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UPDATE ON THE FRESHWATER DISTRIBUTION OF *SOTALIA* IN COLOMBIA, ECUADOR, PERU, VENEZUELA AND SURINAME

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Sotalia dolphins inhabit the Amazon and Orinoco River basins and the Caribbean and Atlantic coasts in Central and South America (Flores and da Silva, 2009). The tucuxi (*Sotalia fluviatilis*) inhabits the Amazon basin, while the Guiana dolphin (*Sotalia guianensis*) inhabits the Caribbean and Atlantic coasts of South America, including some estuarine and riverine areas (Borobia *et al.*, 1991). To date, it is unknown what species inhabits the Orinoco basin (Caballero *et al.*, 2007).

Most of the information on the freshwater distribution of cetaceans that inhabit these areas is derived from incidental sightings and from small-scale, localized surveys. Knowledge of the distribution of wildlife species is necessary to evaluate their conservation status and to monitor possible changes overtime. *Sotalia fluviatilis* is currently listed by the International Union for Conservation of Nature (IUCN) as Data Deficient (Reeves *et al.*, 2008¹²) and the status of *Sotalia guianensis* has yet to be established. *Sotalia* is listed in Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Locally, *S. fluviatilis* is listed as Vulnerable in Colombia (Trujillo *et al.*, 2006), Endangered in Ecuador (Tirira, 2001; Utreras *et al.*, 2001), Data Deficient in Brazil (Ibama, 1997), and Data Deficient in Peru (E. Aliaga-Rossel, pers. comm.). *S. guianensis* is listed as Vulnerable in Venezuela (Bolaños-Jiménez *et al.*, 2008) and its status in Suriname has yet to be established. An update on the distribution of *Sotalia* would improve information useful to the IUCN to list the species into categories of threat and to recommend actions for their conservation (IUCN, 2010).

Our goal in this paper is to review and update the

current distribution of *Sotalia* dolphins that inhabit freshwater in Colombia, Ecuador and Peru, as well as freshwater and estuarine areas in Venezuela and Suriname. This review and update is based on previous research and on information from recent surveys conducted in selected rivers across the Amazon and Orinoco River basins, and in estuarine areas of Suriname. This paper is part of an initiative to establish a network of Freshwater Protected Areas (FWPAs), specifically involving researchers, governments and local communities into the South American River Dolphin Protected Area Network (SARDPAN), whose goal is to investigate the ecological integrity of freshwaters for the conservation of river dolphins in the Amazon and Orinoco River basins in South America (Portocarrero-Aya *et al.*, 2009¹³; 2010).

HISTORICAL DISTRIBUTION RECORDS

We summarize first historical published information regarding the distribution of *Sotalia* in riverine and estuarine habitat. *S. fluviatilis* is distributed in many rivers and tributaries of the Amazon River basin in Brazil, Colombia, Ecuador and Peru at an elevation ranging from 0-300m above sea level (Borobia *et al.*, 1991; da Silva and Best, 1996; Caballero *et al.*, 2007). In the Orinoco River basin, *Sotalia* sp. is distributed in the middle and lower Orinoco River and in the estuaries and lower reaches of many other rivers flowing into the Atlantic Ocean (Borobia *et al.*, 1991; da Silva and Best, 1994; 1996; Bolaños-Jiménez *et al.*, 2008). Although Bolaños-Jiménez *et al.* (2008) included *Sotalia* from the lower and middle Orinoco in their review under the specific name of *S. guianensis*, in the present paper we

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¹³ PORTOCARRERO-AYA, M., HOYT, E., WOOD, A. AND GOMEZ-SALAZAR, C. (2009) Building a network of freshwater protected areas (FWPAs) critical to river dolphins conservation. In Proceedings, 1st International Conference on Marine Mammal Protected Areas. 30 March - 3 April 2009. Maui, Hawaii, USA.

refer to these populations as *Sotalia* sp., on the basis of taxonomic uncertainty (e.g. Cunha *et al.*, 2005; Caballero *et al.*, 2007; Bolaños-Jiménez *et al.*, 2008). *S. guianensis* is distributed along the Caribbean and Atlantic coasts of South America from Nicaragua to Southern Brazil, including some estuarine and freshwater areas of Venezuela and Suriname (e.g. Borobia *et al.*, 1991; Caballero *et al.*, 2007). In this study we would only refer to the populations of *S. guianensis* in Suriname that inhabit riverine and estuarine areas.

