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INTRODUCTION

Fishing for piracatinga (*Calophysus macropterus*) has been causing problems for the conservation of dolphins in the Amazon. The Amazon river dolphin or boto (*Inia geoffrensis*) and the tucuxi (*Sotalia fluviatilis*) are classified as 'Endangered' (EN) by IUCN mainly due to negative interactions with fishing activities; and, for the boto, piracatinga fishing is the most emerging threat. The fatty meat of this dolphin is used as bait for piracatinga, a catfish of low commercial value, not consumed by riverine communities in the Brazilian Amazon, but appreciated in Colombia. This fishery draws attention by the use of large species (dolphins and caimans) for the capture of a small catfish, of about 1 kg (Brum et al., 2015), motivated by the reduction of fishing species of high commercial value, in a well-known process called 'fishing-down' (Welcomme, 1999; Castello et al., 2013). Quantitative information on the impact of this activity at the population level on dolphins in the Amazon is scarce, and the need for long-term studies and abundance estimates is wide open.

Unintentional mortality and persecution of the riverine dolphins of Amazon related to fisheries activities are also a known, probably intense, but unquantified threats to these species (Brum et al., 2021). Dolphins get entangled in nets as they pursue their prey (Brum, 2011; Iriarte e Marmontel, 2013a), and are also intentional killed because fishers perceive them as competitors due to the high frequency of negative interactions during fishing events (Trujillo et al., 2010; Brum, 2011; Alves et al., 2012). As so, interactions with fisheries (unintentional mortality, persecution and intentional use as bait) are considered the main threat to these dolphins (Brum et al., 2021; da Silva et al., 2020; 2018; CMP, 2020).

Because biologic characteristics of the species, which are long-lived mammals, with low reproductive rates; and also because fisheries-related mortality is unquantified, the impacts of fisheries in the Amazon riverine dolphins are unknown. Producing baseline information and implementing and maintaining monitoring schemes are essential to understand and manage these anthropic impacts.

In this work, we presented the preliminary results of monitoring of Amazonian riverine dolphins populations in an area highly impacted by fisheries. The monitoring aims to estimate abundance and trends of botos and tucuxis in this area, but here we will present and discuss just the encounter rates of these dolphins.

METHODS

Study area

The study area is in the Solimões River, Central Amazon, in the vicinity of the city of Manacapuru, AM (3°18'37"S / 60°37'38"W), one of the largest Amazon cities and an important fishing port. Solimões River is a 'white water' river, characterized by high dissolved sediment in the water and consequent high productivity. The Manacapuru region has an important area of 'várzea', a high productive floodplain area that comprises land, lakes, and channels totally related with the river pulse (Sioli, 1984), and the preferred habitat for botos (Martin and da Silva, 2004). In this city, there are many freezing plants processing piracatinga and promoting this fishery (Brum et al., 2015). Fishery is one of the most important income sources for the population of Manacapuru (Beltrão et al., 2017). There are no protected areas or successful experiences in fisheries co-management in the area.

Data collection

Six field trips were carried out between August 2018 to November 2019, corresponding for draining and dry seasons in 2018, and all river pulse periods in 2019 (raising, flooded, draining and dry season). All surveys were boat-based, in a small motorboat, locally known as 'voadeira' (around 2m at eye level to the water). The speed of the vessel was maintained at 10-12 km/h.

Due to technical constraints, it is unfeasible to design transects surveys previously, as suggested by Thomas et al (2007). Besides that, river dolphins are known to concentrate close river margins and use channels just to pass by (Martin et al., 2004). In this sense, sampling occurred using two types of line transects (e.g. Vidal et al., 1997), each of approximately 2km, designed to explore the area as random as possible and to cover each habitat type representatively. The first was oriented parallel to the river bank, at an average distance of 100-150m from the margin; and the second type occurred only on water bodies with more than 1km in length, and involved crossing between the margins.

