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Full Length Research Paper

Ecology and behavior of the estuarine dolphin, *Sotalia guianensis* (Cetacea: Delphinidae) in Sepetiba Bay, South-eastern Brazil

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The dynamics of habitat utilization by *Sotalia guianensis* has been investigated. Between January 1997 and May 1998, 145 h of direct observations were made from a fixed location at Ponta do Zumbi on Marambaia Island, and 249 groups of dolphins were sighted. Initial and final times of the observation, approximate location, presence of calves, activities performed by the dolphins and prevailing weather conditions were recorded for all sightings. Dolphin groups were observed during all seasons of the year, and sightings occurred mainly during the late morning (9:00 - 11:59 h) and early afternoon (12:00 - 14:59 h). Dolphins exhibited a preference for the sheltered sub-areas of the bay rather than for the sub-area adjacent to the open sea. The most commonly observed aggregation of animals consisted of groups of 1 – 10 individuals. The activities performed by the dolphins were, in decreasing order of frequency of occurrence: foraging/feeding, travelling, socialization and resting. Daily and seasonal profiles of dolphins activities were dictated by many interacting factors (temporal, environmental and population characteristics), none of which could alone explain the manner in which the animals utilize the area or the organization of life cycle in the habitat.

Key words: *Sotalia guianensis*, habitat use, behaviour, group size.

INTRODUCTION

The study of cetaceans in their natural environment is still a challenge, because they are highly mobile and spend the most part of their life underwater. Besides these difficulties, our knowledge of the behavior, ecology and social organization of many cetacean species has improved significantly in the last decades.

The estuarine dolphin, *Sotalia guianensis* (Van Bénéden, 1864) is a small dolphin that may be found along the coast of Central and South America, from Honduras (14°35'N, 83°14'W) to southern Brazil (27°35'S, 48°35'W) (Flores, 2002), especially in estuarine and bay areas (Silva and Best, 1994). Despite its abundant distribution along the South American Coast, information about this dolphin is considered insufficient and the species is categorized as “data deficient” by the International Union for Conservation of Nature and Natural Resources (IUCN, 2010) for conservation purposes. A taxon is considered data deficient when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, but appropriate data on abundance are still lacking. Reports concerning the dynamics of *S. guianensis* populations, located along the Brazilian coast, are available and they provide information concerning size and composition, distribution, daily and seasonal movements, and has correlation with biotic and abiotic factors (Lodi, 2003; Daura-Jorge et al., 2005; Azevedo et al., 2005; Araújo et al., 2007; Flach et al., 2008).

