SC/69B/SM/09

Sub-committees/working group name: SM

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INTRODUCTION

The franciscana dolphin, *Pontoporia blainvillei*, is the most endangered cetacean in the southwestern Atlantic Ocean (Secchi et al., 2021), and is listed as “Vulnerable” on a global scale (Zerbini et al., 2017). Bycatch in gillnets is the main threat, causing the mortality of hundreds of animals every year throughout the species' distribution (Ott et al., 2002; Prado et al., 2016; Secchi et al., 2021). The species' main habitat is the coastal region, at depths of up to 30 meters, although it can also occur in areas up to 50 meters deep. This coastal distribution makes the species very vulnerable to interactions with fishing activities, which are more intense in this region.

Four management stocks (Franciscana Management Areas – FMAs) were initially proposed for franciscana dolphins across the entire range of the species, based on a phylogeographic approach (Secchi et al., 2003). Cunha et al. (2014) expanded the genetic analyzes and proposed a subdivision of the FMAs. More recently, Nara et al. (2022) deepened knowledge about population structure and proposed new subdivisions for the FMAs. In this new approach, the Babitonga bay population became a new stock, and was recently recognized as FMA Babitonga (IWC 2023).

In Babitonga Bay, Southern Brazil, occurs a resident population of franciscana dolphins living inside an estuarine area. The use of photo identification methods indicates that this population is resident, showing a high site fidelity (Sartori et al., 2017; Cremer et al., 2018), and the tagging of four individuals with satellite transmitters showed that this population had unusually small ranges, varying from 5.5 to 7 km^2, using only a small portion of the bay (Wells et al., 2022). Different impacts have affected this small population over the last few decades, including the contamination and vessel traffic, but the incidental capture in fishing nets is probably the most important (Cremer et al., 2018).

Artisanal fishing is widespread throughout the bay, including the use of bottom and surface gillnets (Pinheiro and Cremer, 2003; Serafini et al., 2014), which are the main fishing gears involved in the incidental capture of franciscana dolphins (Secchi et al., 2021).

The first abundance estimates for this population was conducted for the period of 2000 to 2003, resulting in 50 individuals (CI = 28-89; CV = 0.30) (Cremer and Simões-Lopes, 2008). Around ten years later, Sucunza et al. (2020) presented a new estimation for the same general region, but for a different survey area, making estimates non-comparable (n = 53 individuals; CV = 0.22). Considering the growing anthropic pressure in the area, the objective of this work was to analyze the status of this population, presenting a new abundance estimate, after 12 years, and the profile of individuals found dead within the bay over 20 years (2001 to 2021).

METHODS

Study area

Babitonga bay is located in South Brazil (26º02'-26º28'S and 48º28'-48º50'W), totaling an area of 160 km2 (Fig. 1). The bay is connected to the ocean through a 1.7 km wide channel and the maximum depth is 28 m in the main channel, with a mean depth of 6 m. There are many islands inside the bay, and its borders are formed by mangroves, rocky shores and muddy-sand beaches. Despite its high importance for biodiversity conservation, the bay has received intense human pressure, generating impacts related to water contamination, noise pollution, vessel traffic and overfishing (Gerhardinger et al., 2021).

Density and abundance estimates

Line-transect boat surveys (Buckland et al., 2001) were conducted in the period of November 20 to December 13, 2023, covering the main area of the bay (Fig. 1). Considering previous work (Cremer and Simões-Lopes 2008; Paitach et al., 2023), this area comprehends the entire area of occurrence of this population.Transects were projected perpendicularly to the coastline for most of the area, but some transects were projected parallel to the coastline due to the presence of islands and tidal flats. A total of 22 transects were established, which were ca. 1000m distant in between when parallel. Two vessels were used to collect data, one 5.5 meters long with a 60 HP outboard engine, and one 6.2 meters long with a 200 HP outboard engine. On each sampling day, one or both vessels were used, depending on the number of observers available. On each vessel there were at least two experienced observers, positioned at the bow, and a pilot. At each detection, observers visually estimated the radial distance, recorded the angle in relation to the bow using an angle border and counted the number of individuals, recording all information on a sound recorder. Babitonga Bay is also home to a resident population of Guiana dolphins, *Sotalia guianensis*, but differentiating the species in the field is easy for experienced observers. At least every two days, before the start of sampling, observers carried out a calibration procedure from the boat to estimate radial distance using objects in the water and a rangefinder, totaling ten positions estimated each day.

