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Population numbers of Amazon river dolphins *Inia geoffrensis* and *Sotalia fluviatilis* (Mammalia: Cetaceae: Delphinidae) in the lower Río Tigre region, Loreto, Perú

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Abstract
We conducted a study to assess the populations of the two potentially endangered river dolphin species *Inia geoffrensis* and *Sotalia fluviatilis* in the river systems of the Río Tigre and the Río Marañon in the Peruvian Amazon region. Various observation methods were used and evaluated along ca. 353 kilometres of river and 134 to a maximum of 173 dolphins were recorded from 125 sightings and about 2000 photographs. Only about 10% of these dolphins could not be determined to species level, at least 57 individuals were identified as *S. fluviatilis*, and 89 individuals as *I. geoffrensis*. The abundance of dolphins along the entire stretch was 0.13 individuals per km for *S. fluviatilis* and 0.25 individuals per km for *I. geoffrensis*. Each participant spent an average of 82 working hours on observation. Evaluation of methods used revealed that observation supported by photographic documentation (PSO) increases observation accuracy by 19%. PSO is thus regarded as an ideal method for future population assessments. Perspectives and potential financial costs for conservation of Amazonian dolphin populations are discussed.

Resumen
Se realizo un estudio para estimar el tamaño poblacional de las especies de delfines de río potencialmente en peligro *Inia geoffrensis* y *Sotalia fluviatilis* en el ecosistema fluvial del río Tigre y el río Marañon, en la cuenca amazónica peruana. Se utilizó diferentes métodos que fueron evaluados a lo largo de 353 kilómetros de ríos. Se registro un mínimo de 134 y un máximo de 173 delfines, de 125 observaciones y alrededor de 2000 fotos. Solo 12 (mínimo) a 24 (máximo) de los registrados no fueron identificados, 43 (mínimo) a 57 (máximo) individuos *S. fluviatilis* y 79 (mínimo) a 99 (máximo) individuos *I. Geoffrensis*. La abundancia de delfines a lo largo del extenso es de 0.13 Ind./km para *S. fluviatilis* y 0.25 Ind./km para *I. geoffrensis*. Cada participante ha pasado un promedio de 82 horas de observación. La evaluación de métodos ha revelado que la observación con ayuda de fotografías aumenta la precisión en un 19% y esto lo demuestra como una método ideal para la evaluación de poblaciones en el futuro. Perspectivas y posible costos financieros para la conservación de las poblaciones de delfines de la Amazonia están en discusión.

Key words
Animal conservation, aquatic mammals, dolphin numbers, dolphin research, endangered species, river dolphin populations, pink river dolphin, population size, whale watching.

Fig. 1. *Inia geoffrensis*: Female (left) with half-grown juvenile; mouth of Río Tigrillo (August 1st 2013; GPS position approximately 4°18′44″ S 74°19′26″ W).

Introduction

The global decline in species richness and species diversity has been estimated to affect one to ten percent of worldwide biodiversity over a ten-year period (Wilson, 1993) but it has also been shown that human interaction accelerates extinction events (Chapin *et al.*, 2000; Dawson, 2011). The main forces driving such extinction events are habitat loss, environmental pollution, invasive species and diseases they carry, exploitation of natural resources, and climate change (Wilcove *et al.*, 1998; IUCN, 2013). To manage the effective conservation of a given animal species, an understanding of its habitats and life history is critical. Although many animal species have been described in detail, standardised empirical population data are still lacking. These are necessary to monitor population development and for subsequently determining the level of threat to the species in question, in order to develop and prioritise conservation strategies. This still applies especially to the aquatic species of South America, including all freshwater cetaceans and manatees.

Although some quantitative surveys of the endemic river dolphin species *Inia geoffrensis* (de Blainville, 1817) (fig. 1) and *Sotalia fluviatilis* (Gervais & Deville, 1853) (fig. 2) have been conducted along the Amazon river and lower Río Marañon (Best, 1984; Crespo, 2009; Gomez-Salazar & Trujillo, 2012; Gomez-Salazar *et al.*, 2013), more complex surveys from the Peruvian Río Tigre and middle to upper Río Marañon, tributaries of the Amazon, are still lacking. Both dolphin species are actually listed as data deficient (DD) by the IUCN (Reeves *et al.*, 2013a–b).

Population data for Peruvian river dolphins are urgently needed, as their environmental situation is undergoing dramatic change. Today the Amazon river is the lifeline of the growing human population in the tropical rainforests along its shores, regularly generating conflict potential between humans and river dolphins (Flores & Da Silva, 2009). While the dolphins were protected in the earlier days of human settlement along the river, they are now subject to direct and indirect threats generated by the growing human population. Dolphins are caught, their teeth and bones used as handicraft materials, their genitals and eyes sold as good luck charms in local markets, and their meat (especially of *Inia geoffrensis*) used as bait for large catfish (Brum *et al.*, 2015; Da Silva, 2009; Da Silva *et al.*, 2011; de Sá Alves *et al.*, 2012; Flores & Da Silva, 2009; Gravena *et al.*, 2008; Loch *et al.*, 2009).