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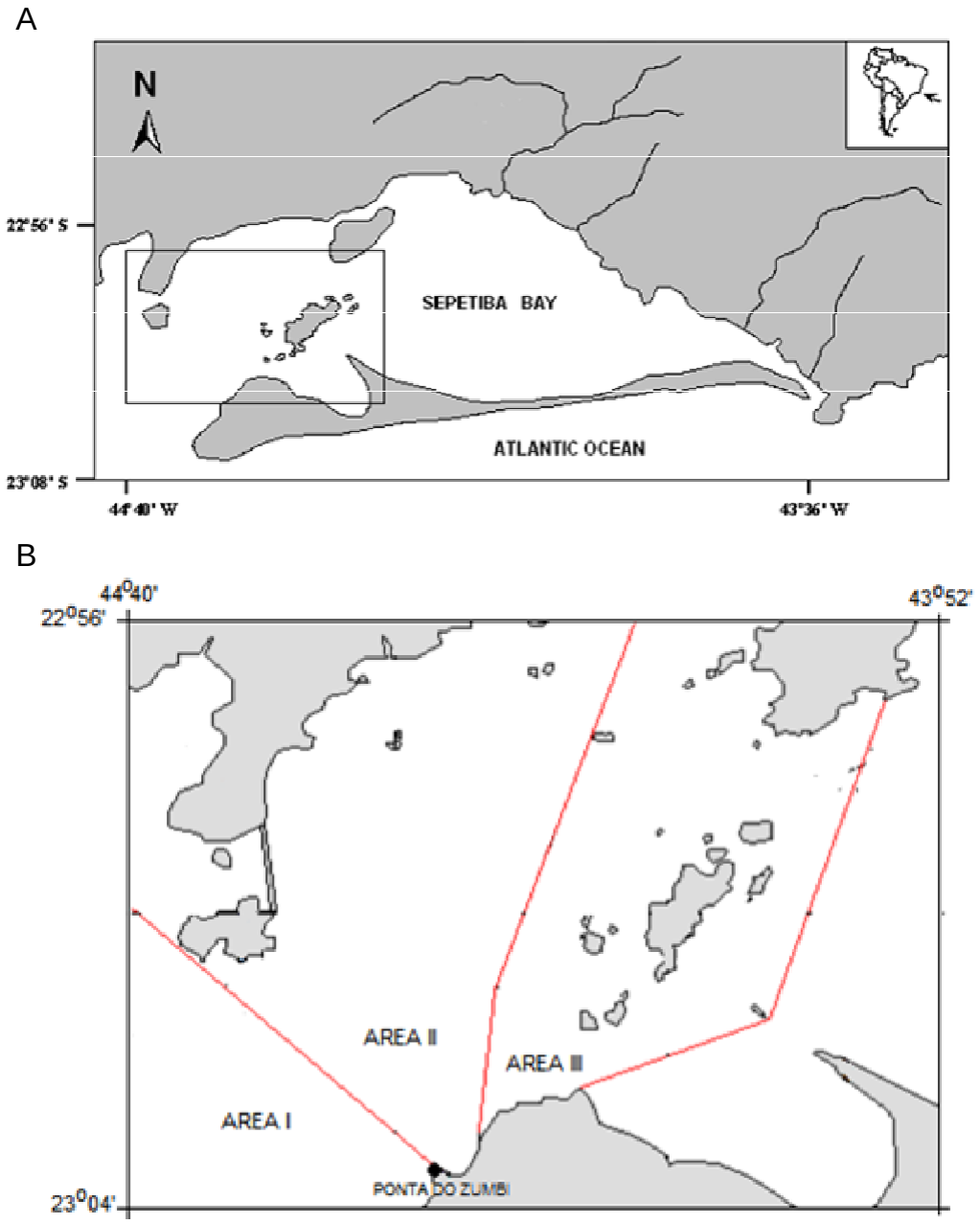

Figure 1. Map of Sepetiba Bay, Southern Brazil: (A) Location of the studied area delimited by the rectangle; (B) Details of the three main sub-areas (I, II and III) studied.

Some environmental variables such as time of day, season and bottom topography are likely to affect dolphin activity patterns and ultimately reflect how the animals use and respond to habitat variation and constraints (Shane, 1990). The study of how activities and the spatial and temporal distribution patterns are related to environmental factors should provide valuable information on the social organization of this species (Shane et al., 1986). Therefore, the aim of the present study was to verify the influence of the environmental factors, period of the day, seasonality and group size on the observed behaviour of estuarine dolphins in Sepetiba Bay (State of Rio de Janeiro, Brazil).

MATERIALS AND METHODS

Study area

Sepetiba Bay (22°59'S, 44°03'W) is a semi-closed coastal lagoon complex of 519 km², bordered to the south by the Marambaia sand bar and to the north and east by the mainland (Figure 1a). Most of the bay area is shallow (approximately 6 m deep), but in some isolated areas, particularly between the islands, depths of about 47 m

have been recorded (Borges unpublished data) . Sepetiba Bay is surrounded by numerous urban centres and has been subjected to intensive degradation, particularly those associated with the nearby trading port, extensive over-fishing and pollution from industrial and agricultural waste (heavy metals and organochlorine compounds).

