



Social Behavior of Sotalia Fluviatilis (Gervais & Deville, 1853) (Cetacea, Delphinidae), in the Northern Channel of the Amazon River, Amapá, Brazil

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Authors' contributions

This work was carried out in collaboration among all authors. Author ALFM developed this study, processed the data, performed the analysis, interpreting the results and worked on the manuscript. Author ASA conceived of the presented idea, interpreting the results and supervised the findings of this work. Author CECC verified the statistical analysis and worked on the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Sotalia fluviatilis is known as “tucuxi” is endemic to the rivers of the Amazon basin, with aggregations of individuals at the mouths of rivers and canals, it is an almost endangered species and information about it is lacking in the state of Amapá. This study was aimed at monitoring the social behavior of *S. fluviatilis* in the northern channel of the Amazon River, Amapá, Brazil. Monitoring was carried out from a fixed point on the bank of the northern channel of the Amazon River, located in a Private Reserve of Natural Heritage. Ninety-six days of monitoring were carried out from a fixed point of observation, totaling 480 hours of sample effort. *S. fluviatilis* was frequently observed throughout the year in predominantly small groups formed mostly by two to three adult animals. Young individuals were observed in larger groups of four to six individuals, formed during activities such as feeding or for protection. Behavioral activities included slow and fast travel, which were in most cases associated with other behaviors, mainly foraging and

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socializing. The largest number of sightings of socialization occurred in the months of January and February, when river water levels are high. Studies on key species are essential for decision making, in order to optimize conservation strategies for this aquatic mammal in the Amapá. As a suggestion for conservation measures, it would be the distancing of vessels when they perceive a group of porpoises using the region, thus stimulating the conservation of the species.

Keywords: Amazon; Tucuxi; Aquatic mammal; dolphin.

1. INTRODUCTION

The tucuxi, *Sotalia fluviatilis* is the only species in the Delphinidae family endemic to the Amazon basin and one of the least studied small cetaceans [1,2]. This dolphin occurs near river banks and at confluences, popularly known as "meeting of the waters", of tributaries of the Amazon basin, and in low densities around islands and in the middle of river channels [3]. The high density of individuals at confluences might be due to special physiographic and hydrological characteristics that support a high diversity and abundance of fish (the main food of dolphins) and provide areas suitable for *S. fluviatilis* reproduction and resting [4].

The behaviors reported in tucuxi populations include leaping, head out, wave riding, tail-slapping, inverted swimming with flapping flippers, belly roll on the water surface, and tail out [5]. Other behaviors also include slow and directed traveling, fast traveling as well as very slow traveling, lying at the water surface [6]. This species also displays intense socializing activities through play by combining various behaviors, such as leaps, fast traveling, body contact and mutual nibbling, suggesting that they occur in a diversified way and are more frequently observed in immature animals [7,8].

Sotalia fluviatilis is a still poorly known species; most biological data were collected opportunistically or in studies developed in restricted areas. This species is considered near threatened by extinction (NT) in the National Action Plan for the Conservation of Amazonian Aquatic Mammals (2016-2020) [9]. The present study aims to report behavioral observations of *S. fluviatilis*, a river cetacean of Brazil and an endemic species to the Amazon basin.

2. MATERIALS AND METHODS

The study was carried out near a Conservation Unit, in a Private Natural Heritage Reserve - PNHR (Reserva Particular do Patrimônio Natural - REVECOM) (00°03'22.5"S, 051°09'16.5" W),

with a total area of 17.18 hectares. The reserve is located within the urban limits of the city of Santana. The 300 meters of beach borders the northern channel of the Amazon River into which two streams flow. One of them, locally known as Mangueirinha, cuts through a large part of the reserve [10].

2.1 Fixed-Point Survey from Land

Onshore monitoring was carried from September 2007 to August 2008 from a fixed point locally known as "trapiche ribeirinho". This pier is located in the PNHR on the banks of the Amazon River, allowing a wide view of the river channel. The study area was divided into four quadrants Q1 (S 00 03. 614 ' , W 051 08. 679'), Q2 (S 00 03. 732 ' , W 051 08. 867'), Q3 (S 00 03. 902 ' , W 051 09. 123'), and Q4 (S 00 03. 983 ' , W 051 09. 367') and the occurrence and behavior of individuals (or group of individuals) within quadrants was recorded during each period of observation [5].

2.2 Focal Animal Sampling

In this type of sampling, an individual in the group was observed within defined time intervals and its behavior was recorded [11]. The observations were made with the aid of Bushnell binoculars (7 x 35), during eight days of each month in a daily effort of five hours, taking turns in the morning and afternoon shifts, thus covering all hours of the day.