Besides hunting, there are more indirect threats to dolphins from environmental changes such as pollution with residual waters, reduction and shifts in food composition due to hydroelectric dams along rivers blocking fish migration and reducing seasonal flooding (Ward & Stanford, 1989; Da Silva, 2009; Reeves *et al.*, 2013; Flores & Da Silva, 2009). These dams are blocking dolphin migration as well, limiting their available gene pool and hence risking localised extinction of the trapped populations (Da Silva, 2009; Evans, 2009; Reeves *et al.*, 2013). In addition to the current planning of a power supply dam in the lower Río Napo north of Iquitos, which may significantly affect the dolphin populations of Loreto, pollution of Peruvian rivers with chemicals from oil drilling and mining has reached critical levels. Dissolved chemicals from oil production and gold mining have repeatedly been reported in recent years throughout the whole Amazon basin (McGuire & Aliaga-Rossel, 2010; Alianza Arkana, 2014). These chemicals include mercury, polycyclic aromatic hydrocarbon (PAH), and polychlorinated biphenyle (PCB), all of which are already being reported in high amounts in river dolphins, causing a high incidence of tumours and lowered reproductive rates (Evans, 2009), or even in quantities close to toxic levels for humans (Rosas & Lethi, 1996). In the year 2015 the Peruvian government has therefore declared large parts of the Amazonian lowlands of Loreto, including the Rio Tigre area, a "National Disaster Area" (Hill, 2010, 2014; Collyns, 2013, 2015; Alianza Arkana, 2014; OCAC-OEFA, 2015, Römer *et al.*, 2015).

Against this background, we have decided to present the basic results of our baseline population survey, as well as first estimations of population densities of *Inia geoffrensis*, commonly known as the bufeo or pink river dolphin, and *Sotalia fluviatilis*, commonly known as the bufeo gris or tucuxi. These data would appear to be essential for developing any reasonable conservation program for the Peruvian Amazon river dolphins.

Fig. 2. *Sotalia fluviatilis*: adult individual of typical habitus jumping in the lower Río Tigre near its junction with the Río Marañon (July 31st 2013; GPS position approximately 4°27′60″ S 74°5′13″ W).

Study area

The study was carried out in the northern Peruvian Amazon Basin (fig. 3) in the department of Loreto. The region around its capital, Iquitos, is characterised by vast demographic growth (Instituto Nacional de Estadística e Informatica, 2015). The river section examined covers approximately 340 kilometres from Nauta to Intuto and includes parts of the courses of the Río Marañon and the Río Tigre.

About 70 kilometres of the Río Marañon and approximately 270 km of the Río Tigre, parts of the lower Río Tigrillo (about 2 km) and the Río Corrientes (about 6 km), and a small number of *quebradas* [1] (near San Antonio and Quebrada Pañayacú) and some oxbow lakes (near the mouth of the Río Corrientes and the small town of St. Helena) along the Río Tigre and the lower Río Corrientes (4 km) were investigated. The only major settlements in this area are the towns of Nauta and Intuto. All other human settlements are villages rarely exceeding 100 adult inhabitants. Some areas have been clear-felled and are used as cattle ranges, others for growing vegetables or fruit. Leaving aside this (still rudimentary) infrastructure, the most important source of protein for human consumption in this region is fish. The rivers Marañon, Tigre, and Corrientes contain white water, while the *quebradas*, the oxbow lakes, and the Río Tigrillo contain black water. In total the stretches of river examined amount to 353 kilometres. Several oil production facilities are located in the so-called BlockA area west of the upper (northern) half of the study area close to the headwaters of the rivers Corrientes and Tigre.

The field study took place from July 30th to August 8th 2013. Observation started at 5:30 am and continued to 6:30 pm local time. Because of the low water levels normal from July to October, the collection of data would generally be comparatively easy, but in 2013 water levels were at least 1.5 metres higher compared to 2012 (Servicio Nacional de Meterología e Hidrología del Perú, 2015a–b).

Observation methods

Most observations took place aboard the historic riverboat Clavero [2], equipped with a 400 HP engine and measuring 28 metres long and 5 metres wide (Bodmer, 2011; Greentracks, 2015), either travelling upstream along the main shipping channel of the rivers investigated at a speed of 4 to 8 km/h, or downstream at a speed of 14 to 16 km/h. The height of the observation decks, approximately 5.5 to 6 metres above water level, was especially advantageous for the river dolphin observations and counts; the resulting height of the standing observer (approximately 6.5 to 7 metres) made for excellent and consistent observation conditions during the survey. Observation from this height permits optimal scanning of the whole width of the river during travel, which would be virtually impossible from lower standing positions. In the event of heavy rain the middle deck was used as an alternative observation base. No sightings were reported during heavy rainfall, which was rare and of only short duration (2 hours in total).

At a few locations observations were also made from the stationary riverboat at anchor. On some smaller rivers and streams observations were carried out from a small speedboat following the same methods, but either standing in the boat or from seats roughly at water level.