Colombia – The first records of *S. fluviatilis* were from the Colombian upper Amazon, close to the city of Leticia (Layne, 1958). *S. fluviatilis* is also distributed in the Caquetá River, downstream from the Córdoba rapids (Trujillo, 1995; Galindo, 1997; Trujillo *et al.*, 2006), in the Putumayo and Apaporis river, and in the Amazon River in adjacent areas such as Loreto-Yacu, El Correo and Tarapoto Lakes and the Amacayacu and Atacuari tributaries (Obregón *et al.*, 1988; Borobia *et al.*, 1991; Beltrán and Trujillo, 1992¹⁴; Trujillo, 1992; 1994; 1997; 2000; Vidal *et al.*, 1997). In the Apaporis River, *S. fluviatilis* is limited by the Estrella and Puerco rapids (F. Trujillo, pers. obs.). There are no corroborated records of *Sotalia* sp. in the Colombian Orinoco. A cranium of *Sotalia* sp. was collected in the town of Amanavén in the middle Colombian Orinoco basin about 15 years ago; however, it is more likely that the cranium was brought from another area where records of *Sotalia* have been corroborated (F. Trujillo, pers. comm.). In addition, locals from the Colombian city of Puerto Carreño have reported the presence of a small dolphin in the Orinoco River, with all the characteristics of *Sotalia* but this has not been verified (F. Trujillo, pers. comm.).

Ecuador – *S. fluviatilis* in the Ecuadorian Amazon have been recorded in the Napo, Pastaza, Bobonaza and Lagartococha Rivers (Borobia *et al.*, 1991; da Silva and Best, 1996; Utreras, 1996; 2001, May-Collado and Wartzok, 2010 this volume), and also in the Cuyabeno River, close to the confluence with the Aguarico River (Herman *et al.*, 1996). A recent review included records from the Putumayo, Guepí, Panayacu, Tiputini, Yasuní, Morona, Mangosiza, Cushuimi, Cangaime, Makuma and Wichimi rivers (Zapata-Ríos and Utreras, 2004; Utreras *et al.*, 2010).

Peru – The first records of *S. fluviatilis*, dating from the 1970s, were from the Amazon River near Iquitos (Kasuya and Kajihara, 1974) and later from the Ucayali, Putumayo and Tigre Rivers (Carvalho, 1961; Grimwood, 1969; Borobia *et al.*, 1991; da Silva *et al.*, 1994; Sokolov *et al.*, 1996). Long term research has been mainly focused in the Pacaya-Samiria National Reserve (Samiria River) (Leatherwood, 1996; Henningsen, 1998; Zuñiga, 1999; Leatherwood *et al.*, 2000; McGuire, 2002; McGuire and

Aliaga-Rossel, 2007; McGuire and Henningsen, 2007; McGuire, 2010 this volume), including the Samiria, Pucate, and Pacaya Rivers, and their associated oxbow lakes and tributaries, as well as the stretch of the Marañón River between the city of Iquitos and the confluence with the Samiria River.

Venezuela – The first records of *Sotalia* dolphins in freshwater were from 130km above the mouth of the Orinoco River in 1800 (von Humboldt, 1852; Hershkovitz, 1963). Subsequently, Osgood (1912) and Pilleri and Pilleri (1982) confirmed the occurrence of *Sotalia* sp. in that region. *Sotalia* have been seen in the river mouth of the Orinoco (Linares, 1998; Romero *et al.*, 2001; Linares and Rivas, 2004), in the rivers that flow into the Atlantic Ocean (Borobia *et al.*, 1991; da Silva and Best, 1994) and across the Orinoco River to the Parguaza rapids (fast-flowing waters) (Boher *et al.*, 1995; Bolaños-Jiménez *et al.*, 2008). In the middle Orinoco, *Sotalia* makes incursions into the Parguaza and Cinaruco Rivers, 1-3km upriver (A. Ferrer-Pérez, pers. obs.).

