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Encounter rates of the Bolivian river dolphin (*Inia boliviensis*) in northeastern Bolivia

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The river dolphin genus *Inia* is distributed along the Orinoco and Amazon basins, with three species, *I. geoffrensis*, *I. boliviensis* and the recently described *I. araguaiaensis* (Best and da-Silva, 1993; Hrbek *et al.*, 2014). The Bolivian bufeo (*Inia boliviensis*) is distributed in the region between the Fortaleza del Abuna and the Teotonio rapids, as well as in the rivers of the upper basin of the Madeira River in the Bolivian province of Beni (Mamoré and Iténez). However, the connectivity of these populations is low and asymmetrical (Best and da Silva, 1993; Gravena *et al.*, 2014; 2015). To reflect the distinctness of *Inia* in Bolivia, we hereafter refer to it by the local name of 'bufeo'; the current IWC-designated common name of 'boto' has Portuguese origin and is not used in Bolivia (Aliaga-Rossel *et al.*, 2006). The bufeo is the only cetacean species present in Bolivia, and knowledge about its population status is increasing by published studies (Aliaga-Rossel, 2002; Aliaga-Rossel *et al.*, 2006; 2012; Aramayo, 2010; Gomez-Salazar *et al.*, 2011; Guizada, 2011; Morales, 2012; Salinas, 2007).

In response to the recommendations of the Regional Action Plan for the Conservation of River Dolphins in South America[1] and the National Action Plan for the Conservation of the Bolivian bufeo[2], studying the distribution of this species is a high priority for Bolivia. This study includes areas previously not surveyed (Negro, Itonámas, Blanco and Cocharcas rivers) and therefore contributes new insights to the distribution of the species.

This study was conducted within the biogeographic province of Beni, located mostly in the alluvial flood plain. This province of Bolivia has a very distinct pluviseasonal climate with an average annual rainfall of 1700mm and an average annual temperature of 26°C, which is accentuated in the northern portion of the department of Beni. The dominant vegetation is herbaceous and wooded groves, and seasonal floodplain forests with gallery forest on both sides of the rivers (Navarro, 2002). The region has different hydro-climatic seasons: low or dry water season (between August and October); rising water (the end of October and December); high or wet water season (January to early March); falling water or wet-dry transition (April to the beginning of July).

Surveys were conducted in five tributaries of the Iténez river: the Negro and Blanco rivers during the dry season (August 2012); Itonámas and Machupo rivers during the wet season (February 2013) and the wet-dry transition season (July 2014); and Cocharcas river during the wet-dry transition season (April 2015) (Figure 1).

Since these tributaries have a constant average width of 65 meters, the standardized 100% strip-width transect method commonly used for river dolphin studies was applied (da Silva, 1994; Aliaga-Rossel, 2002; McGuire, 2002; Gomez-Salazar, 2004; Martin and da Silva, 2004; Bashir *et al.*, 2010; Mosquera-Guerra *et al.*, 2015). The survey was carried out from a small vessel (eight to ten meters of length) powered by 40hp outboard engine traveling at a constant speed between 7-9km/h. Two observers and one data recorder were located at the bow, 2.5m above water level. Double counts were avoided by direct communication between the two observers and the recorder. For each sighting, time, location coordinates, and

[1]Trujillo, F., Crespo, E., Van Damme, P. and Usma, J., Eds (2010) *The Action Plan for South American River Dolphins 2010 – 2020*. Bogota, Colombia.
[2]MMAyA (2012) *Plan Nacional para la Conservación del Bufeo boliviano* (Inia boliviensis) *(2012-2016)*. Cochabamba, Bolivia.