[1] Quebradas are small streams or systems of streams along major rivers, and may dry up seasonally.

[2] More historical and technical data about this boat are available at https://www.perunorth.com/clavero/.

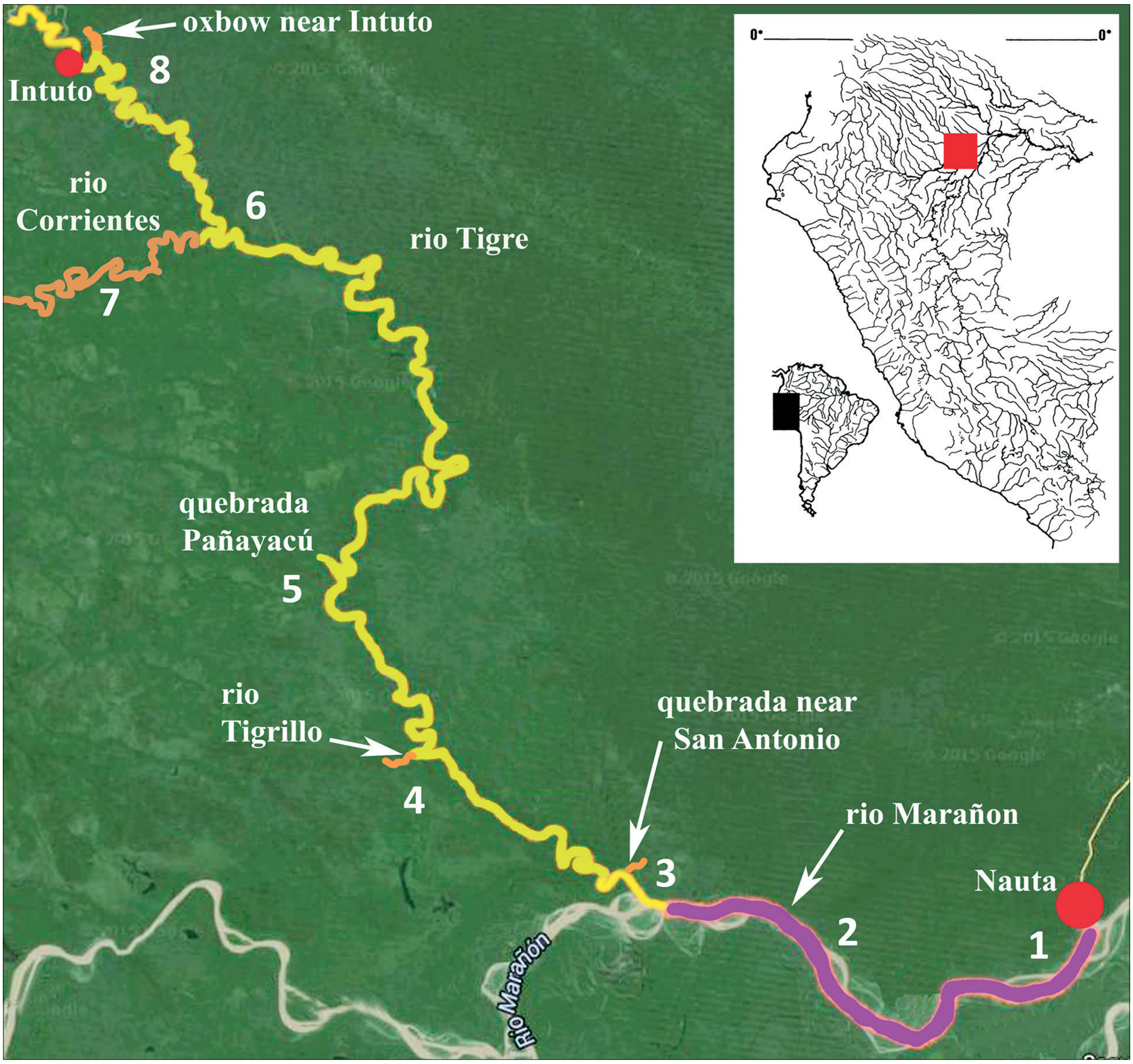

Fig. 3. Location of the study area: Sections of the Río Marañon and Río Tigre investigated, adapted from Landsat Kartendaten 2015: **1**: Starting point at Nauta (Río Marañon); **2**: Río Marañon; **3**: Mouth of Río Tigre; **4**: Junction of Río Tigrillo with Río Tigre (48 hours stopover, speedboat voyage); **5**: Quebrada Pañayacu (speedboat voyage); **6**: Mouth of Río Corrientes; **7**: Lower course of Río Corrientes (speedboat voyage, oxbow); **8**: Large oxbow near settlements of St. Heléna and Intuto (340 km, turning point of expedition).

