Density, abundance and group size of river dolphins (*Inia geoffrensis* and *Sotalia fluviatilis*) in Central Amazonia, Brazil

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ABSTRACT

A boat-based survey was conducted in the Tefé river and lake (Brazil) in December 2013, during the transitional water period. A combination of strip-width transects parallel to the river, lake-margins and confluences, and cross-channel line transects in the lake, were used to cover a total distance of 670 linear kilometres of the dolphins' habitat. A total of 383 groups of Amazon river dolphin and 124 groups of tucuxi were observed. Group size, density and abundance estimates were obtained per species and habitat (tributary, lake-margin and confluence). Group sizes ranged from one to six individuals for the Amazon river dolphin and from one to eight individuals for the tucuxi. The abundance of river dolphins was higher for the Amazon river dolphin (911, CV = 0.15) than the tucuxi (511, CV = 0.26). Higher densities were found in the lake-margin and tributary for the Amazon river dolphin and in the confluences for the tucuxi. Lake-margins, confluences and tributaries are therefore proposed as critical habitats for the conservation of river dolphins in central Amazonia. The Tefé lake is identified as an area of concern due to a high number of human stressors such as boat traffic, fishing and habitat degradation.

KEYWORDS: ABUNDANCE ESTIMATES; HABITAT; SURVEY-VESSEL; MONITORING; SOUTHERN HEMISPHERE; SOUTH AMERICA

INTRODUCTION

The Amazon river dolphin (*Inia geoffrensis*, Blainville 1817) and the tucuxi (*Sotalia fluviatilis* Gervais and Deville, 1853), are widely distributed in the Amazon, Orinoco and Tocantins river basins of South America (Best and da Silva, 1993; Hrbek *et al.*, 2014; Santos *et al.*, 2012). The Amazon river dolphin is listed as 'Endangered' by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (da Silva *et al.*, 2018) and the National List of Brazilian Fauna Threatened with Extinction (Brazilian Ministry of the Environment, 2014); the tucuxi is listed as 'Data Deficient' in both of the lists primarily due to the lack of data and associated assessments to evaluate the risk of population decline (Secchi, 2012). Lack of data is of concern, particularly because river dolphins are facing increasing human threats such as negative interaction with fisheries, population isolation by dams, bio-contamination by heavy metals (mining) and their illegal harvest for use as bait in fisheries for the *piracatinga* catfish, *Calophysus macropterus* (Gómez *et al.*, 2008; Hoyt, 2005; Iriarte and Marmontel, 2013; Trujillo *et al.*, 2010). Furthermore, the Action Plan for South American River Dolphins 2010–20 (Trujillo *et al.*, 2010) recommended that density and abundance estimates be generated to evaluate and monitor the status of dolphin populations and to prioritise conservation and management actions, particularly in areas with absence of information.

This study provides estimates of density and abundance of river dolphins in a sub-basin of the Amazon river in central Amazonia as part of an initiative to strengthen an existing network of researchers and managers known as the South American River Dolphin Protected Area Network (SARDPAN). The overarching goal of this study is to contribute to the evaluation and monitoring of the conservation status of river dolphins in South America. The research reported here constitutes the first estimate of density and abundance of river dolphins for the Tefé river and lake.

METHODS

Study area

Boat-based surveys were conducted in the Tefé lake and river (a tributary of the Solimões river), a narrow river and lake system of central Amazonia (3°21'0.35''S, 64°42'54.04''W), see Fig. 1. The Tefé river is a narrow tributary whose headwaters rise in lowlands dominated by sandy soils (Goulding *et al.*, 2003; Sioli, 1984). The tributary and lake are formed by black waters that are poor in nutrients, with high concentrations of organic compounds leading to an acidic pH (Goulding *et al.*, 2003; Sioli, 1984). The lake has low water quality near the town of Tefé because of household sewage and solid waste disposal (Borges *et al.*, 2013). Fisheries activity is widely spread in the Tefé river and lake (Barthem, 1990), contributing to almost 30% of the fish landed in the town of Tefé (Ilha, pers. comm.).