Two observation platforms, located in the bow and stern, were used. The team consisted of four observers. Both platforms covered a viewing angle of 180°. The platforms were independent, visually and acoustically separated; and the stern platform communicated via radio its observation to identify duplicates. Highly experienced observers with more than five years working with these species, were able to characterize the groups very well on both platforms, all the time. The vessel did not slow down or alter its course when a dolphin group was detected (passing mode; Dawson et al. 2008). Environmental conditions that could affect the sightings were also recorded at the start and end of each transects, at each sighting, and when conditions changed: river state (adapted Beaufort scale, varying from 0 to 4), glare and visibility, both ranging from 0 to 3. Surveys were performed only when 'river state' was ≤ 3 and 'glare' was ≤ 1.

Fishing activities were also identified on the surveys. The observers are highly experienced in identifying fishing activities, and the boat driver, a local fisher, was also consulted to confirm the kind of fishery gear. A map with the overlap of prevalence of fishing nets (the most

damaging gear to dolphins) and dolphin's presence based on the frequency of observations in all surveys was also produced.

RESULTS AND DISCUSSION

Here we present the preliminary results on the encounter rates and presence of fishing nets. This monitoring is ongoing, aiming to estimate the abundance and trends of these species in the study area. The encounter rates found and other survey information are described in Table 1. Environmental conditions in all surveys were very good (visibility=3), and probably do not affect our detections between the surveys.

Table 1. Survey results indicating the season, the data of the expedition (month and year), the linear kilometers surveyed (KM), total number of tucuxis and botos observed, the encounter rates of both species (dolphins/km) and the number of nets observed in each survey.

SEASON	DATE	KM	No TUCUXIS	No BOTOS	TUCUXI/KM	BOTOS/KM	No NETS
Draining	08/2018	170,76	160	18	0,9	0,1	75
Dry	09/2018	168,6	175	42	1	0,2	38
Rising	02/2019	196,2	207	39	1,1	0,2	27
Flood	05/2019	191,94	331	75	1,7	0,4	38
Draining	10/2019	172,37	187	30	1,1	0,2	56
Dry	11/2019	201,13	270	44	1,3	0,2	37

In Figure 1, we present the fishing overlap areas. The fishing gears identified were: hand-line, longline, and different types of nets ('tramalhas', gillnets, 'arrastão', and seine net). In Table 1, we presented just the number of nets, as they are the most harmful to dolphins (Brum, 2011).