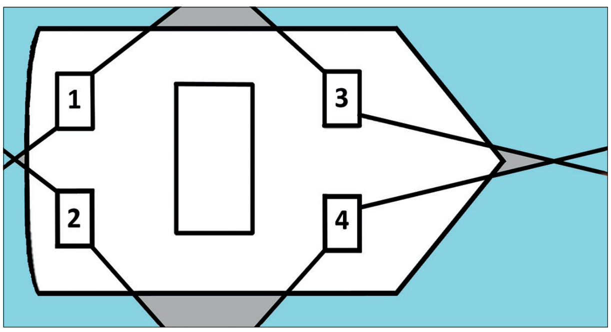

Fig. 4. Stations of observers on the riverboat *Clavero*.

Fig. 5. Observer and photographer at station 3 on the riverboat *Clavero*.

Observations were carried out by 13 people, working in teams of at least four observers and a photographer per individual shift on deck. The on-board positioning of the observers is shown in figure 4. Initially observers 2 and 4 scanned the right-hand side and observers 1 and 3 the left-hand side. From August 3rd on, observers 1 and

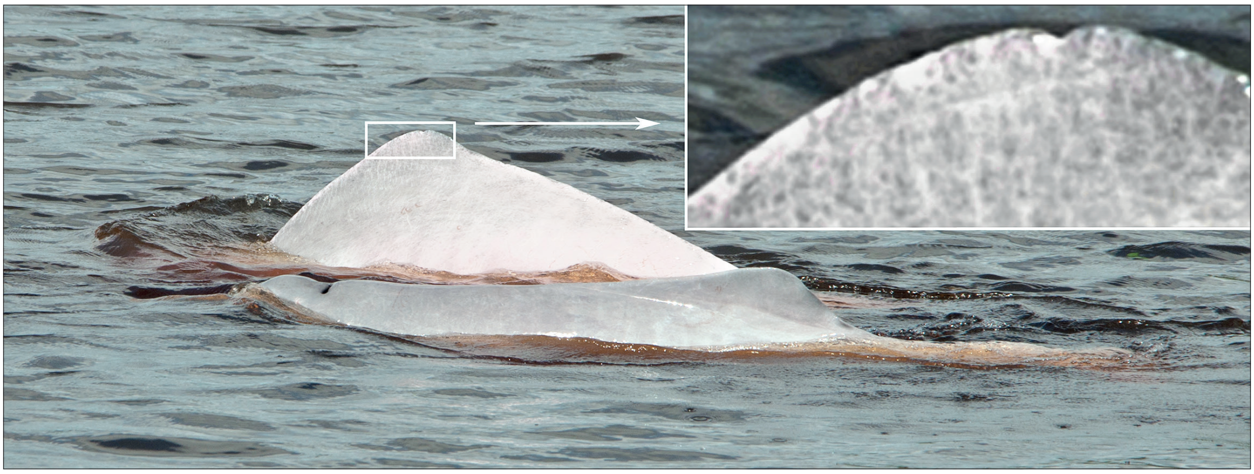

Fig. 6. Example of individual markings in *Inia geoffrensis*: the pattern of vertical stripes, as well as the extent of the pink and grey areas on back and dorsal fin, is highly variable and permits identification of specific individuals (August 2nd 2013; GPS position approximately 4°18′44″ S 74°19′26″ W).

Fig. 7. Example of individual markings in *Sotalia fluviatilis*: damage to the tip of the dorsal fin, as seen in the right-hand dolphin, is commonplace and comparatively easy to detect, and varies in shape, colour, and extent (July 31st 2013; GPS position approximately 4°27′60″ S 74°5′13″ W).

2 observed the water downstream and observers 3 and 4 upstream. Where possible, sightings were checked using binoculars.

Approximately 2000 photographs were taken during the dolphin count and later used for analysis. These photos were taken with the aim of being able to validate observations and to improve the ability of the team members to identify dolphins and, as a result of this, the quality of the data collected. For this reason a photographer was positioned in the middle of the riverboat's observation deck, ready to respond and take photographs of any dolphins sighted (fig. 5). A Nikon D 300, equipped with an AF VR-NIKKOR 80–400 mm 1:4.5–5.6 D telephoto lens and a GPS Sensor (Solmeta-Geotagger), was used for this purpose. Photographs were correlated with individual observations by using the metadata in the picture files. Photographs were saved as highest resolution JPEG and RAW/NEF files for subsequent decoding using software such as GeoSetter.Ink [Version 3.4.16 / © 2011 F. Schmidt; available at http://www.geosetter.de] and Adobe Photoshop CS5 [Adobe Systems Software; San Jose, California, USA]. Photographs were used for daily training sessions for observers every evening after the end of field observations. Whenever availability of photographs of an observation made this possible, the natural markings of dolphins (figs. 6–7) were used for the identification of individuals (see also Gómez-Salazar *et al.*, 2011, 2014). As *Inia geoffrensis* are generally living solitary except females with calves or small groups during mating, they may be more difficult to detect during counts than *Sotelia fluviatilis*. This problem will become more evident during periods with high water levels, as bufeo are entering the drowned forest for hunting, whiles tucuxi stay in the main river channels.