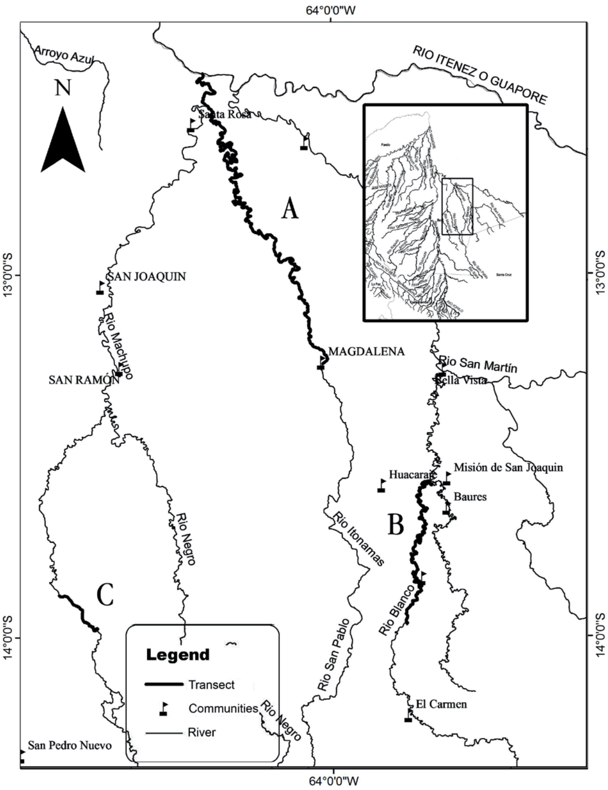

Figure 1. Study area, systems Itonámas-Machupo (A), Negro-Blanco (B) and Cocharcas (C). Department of Beni (Bolivia).

vessel speed were recorded using a GPS. The width of the river at the sighting location was measured with the help of a laser rangefinder and information on the river characteristics (main channel, confluence, meander) were recorded. Surveys were conducted from 07:00h and 17:00h with a one-hour break at noon. In case of unfavorable weather conditions (strong winds, waves or rain), the transect was suspended until optimum climatic conditions returned (Aliaga-Rossel *et al.*, 2006). To correct any possible miscounting, we used two routes (upstream and downstream) and selected the route with more sightings.

The observers searched for dolphins in front of the boat and along either side of the boat, covering 180°. Snorting sounds offered audible clues for visual confirmation. Every detection of one or more individuals was considered as one sighting. A group was defined as the total number of dolphins observed during a sighting within an estimated 15 to 20m radius of the boat. This definition differs from the conventional definition of a group, and does not imply anything about the social cohesion or interactions of the observed dolphins (McGuire, 2002; Aliaga-Rossel *et al.*, 2006). In addition to the number of dolphins, their age group was recorded according to relative size in the following way: adults had a total length (snout to tail) between 1.5 to 2.5m, and were whitish, pink, or grey with patterns of shades of pink. Calves were less than 1m total length, were uniform gray in color, had very short beaks, and were always accompanied by an adult. The criteria employed to define age class is subjective due to the difficulty in estimating the size of a dolphin in the water. All of the lengths were visually estimated, and the designation of adult or juvenile does not necessarily indicate sexual maturity or immaturity (Aliaga-Rossel, 2002). To reduce the probability of recounting the same dolphin, the observers only turned to the rear of the boat for confirming the number and size classes of dolphins they detected in front of or alongside the boat. When observers were unable to determine the exact number of individuals present, the lowest reliable count was recorded (McGuire and Winemiller, 1998; Aliaga-Rossel, 2002).

The encounter rates were calculated as the quotient of the number of observed-detected bufeos and the kilometers traveled in each aquatic system (n/l; were *n* is the number of bufeos and *l* is the transect length). For analysis of representation by season and type of habitat, the data were grouped into river systems based on the time of sampling, uniting those sampled in the same season.

The encounter rate ranged from 0.13 to 2.7bufeos/km on river systems, and the group sizes apparently increased during periods of transition (Tables 1 and 2). Sightings focused on the habitat of the main river channel more than confluences or meanders (river curves): in the Blanco/Negro river system 80% in main river, 20% in confluences (dry season); in the Itonámas/Machupo river system, 82.49% in main river, 4.52% in meanders and 12.99% in confluence (wet-dry season).

There was a marked difference in encounter rates in the Itonámas and Machupo rivers for two different seasons with 0.66-2.7 bufeos/km during the transition season and 0.27-0.24 bufeo/km during wet season, respectively. This difference in a single system can be attributed to seasonal habitat use of the species as mentioned by McGuire and Aliaga-Rossel (2007) who argue that during the rainy season the river is wider, resulting in more area for dolphins and their prey to disseminate in, as opposed to the low-water season, when they tend to be more concentrated in the main channel. This characteristic is true in several other river systems (Gomez-Salazar *et al.*, 2011; Aliaga-Rossel *et al.*, 2012; Guizada and Aliaga-Rossel, 2016).

