistical support. We are grateful to Wagner B.P. Cavalcante for field work assistance. The Conselho Nacional para o Desenvolvimento Científico e Tecnológico (CNPq-Brazil) granted a graduate fellowship to A.F. Azevedo (grant no. 140853/02-2). Monique Van Sluys had a research grant by CNPq-Brazil (grant no. 302405/02-0).

REFERENCES

Altmann, J., 1974. Observational study of behavior: sampling methods. *Behaviour*, **49**, 227–267.

Azevedo, A.F., 2000. *Emissões sonoras do boto-cinza* (Sotalia fluviatilis *Gervais, 1853) na Baía de Guanabara - RJ.* MSc thesis, Universidade Federal Rural do Rio de Janeiro, Seropédica, Brazil.

Azevedo, A.F., Lailson-Brito, J. Jr, Cunha, H.A. & Van Sluys, M., in press. Site fidelity of marine tucuxis (*Sotalia fluviatilis*) in Guanabara Bay, southeastern Brazil. *Journal of Cetacean Research and Management*.

Flores, P.A.C., 2002. Tucuxi *Sotalia fluviatilis*. In *Encyclopedia of marine mammals* (ed. W.F. Perrin et al.), pp. 1267–1269. San Diego: Academic Press.

Geise, L., 1989. *Estrutura social, comportamental e populacional de* Sotalia *sp. (Gray, 1886) (Cetacea, Delphinidae) na região estuarino-lagunar de Cananéia, SP e na Baía de Guanabara, RJ.* MSc thesis, Universidade do Estado de São Paulo, São Paulo, Brazil.

Karczmarski, L., 1999. Group dynamics of humpback dolphins (*Sousa chinensis*) in Algoa Bay region, South Africa. *Journal of Zoology*, **49**, 283–293.

Karczmarski, L. & Cockroft, V.G., 1999. Daylight behaviour of humpback dolphins *Sousa chinensis* in Algoa Bay, South Africa. *International Journal of Mammalian Biology*, **64**, 19–29.

Perin, G., Fabris, R., Manente, S., Rabello-Wagener, A., Hamacher, C. & Scotto, S.A., 1997. Five-year study on the heavy-metal pollution of Guanabara Bay sediments (Rio de Janeiro, Brazil) and evaluation of the metal bioavailability by means of geochemical speciation. *Water Research*, **31**, 3017–3028.

Santos, M.C.O., 2004. *Uso de área e organização social do boto-tucuxi marinho,* Sotalia fluviatilis *(Cetacea, Delphinidae), no estuário de Cananéia, SP.* PhD thesis, Universidade de São Paulo, São Paulo, Brazil.

Shane, S.H., 1990. Behavior and ecology of the bottlenose dolphin at Sanibel Island, Florida. In *The bottlenose dolphin* (ed. S. Leatherwood and R.R. Reeves), pp. 245–265. San Diego: Academic Press.

Submitted 13 October 2004. Accepted 20 January 2005.