Observations were registered by each observer team on personalised observation sheets, which were successively developed throughout the study. Besides the names of observers and photographer(s), details such as date, time, river, type of boat; GPS data, direction of photo (taken from GPS device), estimated distance between boat and position of dolphin(s) in the river in direction of sighting, height above sea level; species (bufeo, tucuxi, or undetermined dolphin), minimum and maximum number of individuals observed, number of calves, juveniles, and/or adults, behaviour, swimming direction; and meteorological conditions (e.g. cloud cover, precipitation) were recorded on the forms. All forms were photographed in the field and all data transmitted to an electronic data file for the PC program Statistica 6.0 for Windows (StatSoft Inc., Tulsa, USA) immediately after the end of each day's observation activities to prevent accidental data losses.

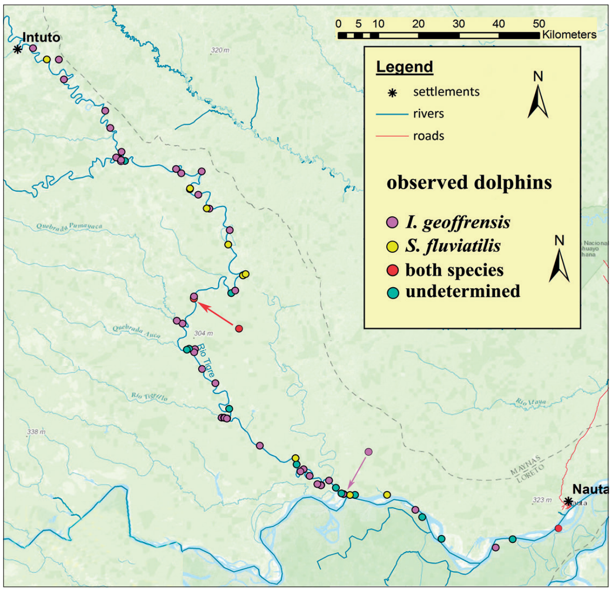

Fig. 8. Species observed during 2013 counts. (identical with species observed travelling upstream).

Results

During this count a minimum of 134 to a maximum of 173 river dolphins were registered along the 353 km section of the river studied (table 1), 131 to 152 during up- or downstream travel, the rest at fixed observation points. Table 2 shows abundances of dolphins observed.

Observation while travelling upstream (table 3) at lower speed was more effective than travelling downstream (table 4): On average 35% fewer dolphins were registered travelling downstream. Since the same area was observed twice and several dolphins were probably sighted twice, only data collected travelling upstream were used for further calculations. We think that the number of dolphins that went unrecorded during counts travelling upstream was extremely low in the main river channel of the Río Tigre. Unlike in studies such as those of Aliga-Rossel (2002) or Gómez-Salazar *et al.* (2011, 2014), in which the observer was positioned about 2 to 2.5 metres above water level, the observation deck in our study was at least 2.5 times higher above water level and permitted optimal scanning of the whole surface of the open water. We probably missed only those individuals that had left the river itself to go fishing in patches of inundated forest close to the mouths of some of the smaller tributaries of the Río Tigre.

Whilst *Inia geoffrensis* were regularly seen along nearly the entire study section of river, significant numbers of *Sotalia fluviatilis* were recorded predominantly in the Río Marañon and the lower course of the Río Tigre (fig. 8). The only exceptions to this distribution pattern were sightings at the junction of the Rio Tigre and the Río Corrientes. This may represent the actual distribution pattern, but on the other hand could be a research artefact caused by identification problems in the field. Sightings of unidentifiable river dolphins occurred mainly in the gap between locations of *Sotalia* sightings in the lower

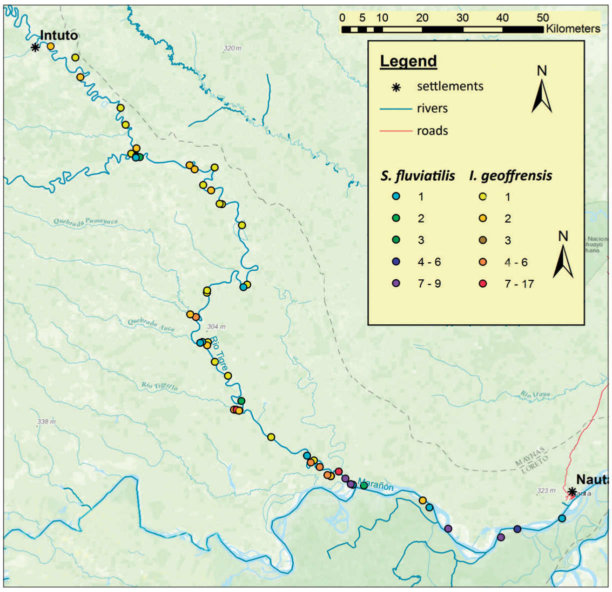

Fig. 9. Group sizes observed (travelling upstream).

course of the Rio Tigre and the mouth of the Río Corrientes. As it cannot be ruled out that a significant number of these sightings were of *Sotalia* individuals not identified as such, the distribution pattern of this species may be more regular than suggested by our data plots.