Sampling protocol

A regional boat-decker, navigating at an average speed of 12kmh^{-1}, was used to conduct a survey from 3–11 December 2013, during the transitional water period at the beginning

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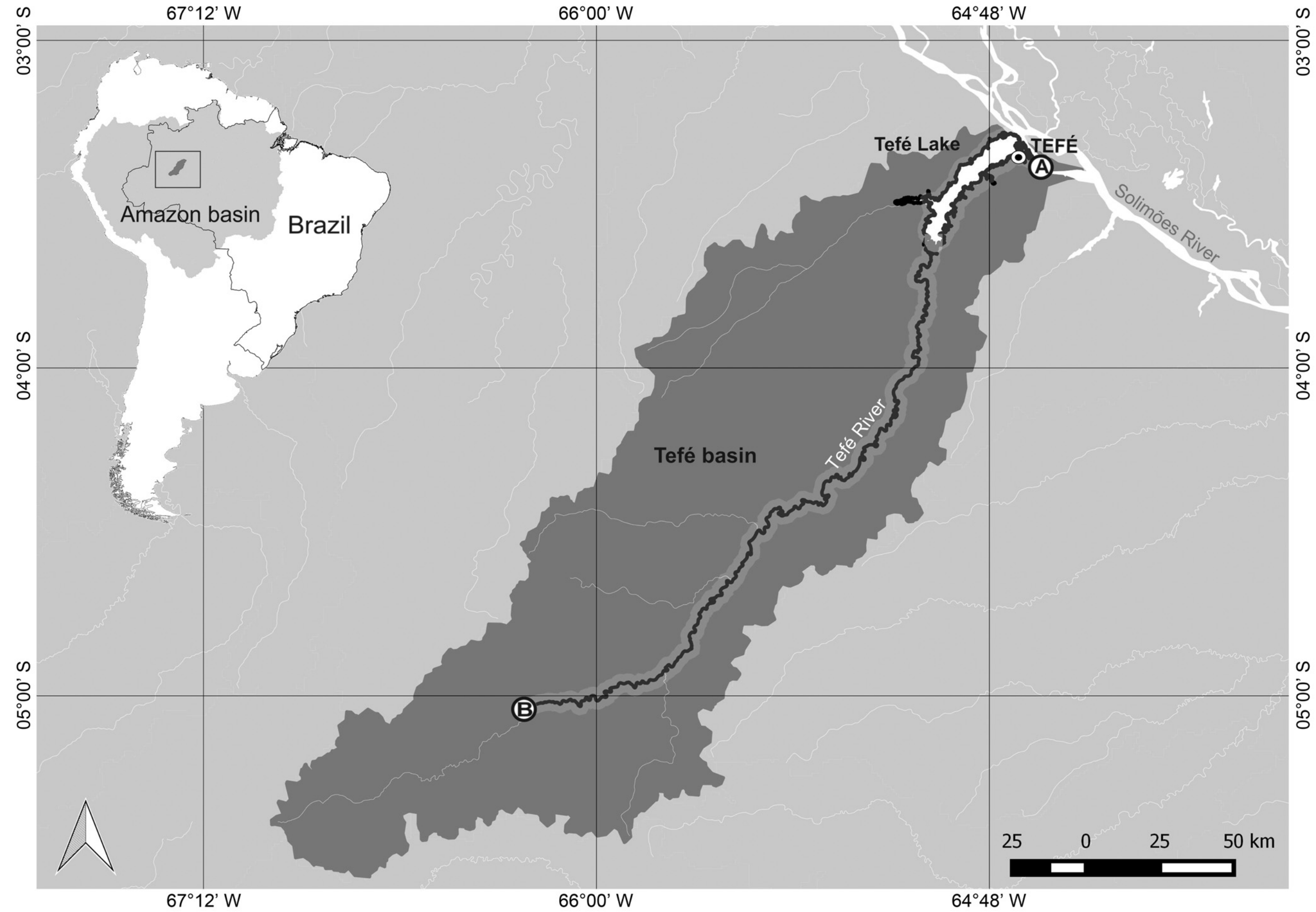

Fig. 1. Map of Central Amazonia (light grey) specifying the sub-basin of Tefé river (dark grey) and Tefé town. Point A indicates the survey starting location at the confluence between the Tefé lake and the Solimões river and point B the survey end location at the Tefé river.

Table 1
Definition of habitat types surveyed during December 2013 in central Amazonia

Habitat type or stratum	Location in this study	Definition
Tributary	Tefé river	Small and medium size rivers with maximum width of 400m (Gomez-Salazar *et al*., 2012a). Most of the small blackwaters rivers are concentrated in the central Amazon, just as Tefé river (Goulding *et al*., 2003).
Confluence	Tefé lake and Solimões river	Connection areas between small or large rivers and lakes with others, including channels. May or may not present a mix of waters (Martin *et al*., 2004, Gomez-Salazar *et al*., 2012a). The confluence between Tefé lake and Solimões river is an example of black and white waters mixing.
Lake	Tefé lake: General	Can present oval, elongated or dendritic shapes and shallow waters with maximum depth ranging from 6-12m in the high-water level. Large lakes, such as Tefé, are connected to rivers most of the time through small channels (Junk *et al*., 2012).
	Tefé lake: Margin area	Area of the lake with a width of 200m from the margin to the channel (Martin *et al*., 2004, Gomez-Salazar *et al*., 2012a).
	Tefé lake: Channel area	Area of the lake excluding the area of lake-margin, *i.e.*, channel further away than 200m of the margin in any perimeter of the lake (Martin *et al*., 2004, Gomez-Salazar *et al*., 2012a).

of the flooding season (between 'low' and 'high' water levels).