Data collection

Field studies were conducted five days per week in a month, whenever meteorological conditions were allowed (for example, Beaufort sea state < 2), during the period between January 1997 to May 1998. Observations were made from a fixed observation post at Ponta do Zumbi, Marambaia Island (Figure 1B) . The adjacent sea area was scanned using binoculars (Minolta 8-20x) and a telescope (ZRT-457M 30x and 60x) and, under ideal conditions, visibility extended to a distance of about 10 km. On the basis of existing land marks and their characteristic features, the scanned area was subdivided into three sub-areas as indicated in Figure 1B. Area I is characterized by the proximity of the open sea; area II is influenced by the port of Guaiba Island and the associated boat traffic; whilst area III is dominated by the presence of various islands. However, the presence or absence of calves amongst the group was noted. Calves were characterized to be ½ or less than the largest individuals in the group.

Observation times were classified as: period 1 (6:00 to 08:59 h), period 2 (9:00 to 11:59 h), period 3 (12:00 to 14:59 h) and period 4 (15:00 to 18:00 h) . The dolphin groups observed were divided into six categories (A – F) according to the number of individuals present in the group, respectively, that is, 1 - 10, 11 - 20, 21 - 30, 31 - 40, 41 – 50 and > 50. The activities performed by the dolphins were classified into four categories: travelling, foraging/feeding, resting and socialization (Shane, 1990).

The behaviour correlated with the season (summer: Jan - Mar, autumn: April - June, winter: July - September, spring: October - December) period of the day and the location of the observation.

The results were analysed using non-parametric tests, ², Kruskall-Wallis and frequency analyses within GraphPad InStat 'software' (Version 2.05).

RESULTS AND DISCUSSION

During the period of study, the areas adjacent to the fixed point at Ponta do Zumbi, Marambaia Island, were scanned for 1140 h, resulting in 145 h (12.7%) of direct observation of dolphins. Animals were sighted in 108 (62.4%) of the 173 days of surveillance, and a total of 249 dolphin groups were documented. According to the frequency of sightings in each of the surveyed areas, dolphins appeared to prefer area II (45.7%), rather than Areas I (17%) or III (37.3%). Most sightings (30.8%) occurred during the autumn months, followed by winter (28.2%), summer (26.2%) and spring (14.8%). However, the number of groups sighted expressed in relation to the total number of days of direct observation carried out in each season, show similar values for all seasons (autumn, 2.4 groups/day; winter, 2.5; spring, 2.7; and summer, 2.3). Analysis of these results using the Kruskall-Wallis test showed that there were no significant differences between the values, despite variations in the numbers of observation days within each season (KW = 4.265; = 0.2342).

Considering the observations on a daily basis, the largest number of sightings took place during periods 2 and 3 (34.5 and 31.0%, respectively), while the fewest occurred in periods 4 (18.5%) and 1 (16.0%). These results confirm the findings of Silva and Best (1996), who reported the diurnal rhythm of activities of tucuxi, *Sotalia fluviatilis*, in the Amazon region such that the highest frequency of sightings occurred between 9:00 to 10:00 am.

The groups of dolphins most frequently observed in Sepetiba Bay fell within size Category A (69.8%), whilst groups of category D were rarely observed (1.2%). In contrast, Lodi (2003) reported a higher frequency of category D groups amongst the *S. guianensis* population of Paraty Bay. In the present study, the average number of dolphins per group is 16, although previous reports have recorded both larger average sizes (~30 individuals: Lodi, 2003; Daura-Jorge et al., 2005; Flores and Fontoura, 2006; Flach et al., 2008) and smaller group averages (1 to 10 individuals: Oliveira et al., 1995; Di Beneditto et al., 2001; Azevedo et al., 2005; Santos and Rosso, 2007). Calves were observed amongst 26.8% of the dolphin groups, particularly in summer (65%) and in the more sheltered and shallower sub-area II.