Individual numbers of both river dolphin species were generally highest in the mouths of rivers, as larger groups of both species were detected here, whilst along the river course in most cases only single individuals were observed. Numbers of *S. fluviatilis* were highest in the Río Marañon, with its abundance (fig. 9) decreasing in the upper section of the study area in the Río Tigre. Group size (fig. 9) of *S. fluviatilis* was higher than that of *I. geoffrensis* in the lower section of the Río Tigre study area.

Table 1. River dolphin sighted in the Río Tigre study area during 2013 travel counts.

Dolphin sightings	*Sotalia fluviatilis*	*Inia geoffrensis*	not determined	total
minimum	43	79	12	134
maximum	50	99	24	173

Table 2. Abundance (n/km) of river dolphins in the Río Tigre study area during upstream travel counts.

	Sotalia fluviatilis	*Inia geoffrensis*	not determined	total
minimum	0.12	0.22	0.03	0.37
maximum	0.14	0.28	0.07	0.49

Table 3. Dolphin sightings travelling upstream.

	Río Marañon (upstream)			
	Sotalia fluviatilis	*Inia geoffrensis*	not determined	total
minimum	23	7	3	33
maximum	30	7	3	40
	Río Tigre (upstream)			
	Sotalia fluviatilis	*Inia geoffrensis*	not determined	total
minimum	18	35	9	62
maximum	18	36	20	74

Table 4. Dolphin sightings travelling downstream.

	Río Marañon (downstream)			
	Sotalia fluviatilis	*Inia geoffrensis*	not determined	total
minimum	10	1	0	11
maximum	10	1	1	12
	Río Tigre (downstream)			
	Sotalia fluviatilis	*Inia geoffrensis*	not determined	total
minimum	4	18	3	25
maximum	4	18	4	26

In the 68 km section of the Río Marañon the abundance of *Sotalia fluviatilis* ranged from 0.34 (min.) to 0.44 (max.) individuals/km, while that of *Inia geoffrensis* was 0.1 individuals/km; nearly 8% of the individuals observed could not be identified.

In the Río Tigre segment the abundance of *Sotalia fluviatilis* was 0.07 individuals/km, while that of *Inia geoffrensis* ranged from 0.15 to a maximum of 0.19 individuals/km; 18% of the dolphins sighted could not be determined to species level.

21 *Inia geoffrensis* were observed during a 2.19 km speedboat voyage along the Río Tigrillo on 1st August (fig. 11). The exclusion of possible duplicated counting left a minimum count of 17 individuals. Examination of photographs revealed a minimum of six different individuals in this blackwater river. During a further 5.6 km speedboat voyage along the Río Corrientes only 3 to 5 individuals of *Inia geoffrensis* were observed.

It was possible to confirm or substantially supplement 17 of 91 sightings in both of the main rivers, Marañon and Tigre, using additional photo identification. In one case erroneous data were corrected. In addition, duplicate sightings were identified using the metadata from the photographs and consequently excluded from further consideration.

In the case of observations made on board the vessel when stationary, photo identification of dolphins using their natural individual markings (figs. 6-7) turned out to be essential. At least six different individuals of *Inia geoffrensis* could be identified with certainty in the blackwater Rio Tigrillo. Two different individuals of *Sotalia fluviatilis* and five of *Inia geoffrensis* (one of which could not be identified with certainty) were determined in the *quebrada* near San Antonio on 8th August 2013.

During observations made from the stationary boat at the mouth of the Río Corrientes, light conditions were extremely bad before and after heavy rainfall, so the majority of photographs taken during this period of observation were of no use for recording the natural markings of dolphins for subsequent identification. Nevertheless it was possible to record seven to a maximum of 17 dolphins, exclusively *I. geoffrensis*.

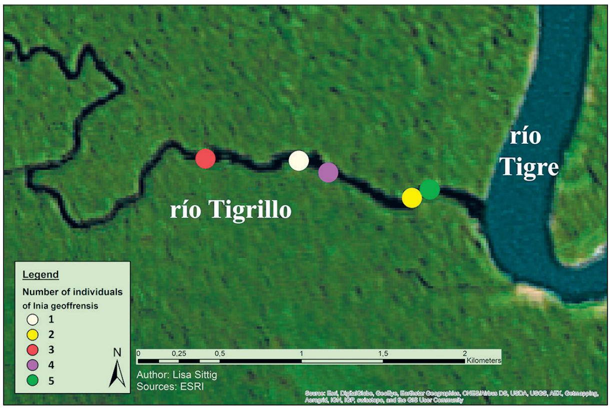

Fig. 10. Sightings of *Inia geoffrensis* in the lower Río Tigrillo.

Counts from the speedboat during a stop on the Quebrada Pañayacú were clearly supported by photographs: a group of four (maximum five) and another group of two individuals of *I. geoffrensis* were seen. The second group may have been part of the first, but four different individuals were identifiable in the photographs and a maximum of seven individuals was recorded.