Suriname – *S. guianensis* in freshwater were first recorded in the locality of the Marowijne River and in the lower parts of main rivers (Hershkovitz, 1963). Also, *S. guianensis* were recorded along the Suriname River, being common near the city of Paramaribo (located ~23km from the river mouth) and were recorded as far up river in the localities of Domburg and Paranam (~39km and ~58km from the river mouth, respectively) (Husson 1978 in da Silva and Best, 1996).

RECENT SIGHTINGS

We now summarize recent sightings obtained from surveys conducted since May 2006 in large rivers of the Amazon and Orinoco River basins in Colombia, Ecuador, Peru, Bolivia and Venezuela (Gómez-Salazar *et al.*, 2009¹⁵, 2011). Six surveys were conducted in different rivers of the Amazon basin (Figure 1). In Peru, surveys were conducted throughout the Samiria, Ucayali and Marañón Rivers, in the vicinity of the city of Iquitos. The most upriver record of *Sotalia* in the Ucayali River was from its confluence with the Marañón River, 160km upriver. In Colombia, surveys were conducted along the Amazon River, including the Loreto-Yacu and Atacuari Rivers and the lakes of Tarapoto, El Correo (Colombia) and Caballo Cocha (Peru). The surveys included the Javari River, a tributary of the Amazon River along the border of Peru and Brazil. *S. fluviatilis* dolphins were seen throughout all of the surveyed Peruvian and Colombian rivers and lakes. In Ecuador, surveys were conducted along the Napo, Aguarico, Cuyabeno, Yasuní and Lagartococha Rivers, but only a few observations of *S. fluviatilis* were recorded

¹⁴ BELTRÁN, S. AND TRUJILLO, F. (1992) Mortalidad incidental y dirigida de *Inia geoffrensis* y *Sotalia fluviatilis* en la Amazonía y Orinoquía colombiana. Page 9 in Abstracts, 5th Reunión de Especialistas en Mamíferos Acuáticos de América del Sur, 28 September - 2 October 1992, Buenos Aires, Argentina.

¹⁵ GÓMEZ-SALAZAR, C., TRUJILLO, F., PORTOCARRERO, M. AND WHITEHEAD, H. (2009) Population estimates of river dolphins in the Amazon and Orinoco basins. Page 95 in Abstracts 18th Biennial Conference Biology of Marine Mammals, 11-16 October 2009, Quebec City, Canada.

in the Cuyabeno and Napo Rivers. Two more surveys were conducted in the Mamoré and Itenez Rivers (Bolivian Amazon) but no *Sotalia* were sighted and there are also no historical records for these rivers (da Silva and Best, 1996).

Three surveys were conducted in the Orinoco River basin (Figure 2). In Venezuela, surveys were conducted in the Orinoco River, starting from the town of Mapire, State of Anzoátegui, going upstream to the city of Puerto Carreño (Colombia) and later starting from the city of Tucupita, State of Delta Amacuro (Venezuela), and ending at the river mouth in the North Atlantic Ocean, across from Trinidad and Tobago. Five channels in this delta were surveyed. *Sotalia* dolphins were recorded in all surveys up to the Parguaza rapids, ~20km away from the border with Colombia (6°41'491"N, 67°6'563"W) and ~800km from the mouth of the Orinoco. The Parguaza rapids do not seem to be a complete natural barrier. In fact, during the rainy season when the water level in the river increases, these rapids almost disappear. In the Colombian Orinoco, surveys were conducted all through the Meta River. *Sotalia* were not sighted and are not historically reported to occur there.

The current distribution of *S. guianensis* in Suriname can be described based on the surveys conducted in the Suriname River estuary by the Dolphin Programme of

the Green Heritage Fund Suriname. *S. guianensis* are distributed in the estuary area of the coast of Suriname and they make incursions into the Suriname River up to ~23km from the mouth of the river (Paramaribo City).

UPDATED DISTRIBUTION

Based on the above review of historical and current records, we present an update of the distribution of *S. fluviatilis* in the Colombian, Ecuadorian and Peruvian Amazon, of *Sotalia* sp. in the Venezuelan Orinoco, and of *S. guianensis* in estuarine and riverine areas of Suriname (Figure 3).