The frequencies of observation of the various activities carried out by the dolphin groups were, in decreasing order: foraging/feeding (47.3%), travelling (37.8%), socialization (9.1%) and resting (5.8%). The behaviour of the dolphins varied significantly depending on the period of the day (² = 27.928, = 0.0066). This pattern of behaviour, which is a high frequency of foraging/feeding activity, seems to be common since it has been previously observed in *S. guianensis* in several other studies (Lodi, 2003; Daura-Jorge et al., 2005; Azevedo et al., 2007; Flach et al., 2008), and has also been reported for other species of coastal dolphins (Shane, 1990; Brager, 1993; Karczmarski and Cockroft, 1999).

Analysis of activities performed during different time periods of the day (Figure 2A) revealed that estuarine dolphins of Sepetiba Bay employed the morning periods preferentially for travelling and foraging/feeding. Such activities constituted the most frequent actions during periods 1 and 2, but diminished in intensity in period 3, whereas resting and socialization increased during this latter period. The preferred morning for foraging/feeding activity is also reported for other *S. guianensis* and *T. truncatus* (for example, Bearzi et al., 1999; Daura-Jorge et al., 2005; Flach et al., 2008). For example, Azevedo et al. (2007) reported that the *S. guianensis* population of Guanabara Bay spent most of the time performing foraging/feeding activities during the morning periods, but these activities decreased in the early hours of the afternoon and increased again by the end of the day. The increased resting and socializing activities during the afternoon could indicate decreased food availability due to diel variation in prey activity (Stevick et al., 2002).

Figure 2B displays the types of activity observed in the present study categorised according to the season in which these two variables were found to be significantly