Discussion

The whereabouts of our observation subjects, the two river dolphin species *Sotalia fluviatilis* and *Inia geoffrensis*, vary within the overall habitat as a result of seasonal flooding. Because of its hunting behaviour, *Inia geoffrensis* in particular is affected by seasonal flooding (Da Silva, 2009; Flores & Da Silva, 2009). During periods of high level waters individuals of this species, other than *Sotalia fluviatilis*, which are preferably hunting in larger groups in open waters, are leaving the main river bed entering the inundated forest searching for prey between twigs and branches of submerged trees and bushes. Tucuxi seem to live more like their marine relatives and are obviously restricted to the main river channels and – evident from literature – hardly ever enter the drowned forest: We were unable to find any report in the available literature mentioning observations of *Soltalia fluviatilis* from flooded forests.

In a study published by Vidal *et al*. (1997), the abundance of *Sotalia fluviatilis* along the main rivers of the Amazon in the border region of Colombia, Brazil, and Peru ranged from 2 to 8.6 individuals per km^2. The calculated average group size was 3.9 individuals. Between 1991 and 2000 McGuire & Aliaga-Rossel determined an average population density of 0.4 individuals per kilometre in the Rio Marañon, while during times of low water levels the density increased to 0.5 individuals/km. With a minimum of 0.12 to a maximum of 0.14 individuals/km, we found significantly lower densities of *Sotalia fluviatilis* in the section of the Rio Tigre studied, but our 0.39 individuals/km in the Marañon were comparable with the findings of McGuire & Aliaga-Rossel. This may be the result of extraordinarily high water levels for the season. According to Bodmer *et al*. (2011), in recent decades the seasonal fluctuations in water levels have been going to extremes never reported before, an opinion broadly confirmed by our own observations from the Peruvian Amazon throughout the last decade.

Best (1984) describes social behaviour in groups of 2 to 6 dolphins. Flores & Da Silva (2009) state that groups consist of female dolphins and calves, as well as males. Gomez-Salazar *et al*. (2011) found that group size varies from 1 to 26 individuals, while larger groups are found at the mouths of rivers. We found groups ranging from 2 to 7 individuals (fig. 11), with larger groups recorded exclusively at the junction of the Rio Tigre with the Rio Marañon and that of the Rio Corrientes with the Rio Tigre. Only single individuals or groups of two were observed in the main channels confirming observations in the study of Gomez-Salazar *et al*. (2011).

McGuire & Aliga-Rossel (2010) report densities of 0.1 individuals of *Inia geoffrensis* per kilometre in the Río Marañon while water levels were rising, and 0.5 individuals/km during falling water levels. We recorded comparable densities of *Inia geoffrensis* in our study, with a minimum of 0.22 to a maximum of 0.24 individuals/km. There are, however, different findings in the literature regarding group size in *Inia geoffrensis*. Best (1984) and Da Silva (2009) argue that *Inia geoffrensis* lives mainly solitary and that groups of 1 to 4 individuals are not permanent, while according to Gomez-Salazar *et al*. (2011, 2012a-b, 2014) group size varies from 2 to 15 individuals. Vidal *et al*. (1997) found an average group size of 2.9 individuals for *Inia geoffrensis* in the border region of Brazil, Colombia, and Peru, while reporting an average of 4.8 individuals per km^2 at the mouths of rivers. According to Gomez-Salazar *et al*. (2012a–c, 2014), larger groups are usually found at the mouths of rivers, and this was also confirmed by our study, where group size for *Inia geoffrensis* ranged from two to a maximum of 17 individuals at the confluence of the Rio Corrientes and the Rio Tigre. The question of whether these groups are permanent or not cannot be adequately answered at present, however. Continuous observation of individual groups and systematic studies of different populations in specific locations and areas would be necessary to resolve this as well as other questions regarding the biology of Peruvian river dolphins.

Conservation status

On the basis of the data presented above, population numbers of Neotropical river dolphins appear to have remained at similar levels in most studies throughout the last decade. This may be of some importance, insofar as it may indicate stable populations, although this might not necessarily be the case in our study area. The comparatively high average numbers of dolphins mainly result from the observation of larger groups in just three locations, all at junctions of rivers (Río Marañon / Río Tigre;

Fig. 11. Group of six jumping *Sotalia fluviatilis* in the lower Río Tigre near its junction with the Rio Marañon (July 31st 2013; GPS position approximately 4°27′60″ S 74°5′13″ W).

Río Tigre / Río Tigrillo; Río Tigre / Río Corrientes). But on the other hand this suggests that dolphin numbers are lower on average in most parts of the rivers, raising the question of why this might be the case.