Overall, dolphins of the genus *Sotalia* in freshwater are distributed through most of the Amazon and Orinoco Rivers, some of their main tributaries, and estuaries in the Caribbean and Atlantic coasts in South America. The freshwater distribution of *S. fluviatilis* and *Sotalia* sp. in the middle Orinoco is limited by shallow waters, large rocks, waterfalls, small channels and rapids, such as the rapids at the western upper Amazon, and in other areas like the Cordoba rapids in the Caquetá River, the Estrella and Puerco rapids in the Apaporis River (Colombia), and the Parguaza rapids in the middle Orinoco (Venezuela). Thus, *Sotalia* dolphins do not reach the Bolivian Amazon or the Colombian Orinoco.

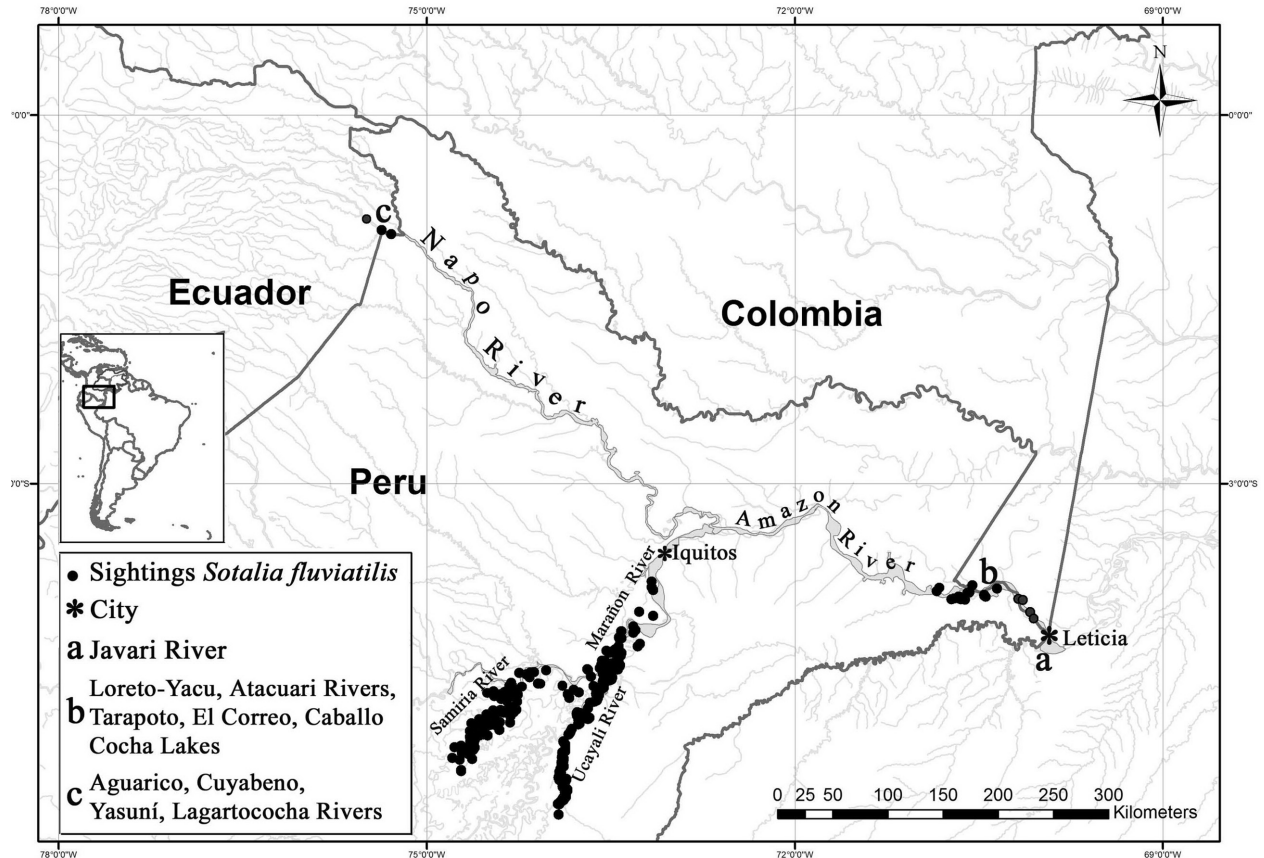


Figure 1. Sightings (2006–2009) records of *Sotalia fluviatilis* in the Colombian, Ecuadorian and Peruvian Amazon basin.