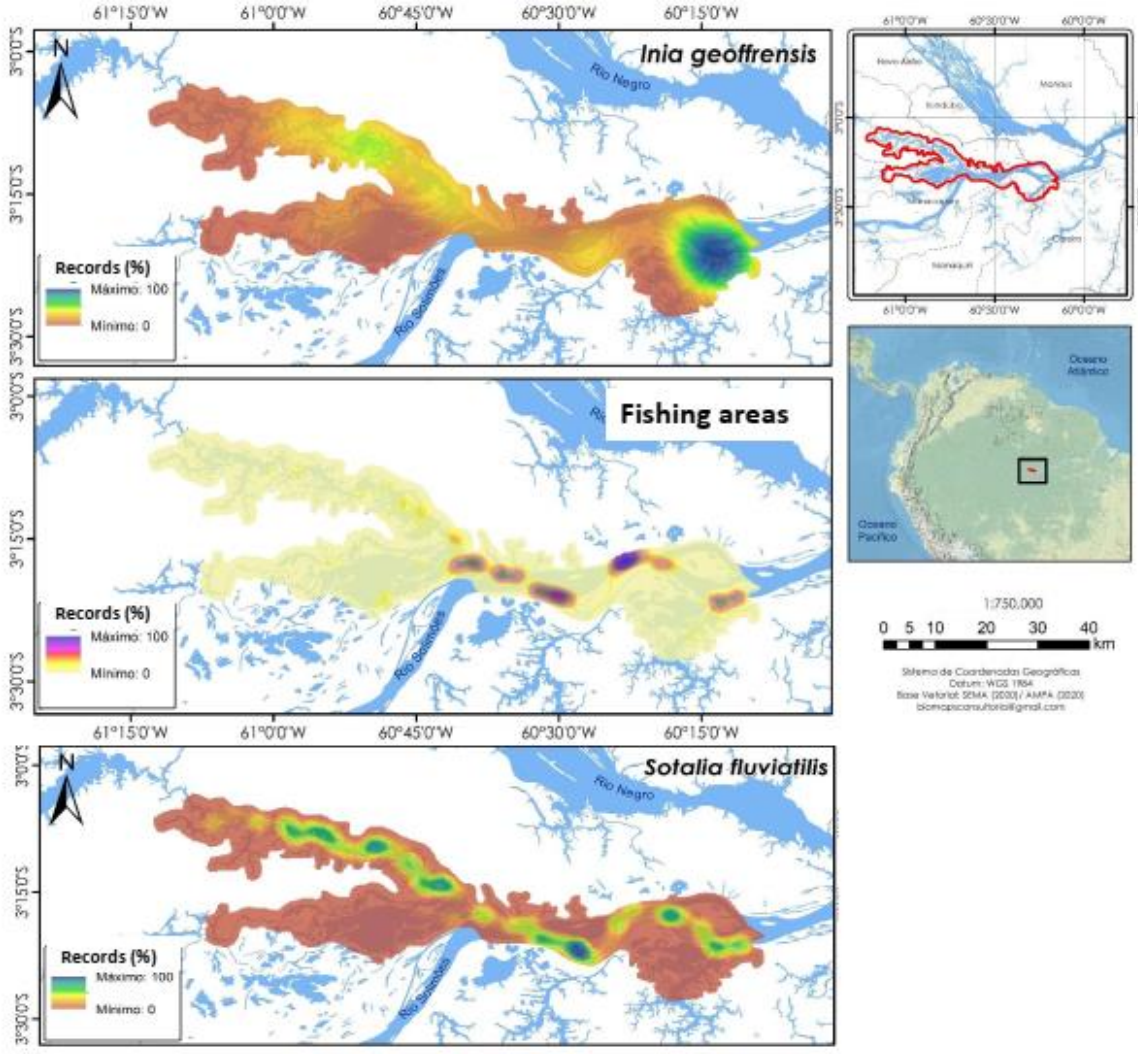

Figure 1: Overlap map between fisheries, botos (Inia geoffrensis) and tucuxis (Sotalia fluviatilis), based on number of registers in all surveys pooled together

'Tramalhas' (Figure 2D) are plastic monofilament gillnets, cheaper and widely used for small-scale commercial fishing and subsistence fishing. Gillnets, 'arrastão', and seine nets are multifilament gillnets, used for commercial fishing. These are extremely resistant and much larger nets than the 'tramalhas'. Gillnets (Figure 2E) are fixed nets about 50m long, used mainly to catch fish of high commercial value, such as tambaqui *Colossoma macropomum*. The 'arrastão' (Figure 2B and 2C), with about 50-100m long, is adrift in the water, being carried by the current of the river. It is used to capture medium and large catfish. And seine nets (Figure 2F), usually up to 10m in height, with small mesh, mobile, used by fishers only when a school is identified and deployed to make a siege on that school. Its use requires a large number of fishers for their handling.

Figure 2: The gillnets. A. Schematic view of a gillnet (from Petrere Jr., 1977); B and C. The 'arrastão' gillnet, used for fishing catfish; D. 'Tramalha' gillnet; E. Gillnet used for fishing tambaqui; F. The seine net, used to encircle a school.

It is important to note that our survey hours (between 8a.m. to 4p.m) are not the preferential hours for fishing. Fishing normally happens very early morning and late afternoon, mainly the subsistence fishing that uses 'tramalha'. On Figure 1, we can note that fisheries activities are concentrated in the main channel of the Solimões River, overlapping mainly with tucuxis. The 'arrastão' gillnet are prevalent in this area, and this kind of net was identified as one of the most problematic regarding entanglement of tucuxis in the medium Solimões River area (Brum, 2011). It is also important to note that the rare observations of botos are also overlapping with fisheries, mainly in the confluences. In this area, the prevalence is of the 'tramalha' gillnet, identified as the most problematic net regarding negative interactions with botos in medium Solimões River, but normally of damage to the gear or to the fish, which leads to conflicts (Brum, 2011). Botos and tucuxis are seen by fishers in different ways. The tucuxi is more related to positive or neutral interactions, and even considered pleasant by the fishers. The conflicts with botos are constant, as they are perceived as competitors, and intentionally killed due this persecution (Brum, 2011; Brum et al., 2021).