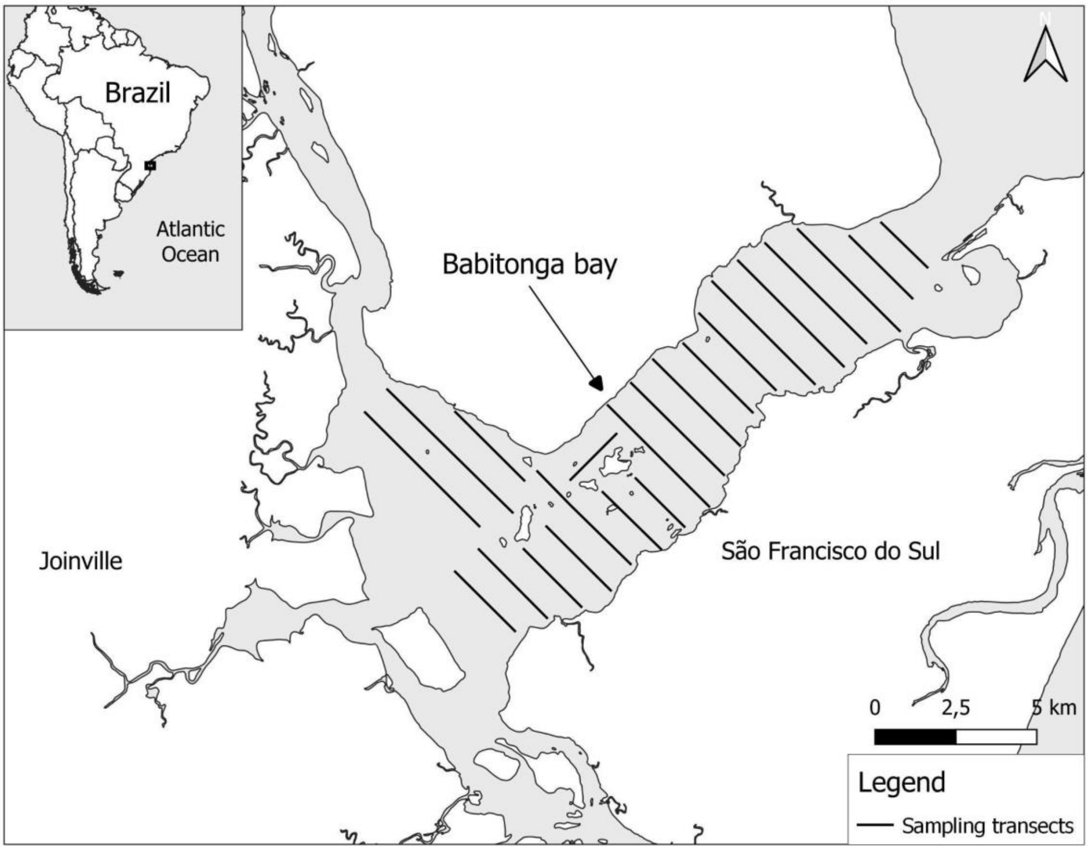

Figure 2 - Study area and transects defined for boat surveys in Babitonga bay, South Brazil, in November and December 2023. This area comprehends the entire area of occurrence of this population of FMA Babitonga.

Detection probability was estimated using Conventional (CDS) and Multiple Covariate Distance Sampling (MCDS) methods (Buckland et al., 2001; Marques and Buckland, 2003). Only the half-normal and the hazard-rate detection functions were proposed to fit distance data. Due to the small number of franciscana groups detected, detections of Guiana dolphins were included in the analyses and the species (factor covariate) was considered a covariate to model distance data. Abundance was estimated using the Horvitz-Thompson estimator following Marques and Buckland (2003). Variance was estimated using the analytical estimator of Innes et al. (2002). Analyses were performed using a set of customized functions (mrds v.2.2.0, Laake et al., 2018) in R, version 4.1.1 (R Core Team, 2021).