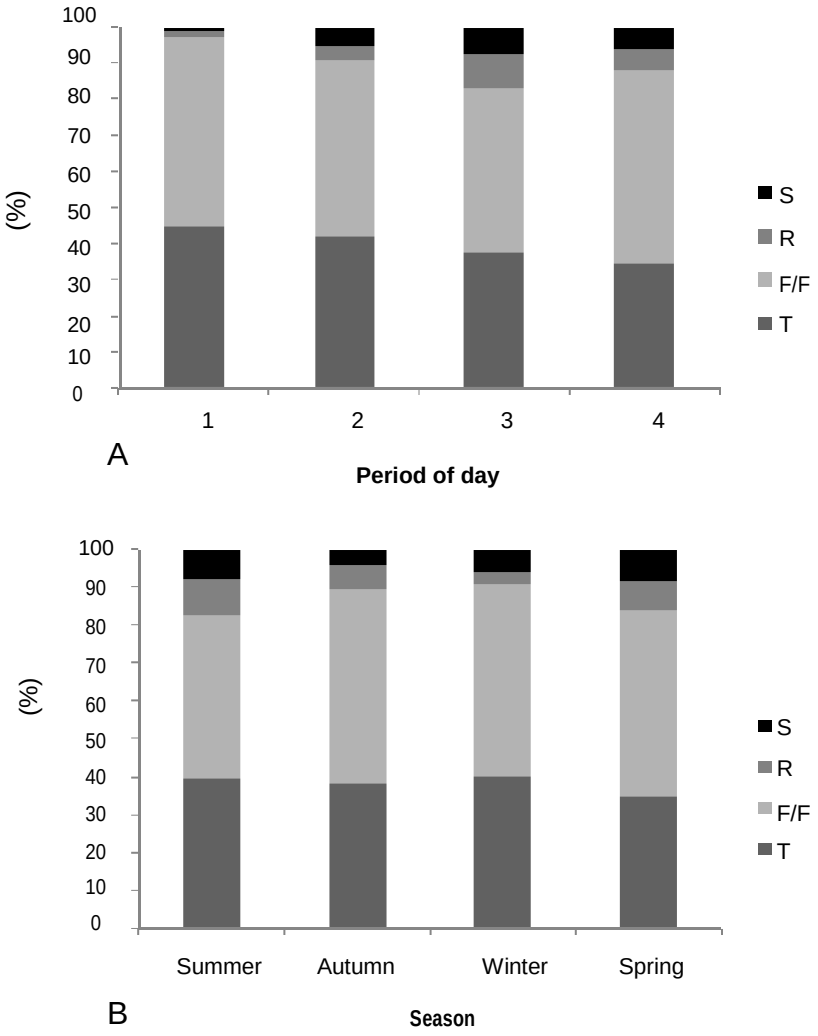

Figure 2. Frequencies of (S) socialization, (R) resting, (F/F) foraging/feeding and (T) travelling activities: (A) During different periods of the day – period 1 (6:00 to 859 h), period 2 (9:00 to 11:59 h), period 3 (12:00 to 14:59 h); period 4 (15:00 to 18:00 h). (B) During different seasons;

associated (² = 38.083, = 0.0009). Travelling and foraging/feeding were the activities most frequently observed throughout the year, but they attained a maximum intensity during winter. Socialization behaviour was somewhat homogeneous throughout winter, spring and summer, but diminished during autumn. Resting was observed most frequently during the summer months. *S. guianensis* at Norte Bay also presented a pattern with seasonal changes on their behaviour (Daura-Jorge et al., 2005).

The seasonal variation in the patterns of activity may be due to changes in the abundance and distribution of prey, as well as to the changing energetic demands of the dolphins. Whilst Cruz-Filho (unpublished data) has stated that the seasonal variation in fish species in Sepetiba Bay is not well characterised, various other researchers have reported that the abundance of fish in coastal areas is higher during summer and lower during winter in comparison with the other seasons (Saloman and Naughton, 1979; Peters and Nelson, 1987; Adams and Blewett, 2004). Assuming this to be the case, there should be plenty of food available during the summer months, and it might be expected that the dolphins would then have more time to spend on non-essential activities. Indeed, it is during this season that resting occurs more often. Furthermore, the greater supply of food in the summer months is sufficient to fulfil the energetic needs of the lactating females. On the other hand, the food supply probably diminishes in the winter, and the dolphins then have to spend more time travelling and foraging/feeding. Geise (1991) verified that the peak of travelling activities performed by estuarine dolphins in the Cananéia Estuary

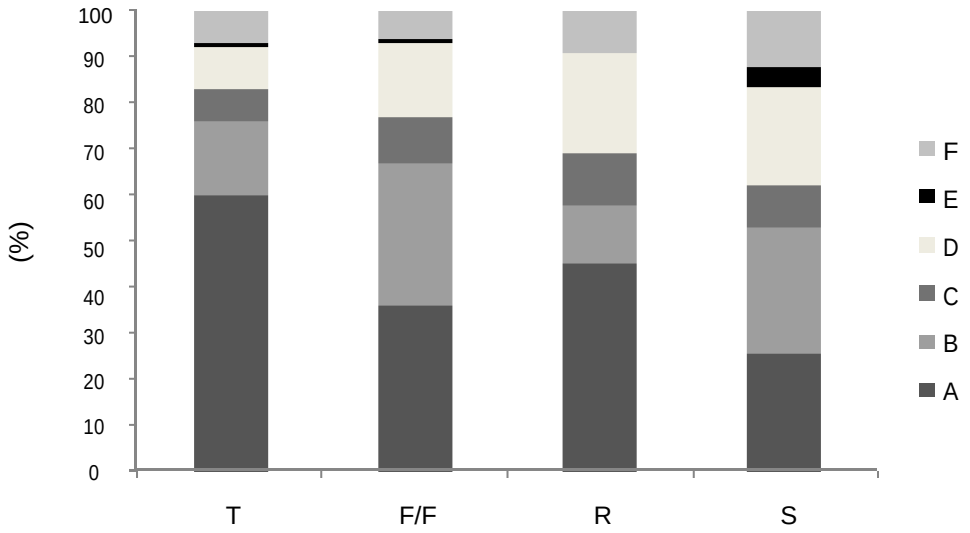

Figure 3. Frequencies at which different dolphin groups performed activities: Groups were defined as A (1 to 10 individuals); B (11 to 20 individuals); C (21 to 30 individuals); D (31 to 40 individuals); E (41 to 50 individuals) and F (>50 individuals). Activities: (T) travelling, (F/F) foraging/feeding, (R) resting and (S) socialization activities.