On the other hand, the results of the Blanco river (0.13 bufeo/km) show values closer to the values of Painter (1994), 0.16 bufeo/km in the Blanco River but not to Salinas (2007), who reported 1.6 bufeo/km; and the values in the Negro River vary significantly from those of Salinas-Mendoza *et al.* (Trujillo *et al.*, 2010) (1.5 bufeo/km vs 0.2 bufeo/km this study). These differences could be attributed to the sampled river segment and the season (which is proposed as a non-homogeneous distribution); as an example, if the sampling was during a dry year, this could overestimate the value. However, it should be highlighted that rivers within the Iténez Departmental Park and Natural Area of Integrated Management had a positive impact in preventing massive

Table 1. Observation of bufeos in each Bolivian river sampled. Encounter rates by length of transect (individuals/km). Average and maximum group size for each season.

River	Season	Bufeos	Kilometers traveled	Encounter rate (#/km)	Mean group size	Maximum group size
Negro	Dry	3	2	1.5	1	1
Blanco	Dry	11	85.35	0.13	1.1	2
Itonámas	Wet	50	182.28	0.27	1.25	5
Machupo	Wet	5	20.76	0.24	1.2	3
Itonámas	Wet-dry	121	182.28	0.66	1.2	7
Machupo	Wet-dry	56	20.76	2.7	1.7	15
Cocharcas	Wet-dry	19	110	0.17	1.9	4
TOTAL	265	603.43				

Table 2. Bufeo group size percent in each river system in Bolivia with its respective season.

River system	Season	Singles (%)	Couples (%)	Trios (%)	> 3 (%)
Blanco/Negro	Dry	92.3	7.7	0	0
Itonámas/Machupo	Wet-Dry	80	16.9	0.8	2.3
Cocharcas	Wet	50	30	0	20

indiscriminate hunting and fishing because of the work of awareness conducted by an international NGO[3]; this might have an impact in the healthy bufeo populations in this area.

Compared to the encounter rates estimated in all the surveyed rivers to date in Bolivia, the estimation for the Itonámas, Machupo and Cocharcas rivers during the transitional wet to dry season is comparable to the estimations for Niquisi River (0.75 bufeo/km) during the same season (Aliaga-Rossel *et al.*, 2012). The Niquisi River and the rivers of this study not only have similar conservation characteristics and high rates of encounter, they are also relatively well-preserved and contain healthy populations of bufeos.

Although most of the encounters were in the main channel as opposed to confluences and meanders, these latter habitats have larger group sizes. Similar observations were described by other studies (Aliaga-Rossel, 2002; Aliaga-Rossel *et al.*, 2006; Gomez-Salazar *et al.*, 2011; Guizada and Aliaga-Rossel, 2016) that concluded that prey density at confluences is higher due to fish becoming disoriented. This increases the benefit to the dolphins to a lower energy cost, leading to the maintenance and support of larger groups (Best and da Silva, 1993; Aliaga-Rossel *et al.*, 2006).

During the sampling period, the proportion of groups encountered increased between seasons (Table 2), showing that couples, groups of three, or greater than three individuals during seasons of wet-dry transition and high water season are more frequent than during the dry season. During this season, the bufeos and their prey do not disperse solely into flooded areas. Most of them occupy tributaries and lagoons, which have special characteristics as areas with less flow in their bends and meanders, as well as the absence of human activities like boat traffic.

One possible explanation is that the flooded season causes relatively shallow areas with comparatively slow water flow, representing an optimum nursery location for the presence of calves and juveniles. This was observed in other tributaries of the basin of the Mamoré with groups of up to 20 individuals (Aliaga-Rossel, unpublished data) and more than 20 in Colombia for *Inia geoffrensis*[4]. Conversely, during descending and low water season (observed in the Negro and Blanco rivers), the whole group is concentrated in the main channels, causing a forced migration, and a possible increase in the competition cost for resources, further instigating a sexual or group segregation into different habitats (Aliaga-Rossel *et al.*, 2006; McGuire and Aliaga-Rossel, 2007; Guizada and Aliaga-Rossel, 2016).

Encounter rates for bufeo in the Itonámas and Machupo rivers (maximum of 0.66 bufeo/km in 182km approx.) are relatively high compared to other rivers in Bolivia. Since the proportion of pairs and larger groups increased during transition seasons in this study period, it is necessary to focus greater study efforts during the breeding season to contribute to conservation measures. This is especially important due to

[3]Vaca, C. and Perez, R. (2006) *Plan estratégico de protección del Parque Departamental y Área Natural de Manejo Integrado Iténez*. WWF-Bolivia.