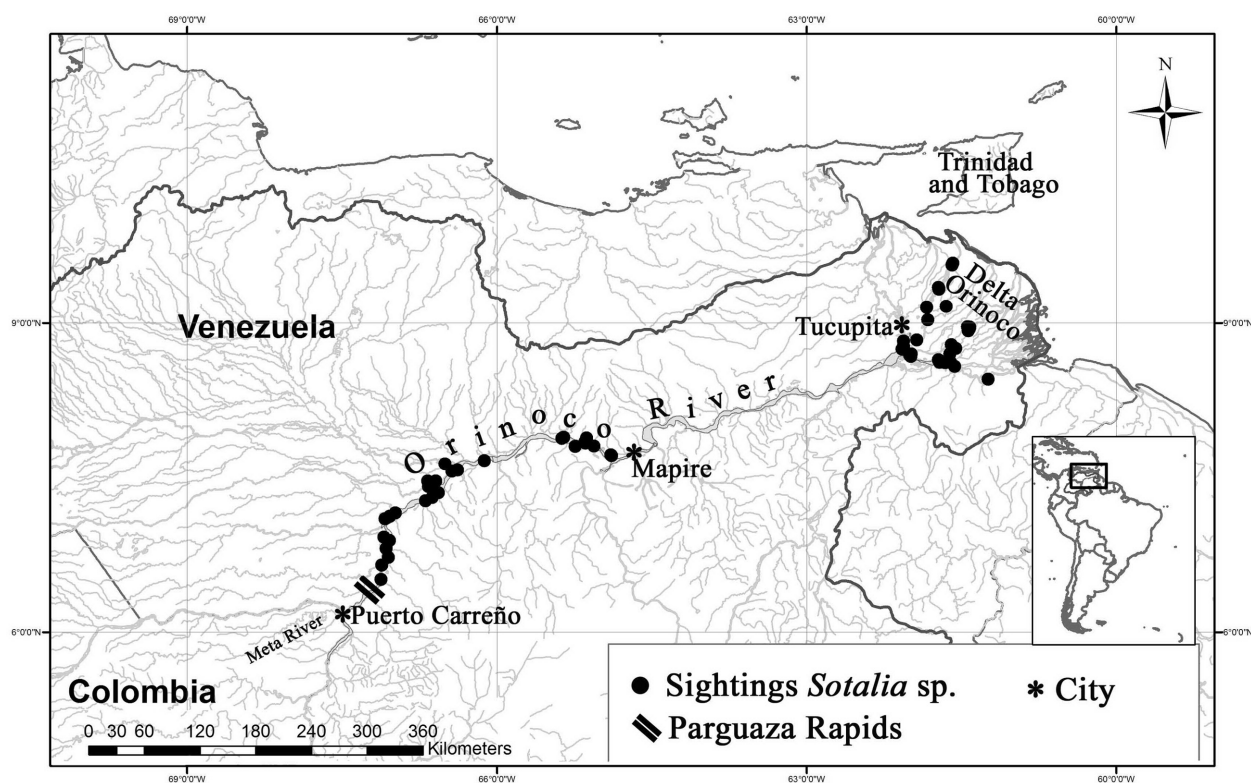


Figure 2. Sightings (2006–2009) of *Sotalia* sp. in the Venezuelan Orinoco basin.