In this context it is essential to mention that later in 2013 a state of environmental emergency was declared by government officials for the Río Corrientes, Río Tigre, and some other river drainages, because limits for contamination by chemicals such as lead, mercury, barium, and polycyclic aromatic hydrocarbons had been seriously exceeded in the rivers in question as a result of oil-drilling activities in the area of their headwaters (Hill, 2010, 2014; Collyns, 2013; Alianza Arkana, 2014; OCAC–OEFA, 2015). Some of the largest natural oil reserves are situated in geological formations below the border area between Peru and Ecuador (Finer *et al*. 2008). In some well-documented cases the oil companies have not taken even the most basic reparatory action to reduce the environmental impact after oil spills (Hill, 2010, 2014). Instead of full restoration activities only a small amount of work has been carried out using caterpillars to superficially cover polluted areas with uncontaminated soil (Alianza Arkana, 2014). Severe health problems have occurred in the local human population as a result of the toxins polluting the(ir) environment not being removed. These issues had historically been ignored for several decades by officials and the oil companies, but recently the first US oil company has been ordered by a court to compensate the indigenous people of the area for such misbehavior (Collyns, 2015). In 2015 the Peruvian Government has announced the development of a restoration plan and provision of financial help for local indigenous people, but taking real action is still pending until today (OCAC–OEFA, 2015).

It seems highly probable that the severe impact of pollution in the area of the rivers Tigre and Corrientes, as well as in the Marañón and Pastaza region, is not only harming local human populations (Hill, 2014), but also having a major impact on the plant and animal life within its range, including the dolphins. This means that even though available data are insufficient for calculating their total population size or trends, both Peruvian river dolphins are probably suffering from environmental pollution. If tucuxi or pink river dolphin are more affected by environmental pollution in the area investigated is a question still open and urgently needed to be answered, but not of relevance for defining their red list status. Anyway, in consequence of this development the status of both, *Inia geoffrensis* and *Sotalia fluviatilis*, should be regarded by the IUCN as at least potentially if not severely endangered. In our opinion the latter status is more likely to reflect the actual environmental situation. The present status of data deficient (IUCN, 2016) is highly problematic, as it does not allow for such classification. We therefore hope that the results of our study will provide a preliminary set of data that may serve as a basic reference for future studies designed to estimate the population sizes and in particular the current population trends of both species of dolphins in this part of Peruvian Amazonia.

Leaving aside the data available from Gómez-Salazar *et al*., (2011, 2012a, b), Martin *et al*. (2004), and McGuire & Henningsen (2007), additional reliable information about the migration of both *Sotalia fluviatilis* and *Inia geoffrensis* is urgently needed. In addition, further knowledge of the dolphins‘ seasonal or water-level-induced movements (Martin & da Silva, 2004) would appear to be necessary in the context of planning the future structural development of the Amazonian lowlands, and especially Loreto. The human population in the area is one of the fastest-growing in the whole of the Neotropics. Urban expansion, for example, triggers increases in factors directly or indirectly influencing dolphin populations, including land use (habitat destruction), overfishing (competition for food), dolphin hunting (direct losses) (Loch, 2009), as well as human needs for fuel (pollution) and electricity (habitat destruction and/or fragmentation). Plans for the construction of dams to solve the latter need are already in existence (Finer & Jenkins, 2012), but the potential impact of such hydro-electric dams on the survival of populations of aquatic mammals, as well as on numerous other non-mammalian migrant aquatic species, cannot be estimated due to a general lack of technical as well as ecological background information. The effects of dam construction may seriously harm any given aquatic animal population's chances of survival in the area (de Carvalho Freitas *et al*., 2012). For example, permanent fragmentation of populations may sooner or later lead to genetic bottlenecks and loss of haplotypes important for the long-term survival of a given species, and/or to the complete loss of the spawning habitats of migratory species. We should therefore be aware that this new factor, in combination with effects of global warming, may additionally put Amazonian dolphin populations at severe risk in some parts of the Amazonian lowlands.

Working Perspective

In spite of the suggestions by Reeves *et al*. (2003) regarding the actions required to increase our knowledge of populations of Neotropical riverine dolphins, the actual situation is showing surprisingly slow improvement. Most of the studies available deal with populations in major and usually more easily accessible rivers (*loc. cit*.). As mentioned above, the tucuxi and the pink river dolphin are still classified as data deficient in the current IUCN list of endangered species (IUCN, 2016). We have been unable to find any publication presenting data from large-scale synchronized surveys in the Orinoco or Amazon basins, but such surveys would seem to be necessary to create a reliable database for future conservation work on the Amazonian dolphin species.

There is only the initiative of Fernando Trujillo with the South American River Dolphin Protected Area Network (SARDPAN)[1] which in 2006 has started to organize collection of counts of dolphin populations, and has been able to consecutively run expeditions on 23 river sections in the cis-Andean Neotropics. In 2015 SARPAN started the all Amazon River count in Peru from Nauta to the triple frontier with Colombia and Brazil. As Gomez-Salazar *et al*. (2012c) have already shown, river dolphins may be indicators for the degradation of ecosystems and hence environmental quality. For these reasons a joint effort by individuals interested in aquatic mammals, environmental institutions, museums, and/or local universities, as well as national and international NGOs, like initiated by SARPAN is urgently required to carry out a synchronous population survey on at least 10% of the potential distribution area of Amazonian dolphin populations as an important and long overdue step in future conservation work. A single institution will probably be unable to carry out an investigation of this scope. The resulting data would probably representatively reflect dolphin population numbers and facilitate the further studies necessary to monitor population trends.

[3] For detailed information about the SARDPAN-initiative see: sardpan.com

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