[4]F. Trujillo, pers. comm., 2015

current unpredictable environmental fluctuations in the area such as flooding or drought (Aliaga-Rossel and Quevedo, 2011).

The threats to the species are numerous, such as conflicts with fisheries, pollution in rivers, dams (Aliaga-Rossel, 2010), including the effects of climate change on the ecosystem and the negative effects on populations of dolphins in the country, warned by Aliaga-Rossel and Quevedo (2011). Extreme droughts, like the one recorded in 2012 (and possibly 2017), and increasingly frequent extreme floods (2013, 2014, and 2015) in Bolivia are phenomena that should not be ignored for Bolivian river dolphin population conservation.

As the population dynamics of the bufeo are still unknown, it is important to continue with long-term studies that relate to the species habitat preference and seasonal migration. These data are usually the starting point for projections and/ or estimates of abundance of the species for the country, which influences decision-making for conservation.

This study provides information on seasonal distribution patterns for river dolphins in Bolivia. These observations should be used to inform national river dolphin conservation initiatives to further preserve them in the northern region of the country.

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References

Aliaga-Rossel, E. (2002) Distribution and abundance of the river dolphin (*Inia geoffrensis*) in the Tijamuchi River, Beni, Bolivia. *Aquatic Mammals* 28(3): 312-323.

Aliaga-Rossel, E. (2010) Conservation of the river dolphin (*Inia boliviensis*) in Bolivia. Pages 55-70 *in* Ruiz-Garcia, M. and Shostell, J. (Eds) *Biology, Evolution and Conservation of the River dolphins in South America and Asia: Unknown dolphins in danger*. Nova Publishers, New York.

Aliaga-Rossel, E., McGuire, T. and Hamilton, H. (2006) Distribution and encounter rates of the river dolphin (*Inia geoffrensis boliviensis*) in the central Bolivian Amazon. *Journal of Cetacean Research and Management* 8(1): 87-92.

Aliaga-Rossel, E. and Quevedo, S. (2011) The Bolivian river dolphin in the Tijamuchi and Ibare rivers (upper Madeira Basin) during rainy season in a "La Niña" event. *Mastozoología Neotropical* 18(2): 293-299.

Aliaga-Rossel, E., Guizada, L., Beerman, A., Alcocer, A. and Morales, C. (2012) Distribución y estado poblacional del bufeo boliviano (*Inia boliviensis*) en cuatro ríos tributarios de la subcuenca del Río Mamoré. *Ecología en Bolivia* 47(2): 134-142.

Aramayo, P. (2010) *Distribución y abundancia del bufeo* (Inia boliviensis) *en el río Yacuma, Beni, Bolivia.* B.Sc. Thesis. Universidad Mayor de San Andrés, La Paz, Bolivia. 70 pp.

Bashir, T., Khan, A., Gautam, P. and Kumar Behera, S. (2010) Abundance and prey availability assessment of Ganges dolphin (*Platanista gangetica gangetica*) in a stretch of Upper Ganges river, India. *Aquatic Mammals* 36: 19-26. https://doi.org/10.1578/AM.36.1.2010.19

Best, R. and da Silva, V. (1993) *Inia geoffrensis*. *Mammalian Species* 426: 1-8. https://doi.org/10.2307/3504090

da Silva, V. (1994) *Aspects of the biology of the Amazonian dolphin genus* Inia *and* Sotalia fluviatilis. Ph.D. Dissertation. University of Cambridge, England. 327 pp.

Gomez-Salazar, C. (2004) *Estimación de abundancia del delfín de río* Inia geoffrensis *utilizando el método de captura-recaptura, en el lago de Caballo Cocha, Perú.* B.Sc. Thesis. Universidad de Los Andes, Bogotá, Colombia. 168 pp.