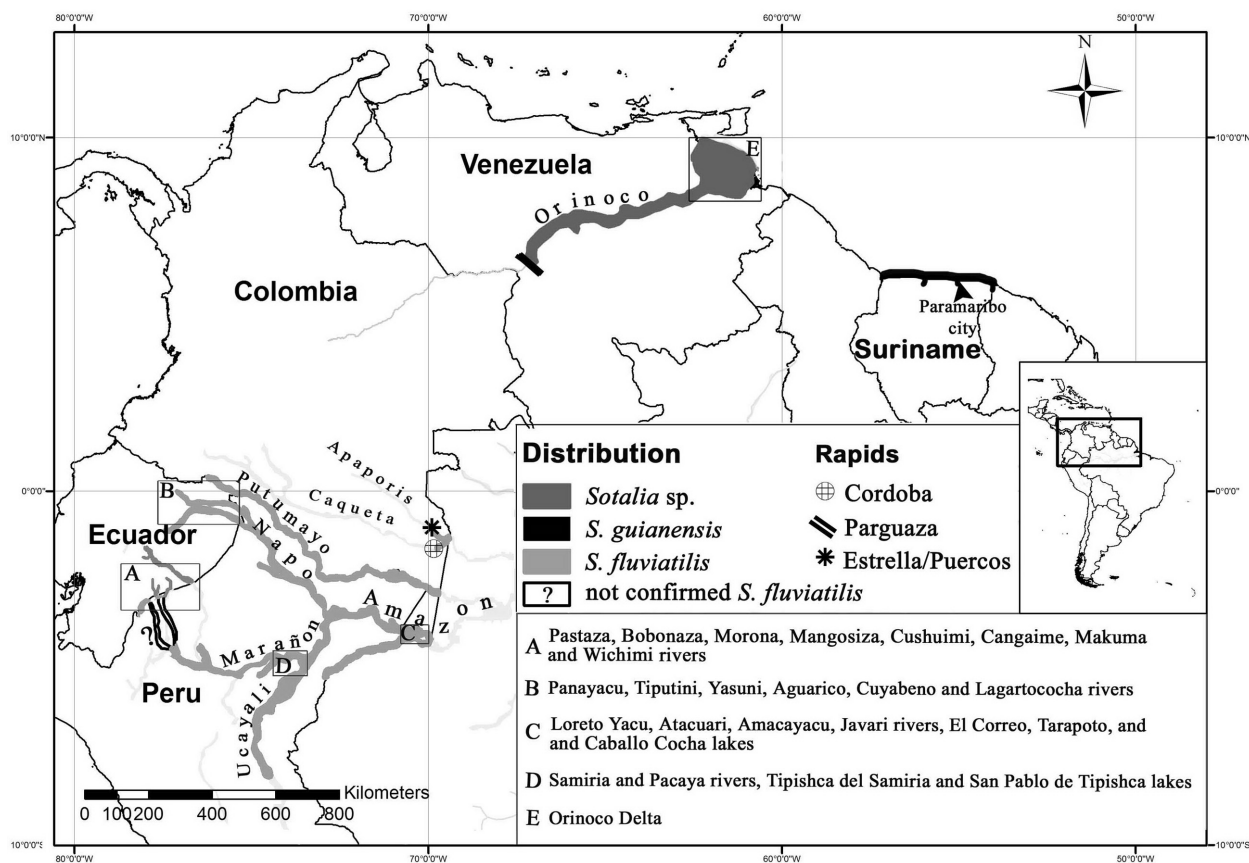


Figure 3. Distribution of *Sotalia* in the Amazon (Colombia, Ecuador, Peru), Orinoco (Venezuela) and Suriname.

Amazon River basin - *S. fluviatilis* is distributed throughout the Ucayali River in Peru, considered the main headwater of the Amazon River, and its confluence with the Marañón River, where the Amazon River begins. *S. fluviatilis* is also distributed through the Pacaya-Samiria National Reserve, including the Samiria and Pacaya rivers and lakes such as Tipishca del Samiria and San Pablo de Tipishca. There are also records of *Sotalia* from the Marañón River and from its major tributaries that flow southeasterly from Ecuador: the Pastaza, Morona, Tigre and Napo rivers. The Pastaza River and its tributary, the Bobonaza River, are located in the southern Ecuadorian Amazon. There are some records in the Morona River, parallel to the Pastaza, and several of its tributaries (the Mangosiza, Cushuimi, Cangaime, Makuma and Wichimi rivers). Finally, fewer records of *S. fluviatilis* occur in the Napo River in northern Ecuador, and some of its tributaries such as the Panayacu, the Tiputini, the Yasuní and the Aguarico (which receives the Cuyabeno and Lagarto Cocha Rivers). *S. fluviatilis* is distributed widely throughout the Amazon River as it flows through the southernmost region of Colombia, receiving the Loreto Yacu (El Correo and Tarapoto Lakes), Atacuari, and Amacayacu tributaries and the Caballo Cocha Lake on the border with Peru and the Javari River on the border of Peru and Brazil. In addition, *S. fluviatilis* is distributed in southwest Colombia in the Putumayo and Caquetá rivers along the border of Ecuador and Peru. The Putumayo and Caquetá Rivers are main tributaries flowing southeast into the Amazon River in Brazil, where their names change to Içá and Japurá, respectively. The most northwestern records of *S. fluviatilis* in the Amazon River basin are from the Apaporis River, a tributary of the Caquetá River in Colombia.