River dolphins' habitat comprises rivers, channels, lakes and confluences, all of which have diverse characteristics (Table 1). They are distributed differentially amongst these various habitats, with densities generally higher at the river margins, confluences and lakes (Gomez-Salazar *et al.*, 2012a; Martin and da Silva, 2004; Martin *et al.*, 2004). Recognising the need to take this into account in the sampling design, data collection as well as data analysis were carried out by means of stratification (Buckland *et al.*, 2001; 2004). A combination of strip and cross-channel line transect field protocols were implemented (Gomez-Salazar *et al.*, 2012a; Martin and da Silva, 2004; Vidal *et al.*, 1997). Cross-channel line transects were conducted by crossing the lake from one margin to another in a zigzag pattern. Strip-width transects of 200m or less (depending on the river width) were conducted parallel to the margin of the lake and the tributary, where the distance to the shore was controlled using a laser range finder. Only strip transects were conducted in the Tefé river due to the limited width of this tributary (mean width of 152m).

Two independent platforms were present, each 7.3m above water level (Gomez-Salazar *et al.*, 2012a; Laake and Borchers, 2004). The first platform was located at the front of the boat (forward platform), and the second platform at the back, facing the opposite direction (rear platform). There were three observers and one data recorder on each platform, an additional effort data recorder in the forward platform and a 'referee' transiting between both platforms. The observers actively searched for the river dolphins from 0° (trackline) to 90° on each side of the platform. For each sighting, the following information was collected: geographic position, species, group size, presence of calves, distance from the dolphins to the margin (collected only for strip transects), angle of the observer to the dolphins and distance from the observer to the dolphin group. Distances to the dolphins and from the dolphins to the margins were estimated by naked eye by observers with previous experience with the survey method described above (CG-S and FT).

Sighting data from both platforms were integrated into a single data sheet at the end of the survey and the correspondence between the dolphins detected by the forward and rear platform was determined (i.e. whether a sighting from the rear platform was a confirmation of one from the front platform or a new detection). This was based on the judgment of the referee regarding time of the sightings, side, angle, species and group size (i.e. whenever the referee had not been able to track the group in real time from the forward to the rear platform).

Following Gomez-Salazar *et al.* (2012a), environmental conditions were recorded every 30 minutes and included river state (0 to 3, increasing turbulence scale), glare (0 to 3, increasing intensity scale) and visibility (1 to 4, 1 being poor and 4 excellent).

Density estimates: strip transects

Density of river dolphins for each habitat *i* (tributary, lake-margin, confluence) were obtained based on a Horvitz-Thompson-like estimator:

$$\hat{D}_i = E(s)\frac{\hat{D}g_i}{w\hat{g}(0)'}$$

where *E(s)* is the mean group size, *w* is the transect width (truncated at 200m or mean width when the distance across the tributary was < 200m) and $\hat{g}(0)$ is the detection probability on the transect line.

River dolphins have been found to be distributed according to a gradient with higher densities closer to the margin in the first 50m lessening towards the river channel up to 200m out (Gomez-Salazar *et al.*, 2012a; Martin *et al.*, 2004). Considering that detection probability decreases with distance, a conflict between density and detection variation may occur. For this reason, corrections for undetected clusters in the 200m strip-width transects were incorporated (*P1* and *P2*) by using a detection function fitted for the cross-channel line transects (Gomez-Salazar *et al.*, 2012a). Therefore, density of clusters ($\hat{D}g_i$) is defined as:

$$\hat{D}g_i = \frac{ER_{i(0-50)}}{P_2} + \frac{ER_{i(50-100)}}{P_1} + \frac{ER_{i(100-150)}}{P_1} + \frac{ER_{i(150-200)}}{P_2}$$

Where *ER* is the mean encounter rate by transect, $P1_{\text{Amazon river dolphin}} = 0.955$ and $P1_{\text{Tucuxi}} = 0.994$ are the detection probabilities between 0–50m from the transect line (i.e. 50–100m or 100–150m from the margin), and $P2_{\text{Amazon river dolphin}} = 0.523$ and $P2_{\text{Tucuxi}} = 0.675$ are the detection probability between 50–100m from the transect line (i.e. 0–50m or 150–200m from the margin).