occurred during the winter months, whilst the peak of socialization activities occurred during spring and summer, although foraging/feeding appeared to be homogeneous throughout the seasons. A similar behaviour pattern was also reported for bottlenose dolphins,*Tursiops truncates,* in Florida (Shane, 1990).

There was a significant association between the size of the dolphin groups and the activities that they performed (² = 46.009, < 0.0001). As shown in Figure 3, all different types of activities, were performed most frequently by groups in size category A, except for socialization that was most frequently observed in groups of dolphins of size category B. It appears, therefore, that the smaller groups (categories A and B) are more frequently involved with activities such as travelling and foraging/feeding, whilst the larger groups (categories B - F) are involved in other activities such as resting and socialization. Flach et al. (2008) also reported that the largest group sizes occurred during socialization, while the smallest during travelling activities for *S. guianensis*, and the same was observed at Guanabara Bay (Azevedo et al., 2005). In contrast, studies in other areas reported the larger groups of *S. guianensis* during the foraging/feeding activity (Lodi, 2003; Daura-Jorge et al., 2005). Similarly, Geise (1991) found that the larger groups of *S. guianensis* dolphins were seen most frequently performing hunting activities in Guanabara Bay and Cananéia Estuary, and the same findings were reported for *Lagenorhynchus obscurus* dolphins in Argentina (Würsig and Würsig, 1980). These reports are not in agreement with our findings, but the divergence could be explained by the different hunting strategies employed by the dolphins in the three areas.

The types of activities were significantly associated with the sub-areas of observation (Figure 1B) employed in the present study (² = 88.024, p < 0.0001). As shown in Figure 4, all activities were consistently observed in all three sub-areas, but the dolphins favoured sub-area I for resting, an activity that occurred much less often in the other sub-areas. Daura-Jorge et al. (2005) also found that *S. guianensis* used specific areas for given activities in southern Brazil. Sub-area I is not very deep (approximately 11 m), and its favoured use as a resting area is in accord with the situation observed for dusky dolphin, *Lagenorhynchus obscurus,* in Argentina (Würsig and Würsig, 1980). Other studies indicate that *S. guianensis* uses areas with depths <6m (Lodi, 2003; Flores and Bazzalo, 2004; Daura-Jorge et al., 2005). However, there are also studies revealing a preference for deeper water for the same species (for example, Azevedo et al., 2007; Flach et al., 2008).

The present study has revealed significant information concerning the relationship between the behaviour of *S. guianensis* and their habitat. Clearly, the organization of the daily and seasonal activities of the species must be related with the habitat in order to maximize the advantages of environmental changes. Such organization depends on various interactive elements and none of the factors (temporal, environmental and population characteristics) alone can explain the manner in which the dolphins utilize the area. The dolphins show a complex pattern of habitat use, and their physical and biological features affect ecological aspects, as behaviour and habitat use (Connor, 2000). However, given the short-term study, further researches should clarify and provide a better understanding of the life history and ecology of *S. guianensis* in Sepetiba Bay.