Orinoco river basin - *Sotalia* sp. is distributed across the Orinoco River (middle and lower Orinoco basin) in Venezuela, beginning 20km from the border of Colombia where the Parguaza rapids are formed, ~815km away from the river mouth. In the middle Orinoco basin, *Sotalia* is distributed 1-3km upriver from the Parguaza and Cinaruco Rivers (major tributaries of the Orinoco River). In the lower Orinoco basin, *Sotalia* (possibly *S. guianensis*) is found in the river mouth where the Orinoco River forms a wide delta that creates hundreds of tributaries and channels that flow northeast into the North Atlantic Ocean.

In Colombia, *Sotalia* dolphins are not present in the upper and middle Orinoco basin south of the confluence with the Meta River in waters shared by Colombia and Venezuela. Therefore, the closest *Sotalia* population is from coastal areas of the Atlantic Ocean (*S. guianensis*) (Caballero *et al.*, 2007). *Sotalia* in the Orinoco River were previously thought to be *S. guianensis* making incursions of up to 800km upriver (Borobia *et al.*, 1991; Boher *et al.*, 1995; Trujillo *et al.*, 2000; Caballero *et al.*, 2007; Bolaños-Jiménez *et al.*, 2008). However, *S. guianensis* is significantly larger than *S. fluviatilis* (Flores and da Silva, 2009) and individuals from the middle Orinoco appear to be smaller

than individuals in the delta of the Orinoco. In terms of morphology, individuals observed in the middle Orinoco in Venezuela have a dorsal fin that has a more slender base, more similar to their counterparts in the Amazon basin, than to *S. guianensis* in the lower Orinoco. *Sotalia* observed in the lower Orinoco (at about 12-15km upriver from the Atlantic Ocean) have a wider dorsal fin base, do not have pink coloration patterns in their flanks, and their eyes appear to be bigger than *S. fluviatilis*, and more similar to *S. guianensis* (Figure 4). We suggest that *Sotalia* dolphins in the Orinoco delta in Venezuela are in fact *S. guianensis* making incursions into the river. Genetic and morphological studies are urgently needed to clarify whether populations in the middle Orinoco of Venezuela are coastal transients making incursions into the river or part of a population that entered via the Amazon to the Orinoco (Borobia *et al.*, 1991; Boher *et al.*, 1995; Cunha *et al.*, 2005; Caballero *et al.*, 2007) or perhaps another subspecies or species altogether.

Differences in the colouration patterns between *Sotalia* species are interesting and worth investigating. *S. fluviatilis* in the Amazon River basin are light grey and their flanks vary from white to pink that continues through their abdomen (da Silva and Best, 1996; Figure 4). *S. guianensis* in Suriname are light grayish-blue to dark grey and also have flanks that vary from pink to light pink and white. However, the colour in their flanks appears to continue through to their abdomen. This is in contrast to *S. fluviatilis* in the Amazon, which have a grey streak in between the light coloration of their flanks (Figure 4). *Sotalia* dolphins in the lower Orinoco do not appear to have any pink in their flanks, and *Sotalia* dolphins in the middle Orinoco have some pink colour in their flanks.

Suriname - Currently, *S. guianensis* in the Suriname River has only been recorded up to ~23km up from the river mouth (Paramaribo city), much less than the ~58km upriver previously recorded by Husson (1978) in da Silva and Best (1996). It is of serious concern that pollution from Paramaribo city may be one of the factors causing this restriction in their movements (M. Pool, pers. comm.). *S. guianensis* is also recorded in the Commewijne River (~38km from the Suriname River mouth) and they are occasionally seen up to the locality of Bakkie during the long dry season. In addition, there are reports of *S. guianensis* in the Corantijn River, the Marowijne and the Coppename Rivers. Overall, *S. guianensis* only swim upriver during the dry season when the saltwater incursion is further upriver and the salinity of the water is high enough.

FINAL REMARKS

We think that the results of this compilation of available information on the distribution of *Sotalia* in freshwater of Ecuador, Peru, Colombia, Venezuela and Suriname are useful for identification of some of the major natural barriers for this species, and provide a baseline for monitoring future changes in their geographic range.