The $\hat{g}(0)$ was estimated with the Petersen estimator:

$$\hat{g}(0) = 1 - \frac{n_{\text{rear new}^2}}{n_{\text{rear}}}$$

Where n_{rear} is the number of river dolphins detected by the rear platform and $n_{\text{rear new}}$ is the number of dolphins detected by the rear platform which were not detected by the forward platform.

Finally, abundance was derived from density as:

$$\hat{N}_i = \hat{D}_i A_i$$

Where A_i is the size of the area surveyed, calculated using Geographic Information Systems (GIS). For tributary and lake-margin habitats, the areas were calculated as the perimeter of the Tefé river and lake multiplied by the average strip width of 152 and 200m respectively. For lake-channel habitat, the area resulted from the difference between the total area of the lake and the area of the lake-margin. For confluence, the width of each confluence was multiplied by the transect length, and then summed to obtain the total area.

The variances of encounter rates were derived empirically, the variances of the detection probability (*P1* and *P2*) were estimated following Gomez-Salazar *et al.* (2012a) and the variances of $\hat{g}(0)$ calculated through the delta method (Seber, 1982). These were used to compute the final variance and correspondent standard deviation (SD) and coefficient of variation (CV).

Density estimates: line transects

It was expected that density estimates of river dolphins in the lake-channel area would be obtained by fitting detection probability models to perpendicular distance data using conventional line transect sampling methods (Buckland *et al.*, 2001). However, only 7 and 2 sightings were recorded for the Amazon river dolphin and the tucuxi respectively, an insufficient sample to properly estimate detection probability (Buckland *et al.*, 2001). For populations that occur in clusters, such as in the present study, the sample size should be larger (~60–80) to accurately estimate abundance of individuals (Buckland *et al.*, 2001). For this reason, the results in the lake-channel were omitted and only the encounter rates were presented in order to compare with relative densities estimated for other habitats. The majority of river dolphins are found in areas closer to the river bank (Gomez-Salazar *et al.*, 2012a; Martin *et al.*, 2004), and thus, it is not expected that omitting estimates from cross-channel line transects will have a large impact in the overall abundance estimate of dolphins for this region.

RESULTS

A total of 590 and 80 linear kilometres of sampling effort were conducted using strip and cross-channel line transects respectively, with a total of 383 sightings of Amazon river dolphins and 124 sightings of tucuxis recorded. Overall, the transects were surveyed during good sighting conditions:

Table 2

Area of stratum (A) (km^2), mean group size $E(s)$ with correspondent standard deviation ($SD(s)$), number of sightings (n), mean encounter rate by transect (ER), abundance ($\widehat{N}$) and density ($\widehat{D}$) (ind km^{-2}) with correspondent standard deviation (SD) and coefficient of variation (CV) for Amazon river dolphin (*I. geoffrensis*) and tucuxi (*S. fluviatilis*) by stratum.

		Amazon pink dolphin								Tucuxi							
Habitat	A	$E(s)$	$SD(s)$	n	ER	$\widehat{N}$	$\widehat{D}$	SD	CV	$E(s)$	$SD(s)$	n	ER	$\widehat{N}$	$\widehat{D}$	SD	CV
Tributary	104	1.44	0.70	395	0.72	582	5.59	0.99	0.18	2.32	1.49	140	0.38	210	2.01	2.58	1.28
Lake-margin	76	1.40	0.73	139	0.65	327	4.28	1.13	0.26	2.35	1.44	122	0.73	290	3.79	1.71	0.45
Lake-channel	328	1.43	0.79	10	0.28	–	–	–	–	1	0.00	2	0.08	–	–	–	–
Confluence	1.2	1.67	1.03	10	0.91	2	1.54	1.03	0.67	3.2	1.90	16	1.60	9	9.08	1.10	0.12
Overall**	509.20	1.48	–	554	0.64	911	3.80	–	0.15	2.22	–	280	0.70	511	4.96	–	0.26

* The values are rounded for two decimal places to fit in the table. Therefore, the multiplication of density and area does not result exactly in the abundance.
** The overall estimates of $E(s)$, ER and $\widehat{D}$ correspond to the mean among habitats.

100% during low turbulence (levels 0 and 1), 84% during minimum glare (levels 0 and 1) and 68% during good and excellent visibility.