Gomez-Salazar, C., Portocarrero-Aya, M. and Whitehead, H. (2011) Population, density estimates and conservation of river dolphins (*Inia* and *Sotalia*) in the Amazon and Orinoco river basins. *Marine Mammal Science* 28(1): 124–153. https://doi.org/10.1111/j.1748-7692.2011.00468.x

Gravena, W., Farias, I.P., da Silva, M.N.F., da Silva, V.M.F. and Hrbek, T. (2014) Looking to the past and the future: were the Madeira River rapids a geographical barrier to the boto (Cetacea: Iniidae)? *Conservation Genetics*. https://doi.org/10.1007/s10592-014-0565-4

Gravena, W., da Silva, V.M.F., da Silva, M.N.F., Farias, I.P. and Hrbek, T. (2015) Living between rapids: genetic structure and hybridization in the botos (Cetacean: Iniidae: *Inia* spp.) of the Madeira River, Brazil. *Biological Journal of the Linnean Society* 114(4): 764–777. https://doi.org/10.1111/bij.12463

Guizada, L. (2011) *Abundancia y distribución de* Inia boliviensis *en el río Mamoré y su implicancia en la conservación.* B.Sc. Thesis. Universidad Mayor de San Andrés, La Paz, Bolivia. 54 pp.

Guizada, L. and Aliaga-Rossel, E. (2016) Population data of the Bolivian river dolphin (I*nia boliviensis*) in Mamore River, Upper Madeira Basin. *Aquatic Mammals* 42(3): 330-338. https://doi.org/10.1578/AM.42.3.2016.330

Hrbek, T., da Silva, V.M.F., Dutra, N., Gravena, W., Martin, A.R. and Farias, I.P. (2014) A new species of river dolphin from Brazil or: how little we know our biodiversity. PLOS ONE 9(1): e83623. https://doi.org/10.1371/journal.pone.0083623

Martin, A. and da Silva, V. (2004) River dolphins and flooded forest: seasonal habitat use and sexual segregation of botos (*Inia geoffrensis*) in an extreme cetacean environment. *Journal of Zoology, London* 263: 295-305. https://doi.org/10.1017/S095283690400528X

McGuire, T. (2002) *Distribution and abundance of river dolphins in the Peruvian Amazon.* Ph.D. Dissertation. Texas A&M University, USA. 233 pp.

McGuire, T. and Aliaga-Rossel, E. (2007) Seasonality of reproduction in Amazon river dolphins (*Inia geoffrensis*) in three major river basins of South America. *Biotropica* 39(1): 129-135. https://doi.org/10.1111/j.1744-7429.2006.00221.x

McGuire, T. and Winemiller, K.O. (1998) Occurrence patterns, habitat associations and potential prey of the river dolphin, *Inia geoffrensis*, in the Cianuco river, Venezuela. *Biotropica* 30: 625-638. https://doi.org/10.1111/j.1744-7429.1998.tb00102.x

Morales, C. (2012) *Abundancia relativa de bufeo* (Inia boliviensis) *a lo largo de gradientes ambientales en los ríos Apere, Ichilo y Mamoré.* B.Sc. Thesis. Universidad Mayor de San Simón, Cochabamba, Bolivia. 78 pp.

Mosquera-Guerra, F.M., Trujillo, F., Diaz-Granados, M.C. and Mantilla-Meluk, H. (2015) Estimación poblacional y densidad para *Inia geoffrensis* y *Sotalia fluviatilis* en los ecosistemas acuáticos de la Amazonia y Orinoquia Colombiana. *Momentos de Ciencia* 12(2): 93-99.

Navarro, G. (2002) Provincias Biogeográficas del Beni y del Pantanal. Pages 159-193 *in* Navarro, G. and Maldonado, M. (Eds), *Geografía ecológica de Bolivia. Vegetación y ambientes acuáticos*. Centro de Ecología Simón I. Patiño, Cochabamba, Bolivia.

Painter, R.L.E. (1994) La fauna de la Reserva de Vida Silvestre de los Ríos Blanco y Negro: Distribución, diversidad y pautas para su conservación. Pages 289-414 *in* F.A.N./W.C.S./ Secretaria Ejecutiva PL-480 (Eds), *Plan de Manejo - Reserva de Vida Silvestre de Ríos Blanco y Negro*. Titulo III-USAID/B, Santa Cruz, Bolivia.

Salinas, A. (2007) *Distribución y estado poblacional del bufeo* (Inia boliviensis) *en los ríos Blanco y San Martín (Cuenca del río Iténez).* B.Sc. Thesis. Universidad Mayor de San Simón, Cochabamba, Bolivia. 95 pp.