Our results revealed the very low rates in botos encounters. Considering recent standard surveys made for this species, employing a double platform design in other rivers, our encounter rates in this section of Solimões River are similar of less productive rivers, like 'clear water' Tapajós and Araguaia Rivers (0.15 and 0.2 botos/km, respectively; Pavanato et al., 2016; Araújo e da Silva, 2014) and the 'black water' of Negro River (0.1 botos/km, ICMBio 2017), as well as rivers in the Napo sub-basin, Ecuador (0.1 botos/km; Gomez-Salazar et al., 2012).

As a ‘white water’ river, and, as so, a very productive river, surrounded with floodplains or *varzea* (botos preferred habitat; Martin e da Silva, 2004), we expected higher encounter rates. Encounter rates of upper Solimões/Maranon River (border region of Brazil and Peru) are between 0.6-0.9 botos/km (Martin et al., 2004; Gomez-Salazar et al., 2012). And other ‘white water’ rivers like Purus and Madeira/Mamoré had registered encounter rates of 1.3 and 1.5 botos/km, respectively (Gomez-Salazar et al., 2012; ICMBio, 2017).

The tucuxis encounter rates are more complicated to compare. Martin et al. (2004) presented overall encounter rates of 0.5 tucuxis/km in the confluence of Solimões and Japurá Rivers. Pavanato et al. (2019) present encounter rates of 2.2 tucuxis/km in Tefé River, a ‘black water’ tributary of the Solimões river. A larger survey in the Solimões River in 2016, during the draining season that encompassed our study area, showed encounter rates of 1.2 tucuxis/km. And in the Purus River, the encounter rate is 2.1 tucuxis/km (ICMBio, 2017).

Although encounter rates are not the best population monitoring index (Uno et al., 2006; Fukawasa et al., 2020; Brum, 2021), mainly between very different designed surveys, our preliminary low encounter rates of botos draws our attention for two reasons: (i) the surveys were repeated in the same area through two years and six opportunities, covering all seasons, and (ii) the area is a well-known of conflicts between fisheries and botos, with large numbers of fishing boats and intense piracatinga fishing area. River dolphins encounter rates are related to the flood pulse of the Amazon basin (Martin et al., 2004), but we cover different seasons with consistently low encounter rates. As so, we hypothesized our unexpected low encounter rate as a consequence of this high conflict with fisheries in this area. The piracatinga fishing area of the Manacapuru region is located in the Solimões River, between Barroso island, including Pesqueiro coast, until Marrecão island (Beltrão et al 2017); which is part of the area we are covering in our monitoring. And we choose this area exactly because of the many mentions of intentional killing of botos, both for use as bait on piracatinga fishing (with killed events reports up to 20 botos in one night), as also due to the conflicts during the use of fishing nets.

CONCLUSIONS

Besides presenting just preliminary results, the numbers of botos inhabiting the study area, a high fishery area, is low. Conflicts with fishing activities are responsible for dolphin population declines worldwide (Halpern et al., 2008; Pompa et al., 2011; Punt et al., 2020), and studies to quantify this mortality and assess the impact of these activities on dolphins in the Amazon are highly recommended (MMA, 2019; Brum et al., 2021).

The use of botos as bait in piracatinga fishing has to be curbed. Nonetheless, as the fishing area is very extensive, it is very difficult to guarantee the non-use of botos as bait. Maintaining information about this activity and the population dynamics of botos is essential so that we can properly manage the situation. There are strong indications, in Brazil, that piracatinga fishing will resume from July 2021, as the fishing industry and fishers associations claim that the

activity can take place without boto bait. So, the monitoring of this activity and its impact on dolphin populations are relevant.

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