Group size ranged from one to six individuals for Amazon river dolphin and from one to eight for tucuxi. Differences in group size across habitats were not observed for both species (Kruskal Wallis test, $\alpha = 0.05$). Almost all animals present were detected: $\hat{g}(0)$ was estimated at 0.99 (CV = 0.002) for the Amazon river dolphin and 0.99 (CV = 0.003) for tucuxi. The highest density of Amazon river dolphins was found in the tributary (5.85 ind km^{-1}, SD = 0.99), while the lowest density was found in the confluences (1.54 ind km^{-1}, SD = 1.03; Table 2). Conversely, the tucuxi's highest density was in the confluences (9.03 ind km^{-1}, SD = 1.29), followed by the lake-margin habitat (3.77 ind km^{-1}, SD = 1.71) (Table 2). Overall, the abundance of river dolphins in the Tefé river-lake system was higher for Amazon river dolphin (911, CV = 0.15) than tucuxi (511, CV = 0.26) (Table 2).

DISCUSSION

This study provides a benchmark for river dolphin abundance estimates in the Tefé river and lake. Group size, density and abundance were explored in different habitats to enable a comparison among them and with other studies.

Group sizes of both species of river dolphins (ranging from 1 to 8) were consistent with previous studies in other regions of Amazonia (Gomez-Salazar *et al.*, 2012b; Martin *et al.*, 2004). Differences in group size across habitats were not identified. As stated by other studies (Gomez-Salazar *et al.*, 2012b; Martin *et al.*, 2004), these differences might arise from repeated surveys conducted in different seasons. Repeated surveys could for example identify the behavioural responses of river dolphins to freshwater floods.

The preference of river dolphins for lakes and confluences instead of narrow rivers has been reported in other regions of Amazonia, as these areas have higher productivity compared with other habitats (Aliaga-Rossel, 2002; Gomez-Salazar *et al.*, 2012b; Martin *et al.*, 2004; McGuire and Wienemiller, 1998). For instance, the mixing of black and white waters in the confluence between the Japurá and Solimões rivers (an area adjacent to our study area) has also been reported as a preferred habitat for tucuxi (Martin *et al.*, 2004). Similarity of features is likely to explain the high density of tucuxi in the confluence between the Tefé lake and Solimões river.

Although confluences represent less than 1% of the proportion of the total study area, this habitat is particularly important in Amazonia for the movement of aquatic life between rivers, tributaries and lakes during and after freshwater floods (Barthem and Goulding, 1997; Fernandes, 1997; Henderson, 1990). Every year during the highwater period, an area of approximately 170,000km^2 in the Amazon is inundated, forming the floodplains (Hamilton and Lewis, 1990). Seasonal freshwater floods enhance the total aquatic productivity in the Amazon and trigger the migration of fish and dolphins between habitats (Barthem and Goulding, 1997; Lewis *et al.*, 2000; Martin and da Silva, 2004).

Contrary to the tucuxi, densities of Amazon river dolphins were the highest in the Tefé river (tributary). Amazon river dolphins have morphological adaptations (e.g. flexible bodies, small dorsal fins and large pectoral fins) that allow them to exploit narrow areas with limited water depth without getting stranded (Martin and da Silva, 2004). This may explain the higher density of Amazon river dolphins in the tributary, and the higher density of tucuxi in habitats that are easier to navigate (i.e. confluences and lakes) during the present study due to the season when the study took place.

Comparing monitoring efforts in Amazonia

Density and population size of river dolphins in South America have been estimated from surveys conducted in small areas using varied methodologies. Earlier surveys were mainly focused on obtaining encounter rates instead of densities and abundance estimates (da Silva, 1994; Herman *et al.*, 1996; Kasuya and Kajihara, 1974; Layne, 1958; Meade and Koehnken, 1991; Pilleri and Gihr, 1977; Trujillo, 2000). More recent surveys have been conducted using standardised sampling methods (Aliaga-Rossel, 2002; Leatherwood, 1996; Martin and da Silva, 2004; Martin *et al.*, 2004; McGuire, 2002; Utreras, 1996; Vidal *et al.*, 1997). However, these latter studies have differences in sighting protocols (e.g. number of observers), analysis (e.g. assumptions about $g(0)$, corrections by the detection probability as a function of perpendicular distances), and the season surveyed. Consequently, caution should be applied when comparing results across areas and studies. Here, the sampling and analytical methods proposed by Gomez-Salazar *et al.* (2012a) were followed, which allowed for a preliminary and relatively simple comparison with density estimates reported in other areas of Amazonia (Figs 2 and 3).