2.3 Recording Method

The information collected was recorded in two index cards, one for direct and objective information on age group, quadrants, behavior, tide level, vessel type, and weather conditions [12]. The second card contained descriptive information observed during the fixed-point survey. A group was described as two or more individuals swimming together, and its composition was characterized by the number of adults and immature individuals. The latter were defined as animals approximately 1/3 to 3/4 of

the adult size. The sighting of a single animal was classified as a solitary animal [12].

2.4 Behavioral Activities

Behavioral activities were divided into slow travel (ST), fast travel (FT), foraging and feeding (Fo/Fe), socialization (S), and distancing (D). To facilitate the collection of information at the time of observation, each group and individual activity was identified by a specific code (Table 1) [13,14,15].

3. RESULTS AND DISCUSSION

Ninety-six days of monitoring were carried out from a fixed point of observation, totaling 480 hours of sampling effort. Comparing the

frequency of sightings between adults and young individuals, a greater number of sightings of the former was observed, mainly in September (N = 21) and October (N = 23) of 2007 and in January (N = 21) and February (N = 24) of 2008. Sightings of young animals occurred mainly in the months of February (N = 2), March (N = 2) and May (N = 2) of 2008, with an increase in the number of observations in June (N = 3) of this same year (Fig.1).

The greater number of adults in relation to that of young animals might be due to group composition, as in small groups, young individuals were always observed accompanied by one or more adults, as reported by some authors [16,17].

Table 1. Behavioral activities of *Sotalia fluviatilis* with their codes

Code	Behavioral Activities
Slow travel (ST)	Directed movement along the bank or the river channel at low speed.
Fast travel (FT)	Directed movement along the river bank or channel at fast speed.
Foraging and Feeding (Fo/Fe)	Pursuit and capture (or not) of preys.
Socialization (S)	Interactions between/among individuals in groups, such as: physical contacts, leaps, somersaults, and bow wave riding.
Distancing (D)	Distancing of the group or solitary animal or disappearing from the focus of observation due to the approach of a vessel.

Source:[13, 14, 15]

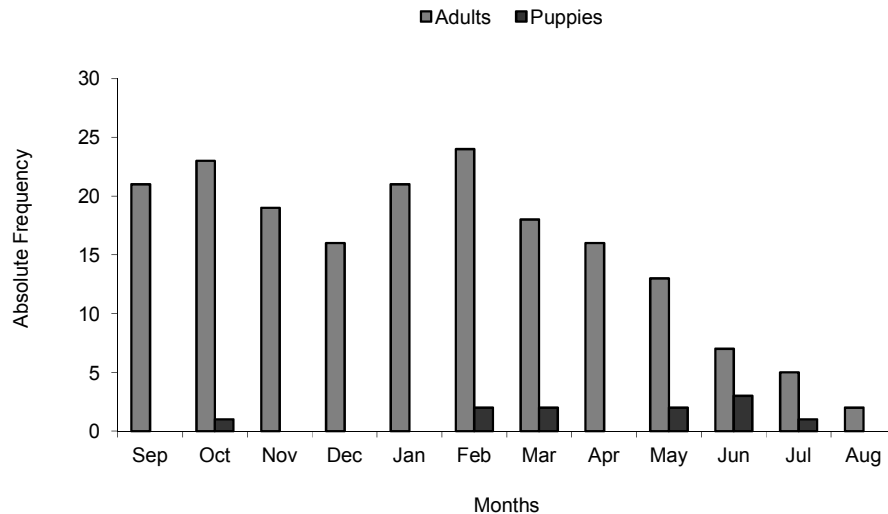


Fig. 1. Absolute frequency of sightings of adults and puppies of *Sotalia fluviatilis* in the northern channel of the Amazon River, Amapá, Brazil

Solitary individuals were observed every month, mainly in October (N = 6), November (N = 9), December (N = 6) 2007, and January (N = 7) 2008 (Fig. 2).

The tucuxi is a social animal that form small groups of two and up to six individuals. In the present study, solitary individuals and small groups formed by two and three individuals were the most frequently observed. Other studies have also reported a mean group size composed of two individuals, especially at the beginning of the year, when a larger number of juveniles was also observed, with groups of two adults or more, frequent for individuals of this age group [18,17]. Sightings of *S. fluviatilis* groups of two individuals were recorded in most months during the study, more frequently in December (N = 5); of three

individuals were registered in September (N = 2) 2007 and January (N = 3) 2008; of four individuals were sighted only in October (N = 2) 2007 and in February (N = 2) 2008; of five to six individuals were rarely seen, with sightings recorded in September (N = 1) 2007 and February (N = 1) 2008, for groups of five individuals and in November (N = 1) and December (N = 1) 2007, for groups of six individuals (Fig. 3).