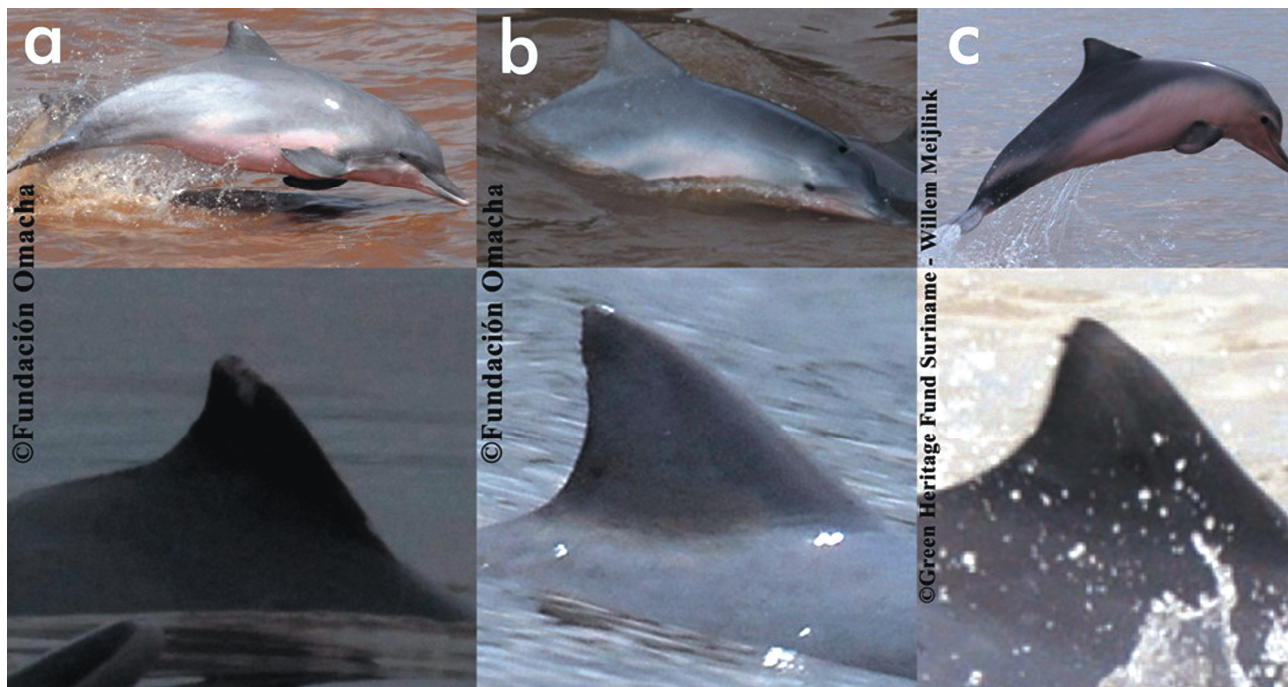


Figure 4. Colouration patterns and dorsal fins of a) *Sotalia fluviatilis* in the Amazon River (Colombia), b) *Sotalia* sp. in the delta of the Orinoco River (Venezuela) and c) *Sotalia guianensis* in the estuary of the Suriname River.

The current distribution of *S. fluviatilis* in the Colombian and Peruvian Amazon basin has not changed compared to historical records. The distribution of *S. fluviatilis* in the Ecuadorian Amazon needs to be assessed in more detail. It is of serious concern that the sighting rate was much lower during the recent surveys in the Ecuadorian Amazon compared to other locations studied. Also, the current and increasing effects of water pollution by oil industry, noise pollution, and other forms of habitat degradation in the western areas near the Andean mountains are of concern (Utreras, 2001; Utreras *et al.*, 2010). The distribution of *S. guianensis* in the Suriname River appears to be changing, with dolphins not moving as far upriver as previously reported. Whether these changes are related to high levels of pollution from the city, or other causes, should be investigated. A long-term monitoring program in these areas is highly recommended. In addition, we present current information that suggests that *Sotalia* in the middle Orinoco River may be more similar, morphologically at least, to *S. fluviatilis* in the Amazon than to *S. guianensis* in the delta of the Orinoco and along the coast. We recommend genetic studies to identify what species use the middle and lower Orinoco basin in Venezuela.

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