The density of the Amazon river dolphin in the Tefé river was higher than the densities reported in tributaries located in Bolivia, Venezuela, Colombia and Ecuador, and similar to one of the highest densities ever reported – in a Peruvian

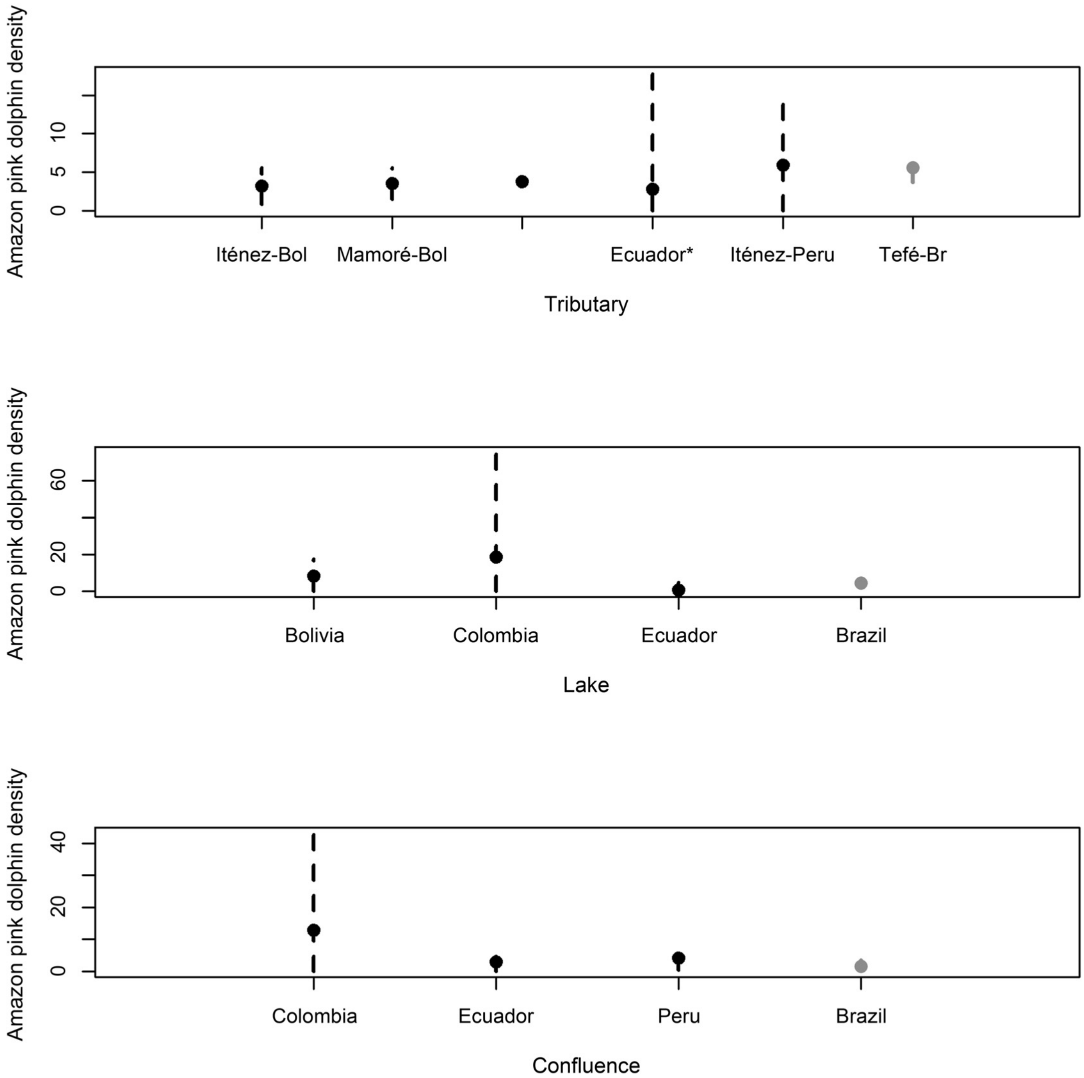

Fig. 2. Density of *I. geoffrensis* estimated in tributaries, lakes and confluences of Colombia, Ecuador, Peru and Bolivia (from Gomez-Salazar *et al.* (2012a) (black) and Brazil (grey). Dots represent the mean estimates and dashed lines the standard errors. *Refers to Cuyabeno, Yasuni, Lagartococha and Aguarico rivers.

tributary (Gomez-Salazar *et al.*, 2012a). This suggests that the Tefé river, together with the Pacaya Samiria Reserve in Peru, the Mamirauá Sustainable Development Reserve in Brazil, and the Iténez and Mamoré rivers in Bolivia, are hotspots for the Amazon river dolphin at a regional scale (hotspots of river dolphins were previously defined and identified as locations with the highest density estimates of dolphins in South America; Gomez-Salazar *et al.*, 2012a).

Conversely, the density estimates of the Amazon river dolphin reported in the Tefé lake and in the confluence were smaller than those obtained in other countries, being only comparable to the low densities of Ecuador (Gomez-Salazar *et al.*, 2012a). Further surveys which take into account seasonality might clarify the importance of the Tefé lake for Amazon river dolphins.