<u>Mortality data</u>

In the period of 2001 and 2021, all carcasses found inside Babitonga bay were recovered and sent to the laboratory for necropsy and sample collection. For each individual, whenever possible, the total length was measured, the sex was determined by direct observation of the ventral region and the age was estimated through analysis of layers of deposition on the teeth according to proposed methodology by Pinedo and Hohn (2000). In some cases, the advanced state of decomposition of the carcass made it impossible to collect this information. To classify the individuals considering sexual maturity, we considered the length at sexual maturity estimated by logistic regression by Cordeiro (2021), who analyzed individuals stranded in Santa Catarina State coast. Following this author, length at sexual maturity was estimated at 130.2 cm for females and 116.1 cm for males.

RESULTS AND DISCUSSION

A total of 217.61 km was conducted inside Babitonga bay and eight groups were detected on effort. Group size varied from to two to five individuals (mean = 3.4; SD = 1.5). The preferred model to fit distance data (Fig. 2) was selected based on visual assessment and to include the effect of both franciscana and Guiana dolphins on detection probability. A total of 93 on-effort sightings (n = 8 franciscana groups; n = 85 Guiana dolphin groups) was used to model distance data, and average detection probability was 0.478 (CV = 0.190). Average density of franciscanas was 0.44 (CV = 0.87) individuals/km^2 and abundance was estimated at 35 (CV = 0.99, 95% CI = 7.87-154.72) (Table 1).

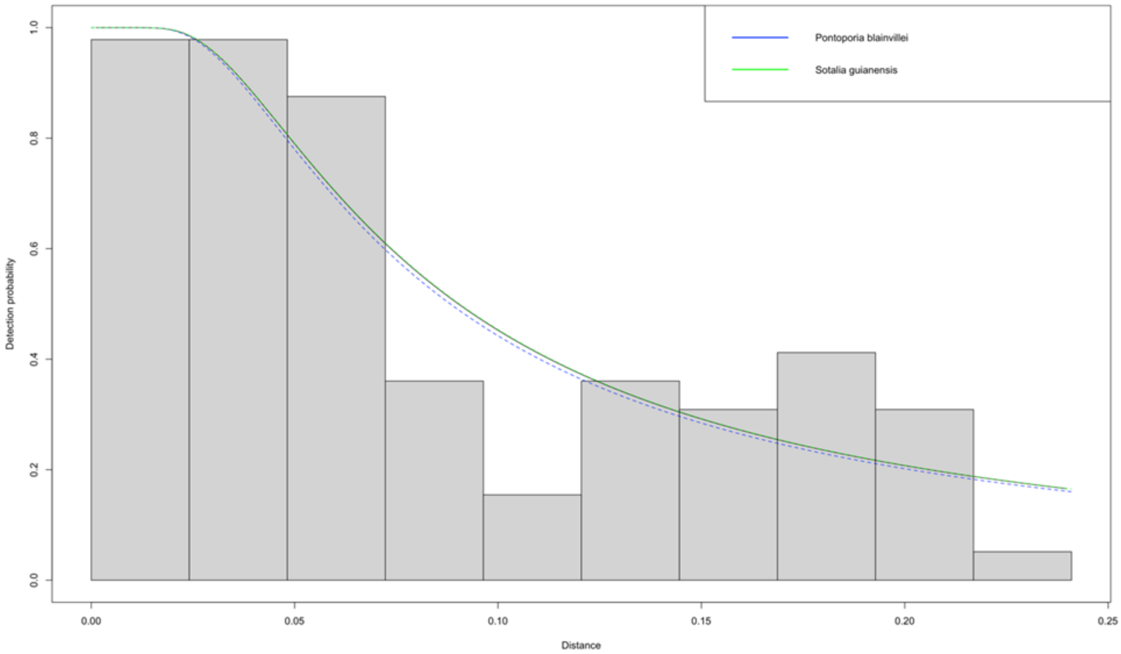

Figure 2 - Detection function plot for franciscana and Guiana dolphins sightings recorded in Babitonga bay. Perpendicular distance was truncated at 0.241 km.