In a study on the composition of groups of *S. guianensis*, the formation of larger groups in this species revealed a temporary or unstable structure, where these populations that occur in the estuary comprised a fission-fusion society characterized by groups constantly forming and separating[19].

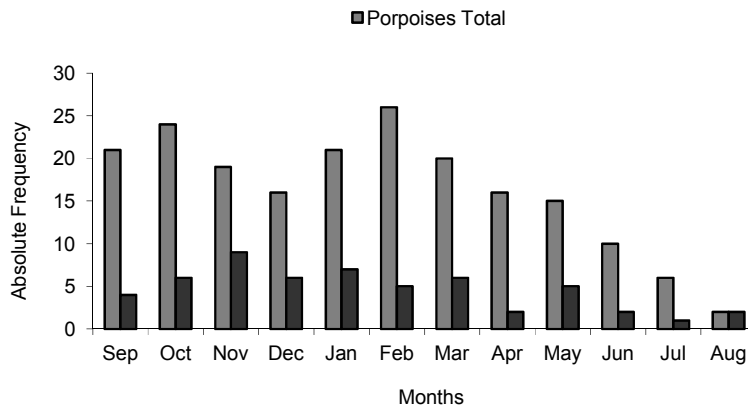


Fig. 2. Absolute frequency of solitary individuals of de *Sotalia fluviatilis* in the northern channel of the Amazon River, Amapá, Brazil

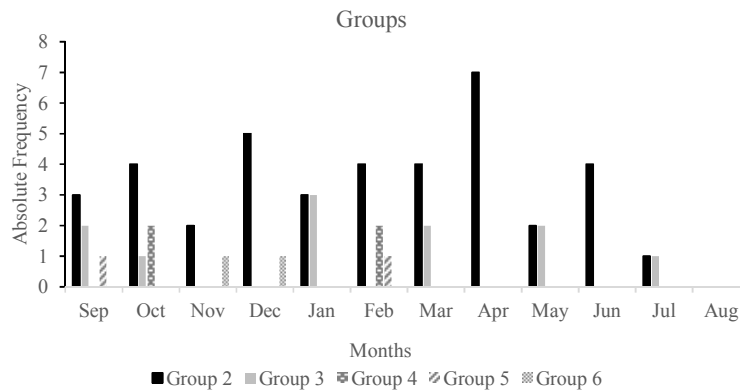


Fig. 3. Absolute frequency of sightings by groups of *Sotalia fluviatilis* in the northern channel of the Amazon River, Amapá, Brazil

In the present study, the occurrence of larger groups composed of four, five and six individuals in months of drought, suggests the formation of groups to better use of food resources, concentrated in the largest bodies of water. The formation of groups depends on the activity performed, suggesting that the size and structure of a group may be associated to the habitat and socio-environmental aspects of the populations, such as abundance of food and dangerous situations such as predation [20].

Slow travel (ST) was recorded in December (N = 14) 2007 and in January (N = 13) 2008 (Fig. 4). Fast travel (FT) was observed mainly in September (N = 11) and November (N = 7) of 2007 and in March (N = 6) and May (N = 5) of 2008 (Fig. 4).

Traveling was observed throughout the monitoring period. It was also the most frequently activity recorded, in most cases combined with other behavioral activities, mainly foraging and socializing. Traveling, and on many occasions socialization, are associated with or are part of a sequence of foraging and feeding behavior strategies [5,8].

Foraging and feeding (Fo/Fe) were observed in February (N = 7) and April (N = 12) of 2008 (Fig. 5).

Travel movements as part of *S. guianensis* foraging strategies are divided into three sequential and distinct phases, starting with “potential food search” characterized by slow and

circular movements, following the contour of the bay, or slow back and forth movements between deeper and shallower regions. The second phase is associated with prey location, pursuit and capture, which requires more intense and faster movements. The third phase is the control over the prey characterized by throwing it in the air and ingestion [21].

Observations of socialization behavior was highest in September (N = 13) 2007 and in February (N = 19) 2008 (Fig. 6). The largest number of sightings of socializing activities occurred at the beginning of the year, when river water levels are high and in the dry season at the end of the year, which may indicate the association of this activity with foraging and feeding. The number of observations of distancing behavior was low or unimportant during the study. This behavior was recorded only in September (N = 2) 2007 (Fig. 6).