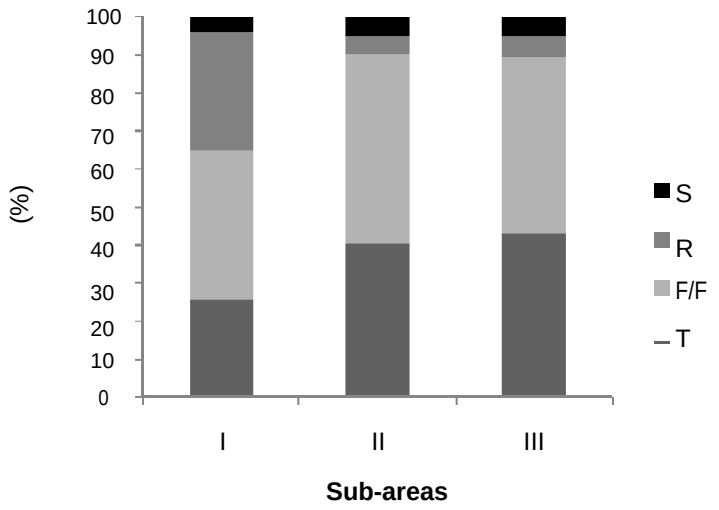

Figure 4. Frequencies of (T) travelling, (F/F) foraging/feeding, (R) resting and (S) socialization activities distributed according to the sub-areas (I, II and III) of Sepetiba Bay.

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REFERENCES

Adams AJ, Blewett DA (2004). Spatial patterns of estuarine habitat type use and temporal patterns in abundance of juvenile permit, *Trachinotus falcatus*, in Charlotte Harbor, Florida. Gulf Caribbean Res. 16(2): 129-139.

Araújo JP, Araújo ME, Souto A, Parente CL, Geise L (2007). The influence of seasonality, tide and time of activities on the behavior of *Sotalia guianensis* (Van Bénéden) (Cetacea, Delphinidae) in Pernambuco, Brazil. Rev. Bras. Zool. 24: 1122-1130.

Azevedo AF, Oliveira AM, Viana SC, Van SM (2007). Habitat use by marine tucuxis (*Sotalia guianensis*) (Cetacea: Delphinidae) in Guanabara Bay, south-eastern Brazil. J. Mar. Biol. Assoc. U.K. 87: 201-205.

Azevedo AF, Viana SC, Oliveira AML, Sluys MV (2005). Group characteristics of marine tucuxis (*Sotalia fluviatilis*) (Cetacea: Delphinidae) in Guanabara Bay, south-eastern Brazil. J. Mar. Biol. Assoc. U.K. 85: 209-212.

Bearzi G, Politi E, Di Sciara GN (1999). Diurnal behavior of free-ranging bottlenose dolphins in the Kvarneric (northern Adriatic Sea). Mar. Mamm. Sci., 15: 1065-1097.

Bräger S (1993). Diurnal and seasonal behavior patterns of bottlenose dolphins (Tursiops truncatus). Mar. Mamm. Sci., 9: 434-438.

Connor RC (2000). Group living in whales and dolphins. In: Mann J, Connor RC, Tyack PL and Whitehead H (eds.), Cetacean societies: field studies of dolphins and whales. Chicago, University of Chicago Press. pp. 199-218.

Daura-Jorge FG, Wedekin LL, Piacentini VQ, Simões-Lopes PC (2005). Seasonal and daily patterns of group size, cohesion and activity of the estuarine dolphin, *Sotalia guianensis* (Cetacea, Delphinidae), in southern Brazil. Rev. Bras. Zool., 22: 1014-1021.

DiBeneditto APM, Ramos RMA, Lima NRW (2001). Sightings of *Pontoporia blainvillei* (Gervais and D'Orbigny, 1844) and *Sotalia fluviatilis* (Gervais, 1853) (Cetacea) in south-eastern Brazil. Braz. Arch. Biol. Tech., 44: 291-296.

Flach L, Flach PA, Chiarello AG (2008). Aspects of behavioral ecology of *Sotalia guianensis* in Sepetiba Bay, southeast Brazil. Mar. Mamm. Sci., 24: 503-515.