Table 1: Density and abundance estimates of franciscana dolphins in Babitonga bay (Franciscana Management Area Babitonga). CV = coefficient of variation; n = number of sightings used for abundance estimation, ER = number of groups/km, p = average detection probability; AG = average expected group size; D = average density (n individuals/km^2); A = abundance; CI = confidence interval.

n	ER (CV)	p (CV)	AG (CV)	D (CV)	A (CV)	CI 95%
8	0.0367 (0.625)	0.478 (0.190)	2.75 (0.113)	0.444 (0.866)	34.894 (0.866)	7.869-154.721

The number of franciscana dolphins detected was low and concentrated in only one transect during the sampling effort, which contributed to the high uncertainty associated with the density estimate. Considering the estimates obtained in 2023, abundance was 32% lower than that obtained by Cremer and Simões-Lopes (2008) for the period of 2000-2003 (n = 50). Although this estimate was not comparable to that obtained by Sucunza et al. (2022) in 2011, it is worth noting that in this period the values were very similar (n = 53).

During the study period for mortality analysis (2001-2021), 47 dead franciscana dolphins were recorded, 34% females, 34% males and 32% whose sex was not defined. For six individuals there is no information on total length or age. The average length was 97 +/- 26.9 cm (59 to 144 cm) for males (n = 16) and 108.3 +/- 29.5 cm (59 to 146 cm) for females (n = 16). Age was estimated for 18 individuals, and the average was 7.8 years (1 to 16 years). Based on total length and/or age information, 43.9% of the individuals were less than one year old. The number of strandings varied from five to 17 between seasons, and winter was the season with the highest number of carcasses recorded.

Considering mean abundance estimates of 53 individuals for this population obtained in 2011, the average annual mortality of franciscanas was 4.2%/year, with a highlight in 2019, when seven individuals were recorded (13.2% of the estimated population). If the current estimate of 34 individuals is considered, the average annual mortality was 6.6%/year, and mortality recorded in 2019 corresponded to 20.6% of the population. Considering only sexually mature individuals, five females (0.2/year) and seven males (0.3/year) were recorded dead in this period.

It is clear that FMA Babitonga is certainly the smallest population of franciscana dolphins in the world, and there are signs that it is declining. Despite the uncertainty associated with the new abundance computed in this study, the mortality that has been recorded over the last 21 years strongly indicates the possibility of decline. Genetic data indicate a high degree of inbreeding in this population (Nara et al., 2022), and individuals monitored with satellite transmitters do not move outside the bay (Wells et al., 2022). Furthermore, it is possible that the mortality is underestimated, because not all carcasses are detected, but even this minimal mortality can be considered as unsustainable for this small population, warning of a risk of local extinction. For such a small population, the loss of any individual directly affects its stability and increases the risk of extinction. Over the last 21 years, the loss of at least five adult females and seven adult males has been documented, although most of the dead individuals were immature.

Constant monitoring of this population is essential, as is the improvement of new abundance estimates. In addition to incidental capture in fishing nets, already documented for the region (Pinheiro and Cremer, 2003), other cumulative impacts are also of great relevance, highlighting the increase in port activity, water contamination and overfishing (Cremer et al., 2018). In this sense, the urgent need for actions to enable the survival of these populations is reinforced, including the creation of a protected marine area in the region that covers the home range of this franciscana dolphin population, and adequate management of fishing activity with the creation of gillnet fishing exclusion areas in this region.

Funding/Support: MJC thanks to Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Technological Development - CNPq, Grant/Award Number: 131777/2020-3). We would like to thank Petrobras for the financial support to the Toninhas do Brasil Project through the Petrobras Socioenvironmental Program and UNIVILLE research support fund for their support over the last 20 years.

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