Behavioral changes were also not observed during feeding, socialization, and traveling by *S. guianensis* when interacting with more than one vessel. However a reduction in aerial behavior was observed as well as distancing of groups with youngsters in interactions with isolated vessels. This suggests that the reduced number of observations of distancing behavior may be associated with the reduced number of sightings of large groups, more likely to include young individuals [15]. Distancing during interactions with boats might be a defensive behavior to avoid contact in order to protect younger animals [15].

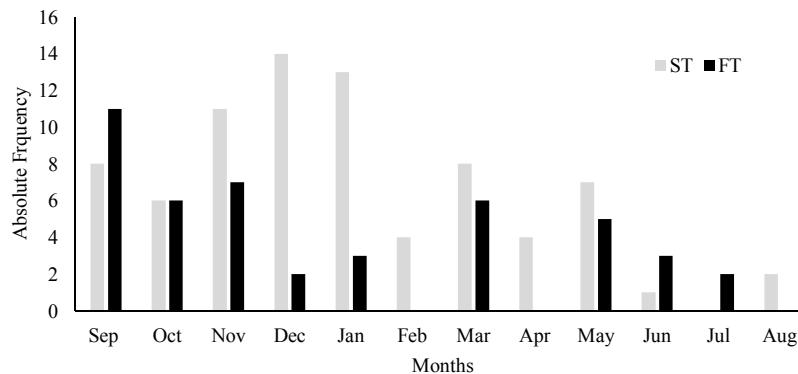


Fig. 4. Absolute frequency of sighting of *Sotalia fluviatilis*, which performed the activity of slow displacement (ST) and rapid displacement (FT) in the northern channel of the Amazon River, Amapá, Brazil

Socialization behaviors were more common in groups formed by four, five, and six animals, among which physical contact was observed, such as touching with body parts in the water and aerial movements. These behaviors observed in the present study corroborate those observed by Hayes [5] in which individuals

displayed behaviors that include leaps, head out, wave riding, tailslapping, and ventral exposure.

Most sightings occurred at low tide, with the highest number of observations in October (N = 12) and December (N = 15) of 2007 and April (N = 12) and March (N = 11) of 2008 (Fig. 7).

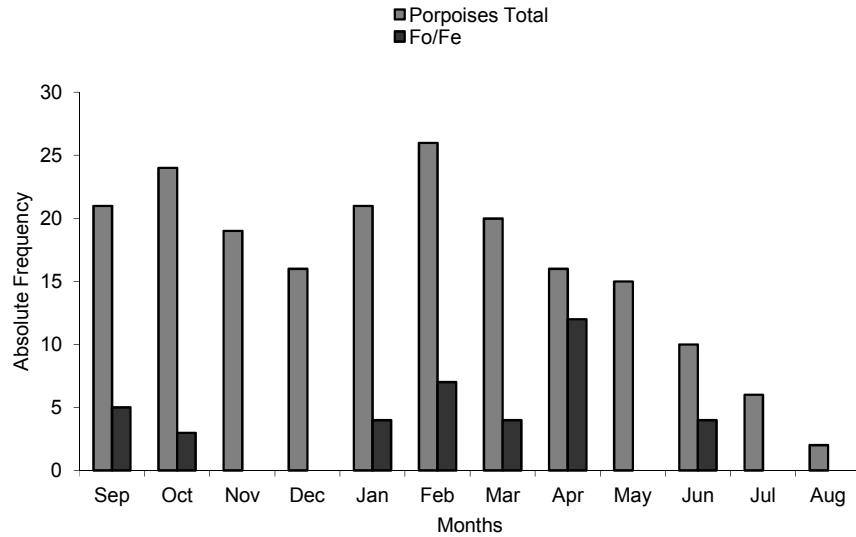


Fig. 5. Absolute frequency of individuals of *Sotalia fluviatilis* that performed the foraging (Fo) and feeding (Fe) activity in the northern channel of the Amazon River, Amapá, Brazil