For tucuxi, the density was smaller than estimates reported in rivers of Colombia and higher than in rivers of Ecuador (Gomez-Salazar *et al.*, 2012a). Conversely, density at confluences was similar to that estimated in Peru (Gomez-Salazar *et al.*, 2012a). Nevertheless, caution is warranted when interpreting these results due to the large CVs associated with the density estimates.

It is also important to highlight that because the abundance of river dolphins in the lake-channel was not estimated due to the small number of detections in this habitat, the overall abundance in the Tefé lake will be negatively biased to an unknown extent. The low abundance of river dolphins in the lake-channel corroborates other studies in which the encounter rates in lake or river channels are usually low (Gomez-Salazar *et al.*, 2012a; Martin *et al.*, 2004).

Human activities impacting river dolphin populations in the Tefé lake

Although density estimates for river dolphins in lake-margin habitats are usually the highest in other areas of Amazonia, this is not the case in the Tefé lake. Due to its proximity with the city of Tefé (human population of 62,662 in 2014), a variety of potentially harmful (to dolphins) human activities take place within the lake region, including fisheries, logging and riverine vessel traffic. A systematic survey reported 11 Amazon river dolphin and 4 tucuxi carcasses in the Tefé lake in 2013 (unpublished data). Taking into account the abundance point estimate provided in this study, these mortalities represent approximately 1.15% of the Amazon river dolphin and 0.8% of the tucuxi population being removed from the Tefé lake in a single year. Evidence of