Flores PAC (2002). Tucuxi *Sotalia fluviatilis*. In: Perrin WF, Würsig B. and Thewissen JGM (eds.), Encyclopedia of Marine Mammals. San Diego, Academic Press. pp. 1267-1269.

Flores PAC, Fountoura NF (2006). Ecology of marine tucuxi, *Sotalia guianensis*, and bottlenose dolphin, *Tursiops truncatus* , in Baía Norte, Santa Catarina state, southern Brazil. Lat. Amer. J. Aquat. Mamm., 5: 105-116.

Flores PAC, Bazzalo M (2004). Home ranges and movement patterns of the marine tucuxi dolphin, *Sotalia fluviatilis*, in Baía Norte, Southern Brazil. Lat. Amer. J. Aquat. Mamm., 3: 37-52.

Geise L (1991) *Sotalia guianensis* (Cetacea, Delphinidae) population in the Guanabara Bay, Rio de Janeiro, Brasil. Mammalia. 55: 371-379.

IUCN (2010). IUCN Red List of Threatened Species. Version 2010.2. <http://www.iucnredlist.org>. Downloaded on 29 June 2010.

Karczmarski L, Cockroft VG (1999). Daylight behavior of humpback dolphins *Sousa chinensis* in Algoa Bay, South Africa. Int. J. Mamm. Biol., 64: 19-29.

Lodi L (2003). Tamanho e composição de grupo dos botos-cinza, *Sotalia guianensis* (Van Bénéden, 1864) (Cetacea, Delphinidae), na Baía de Paraty, Rio de Janeiro, Brasil. Atlântica, 25: 135-146.

Lodi L (2003b). Seleção e uso do habitat pelo boto-cinza, *Sotalia guianensis* (Van Bénéden, 1864) (Cetacea, Delphinidae) na Baía de Paraty, Estado do Rio de Janeiro. Bioikos 17: 5-20.

Oliveira JA, Ávila FJC, Alves-Júnior TT, Furtado-Neto MAA , Monteiro-Neto C (1995). Monitoramento do boto cinza, *Sotalia fluviatilis* (Cetacea: Delphinidae) em Fortaleza, Estado do Ceará, Brasil. Arq. Cienc. Mar., 29: 28-35.

Peters DJ, Nelson WG (1987). The seasonality and spatial patterns of juvenile surf zone fishes of the Florida east coast. Fla. Scientist, 50: 85-99.

Saloman CH, Naughton SP (1979) Fishes of the littoral zone, Pinellas County, Florida. Fla. Scientist, 42: 85-93.

Santos MCO, Rosso S (2007). Ecological aspects of marine tucuxi dolphins (Sotalia guianensis) based on group size and composition in the Cananéia estuary, southeastern Brazil. Lat. Am. J. Aquat. Mamm., 6: 71-82.

Shane SH, Wells RS (1986). Ecology, behavior and social organization of the bottlenose dolphin: a review. Mar. Mamm. Sci., 2: 34-63.

Shane SH (1990). Behavior and ecology of the bottlenose dolphin at Sanibel Island, Florida. In: Leatherwood S. and Reeves RR (eds.), The Bottlenose Dolphin. San Diego, Academic Press. pp. 245-265.

Silva VMF, Best RC (1994). Tucuxi *Sotalia fluviatilis* (Gervais, 1853). In: Ridgway SH and Harrison R (eds.), Handbook of Marine Mammals: the first book of dolhphins. London, Academic Press. pp. 43-49.

Silva VMF, Best RC (1996). *Sotalia fluviatilis*. Mamm. Species. 527: 1-7.

Stevick PT, McConnell BJ, Hammond PS (2002). Patterns of Movement. In: Hoelzel RA (ed.), Marine mammals biology: an evolutionary approach. Oxford, UK, Blackwell Science. pp. 185-216.

Würsig B, Würsig M (1980). Behavior and ecology of the dusky dolphin, *Lagenorhynchus obscurus*, in the South Atlantic. Fish. Bull., 77: 871-890.