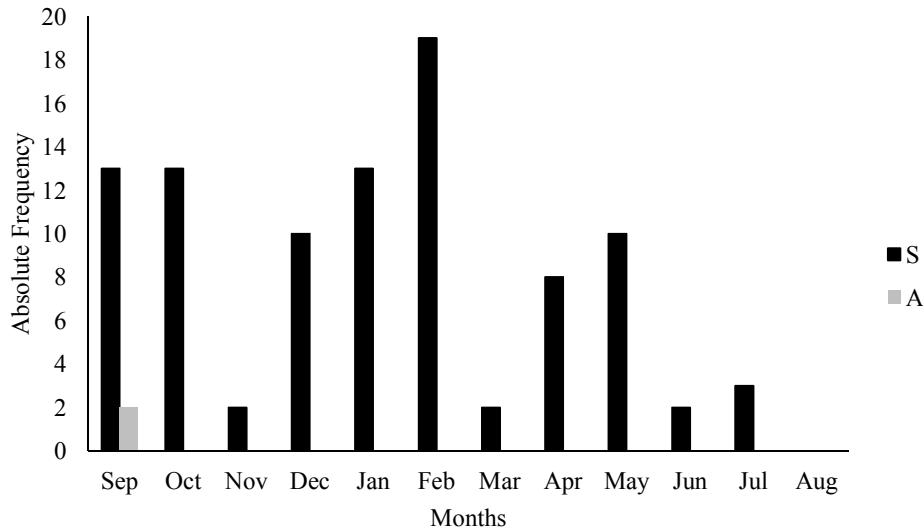


Fig. 6. Absolute frequency of sighting of individuals of *Sotalia fluviatilis* performing socialization (S) and removal (A) activity in the northern channel of the Amazon River, Amapá, Brazil

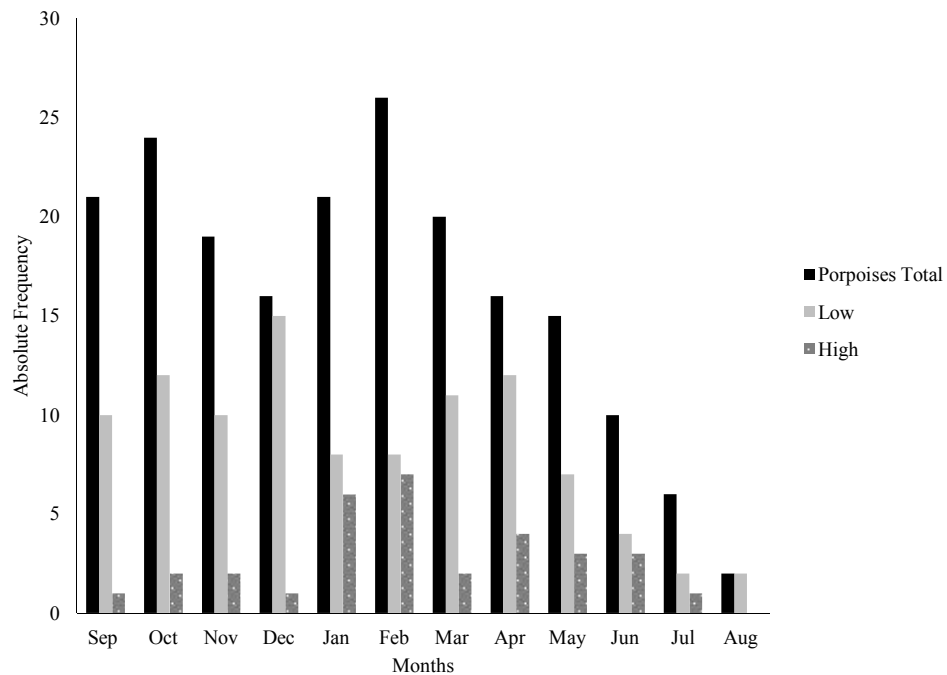


Fig. 7. Absolute frequency of sighting of *Sotalia fluviatilis*, with the level of low tide (Low) and high tide (High) in the northern channel of the Amazon River, Amapá, Brazil

Tide level seems to influence the behavior of animals, as during low tides a greater number of individuals was observed compared to high tide. This might be due to easier foraging and feeding, because fish schools are concentrated in a body of water with a smaller volume [22]. The preference of *Sotalia fluviatilis* for low current environments suggests that these are a more favorable for more intense movements with a lower energy expenditure [3].

4. CONCLUSION

In the present study, *Sotalia fluviatilis* was observed in all months of the year, and more frequently when the water level in the rivers is high. This suggests an association with the reproductive cycle of *S. fluviatilis* and access to food resources at the mouth of streams. Thus, studies with key species are essential to provide a framework for decision making, aiming to optimize conservation strategies for this aquatic mammal in the state of Amapá. As a suggestion for conservation measures, it would be the distancing of vessels when they perceive a group of porpoises using the region, thus stimulating the conservation of the species.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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