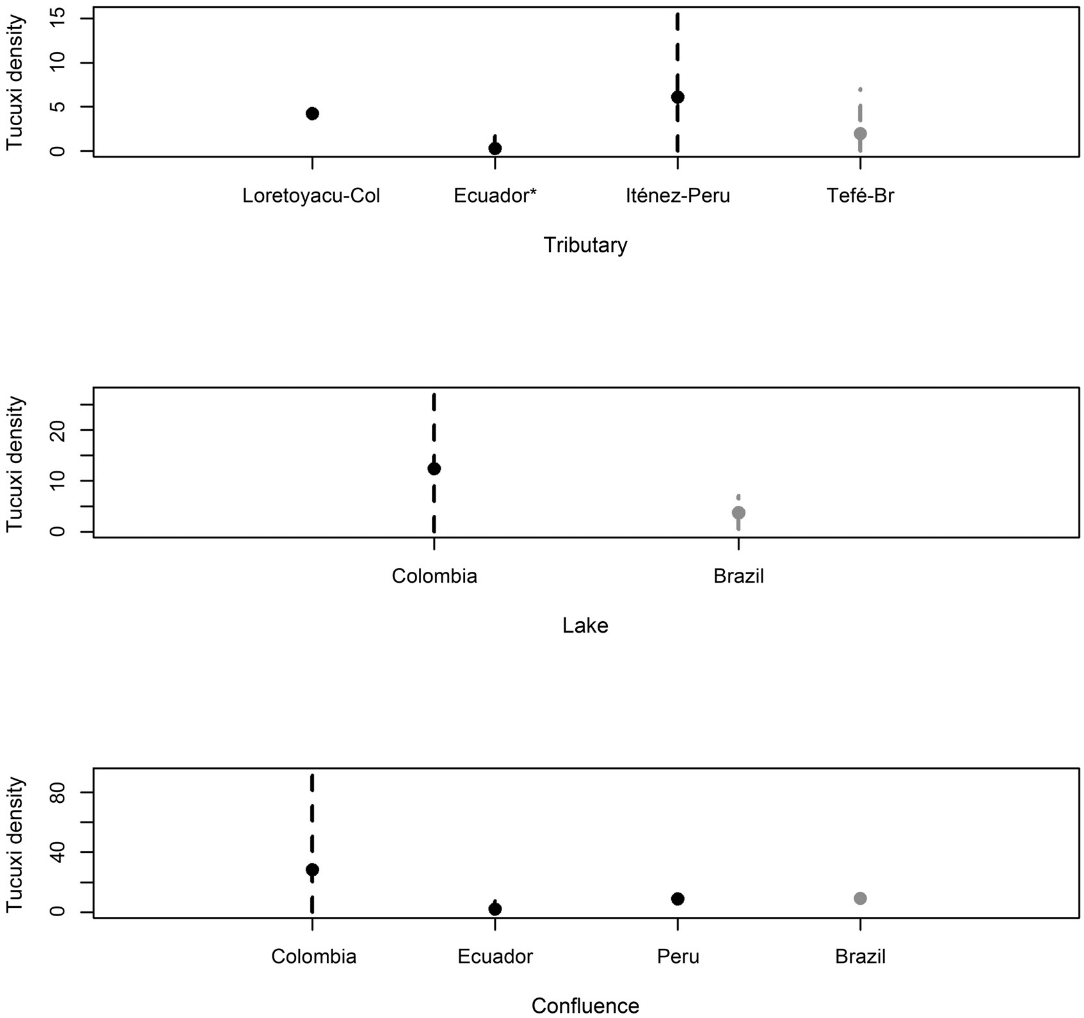

Fig. 3. Density of *S. fluviatilis* estimated in tributaries, lakes and confluences of Colombia, Ecuador and Peru (from Gomez-Salazar *et al.* (2012a) (black) and Brazil (grey). Dots represent the mean estimate and dashed lines the standard errors. *Refers to Cuyabeno, Yasuni, Lagartococha and Aguarico rivers.

interaction with fisheries based on possible marks of gillnets (entanglement) and of intentional killing (spear and axe marks) were observed in 55% of the carcasses (Santos *et al.*, 2014). Another threat to these populations includes habitat degradation, in particular chemical pollution. The city of Tefé does not have basic sanitation services and as a consequence, household sewage, wastewater and solid waste have been released into Tefé lake (Borges *et al.*, 2013). The poor water quality of the lake may explain findings of abscesses in the river dolphins necropsied which may be due to infectious diseases such as tuberculosis, pneumonia, golf ball disease and others (Bueno, pers. comm.). It is important to highlight that the number of carcasses reported probably represent a minimum mortality value as they do not account for unobserved records.

Of most serious concern is the decline in apparent survival of Amazon river dolphins for the past ten years in an area adjacent to the Tefé lake (Mintzer *et al.*, 2013). This decline has been attributed to the illegal harvesting of dolphins to be used as bait for the *piracatinga* catfish fishery. Moreover, the harvest rates reported seemed to exceed conservation limits and may be unsustainable (Mintzer *et al.*, 2013). In response, the Brazilian government has banned the commercial capture of the *piracatinga* catfish for five years starting on January 2015. There is no sign that this illegal harvesting is currently occurring in the Tefé river-lake system, although purchase, storage and disposal of *piracatinga* catfish still occur in the town of Tefé (Botero-Arias *et al.*, 2014).

In addition, disturbance due to elevated levels of noise generated from human activities can cause sub-lethal impacts (New *et al.*, 2013; NRC, 2005; Pirotta *et al.*, 2014). The potential impacts of noise on river dolphin populations in general have not as yet been studied (e.g. possible displacement from important habitats and foraging disruption), and noise exposure is potentially an additional human stressor to river dolphins in the Tefé lake.

Overall, human activities in South America riverine areas are increasing and some of these activities are causing lethal and/or sub-lethal impacts on river dolphin populations. The local and regional magnitude of these potentially cumulative impacts is not as yet fully understood.

FINAL REMARKS AND RECOMMENDATIONS

This study represents the first attempt at a standardised monitoring programme with the goal of assessing population trends of Amazon river dolphins and tucuxi in the Tefé river-lake system. Confluences, which are important areas for river connectivity, as well as lake-margin areas, had the highest density estimates of tucuxis. Conversely, the Tefé river had some of the highest density estimates ever reported for the Amazon river dolphin. Therefore, we propose these confluences and Tefé lake as areas of high priority for tucuxi conservation at a local scale, and the Tefé river as an important area for the conservation of the Amazon river dolphin at both local and regional scales.

The relatively low density estimates of river dolphins in the Tefé lake, as well as the high number of increasing human activities observed in this study and in the Amazon as a whole, should be further investigated. Estimating and monitoring the potential lethal and sub-lethal impacts of human activities on river dolphin populations is recommended as a process to be undertaken in parallel to efforts to monitor river dolphin distribution and abundance. This information is fundamental to informing conservation priorities in the region.

As previously reported, repetitive surveys conducted in riverine areas using comparable methodology are required to investigate how seasonality, habitat, and other potential environmental and human variables drive variation in the density of river dolphins. However, due to funding constraints, repetitive surveys cannot be always implemented in these remote areas. In those cases, it has been proposed to survey areas during the transitional water periods, where most of the habitat types are available (e.g. channels are not completely dry and lakes are still connected to the main rivers) to make studies more comparable (Gomez-Salazar *et al.*, 2012a).

This study reports on current efforts, which are being replicated in several rivers of South America, to improve knowledge on river dolphin population parameters. Equally important, these studies are being designed with the goal of strengthening SARDPAN and enhancing capacity building in South America.

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