

New distribution records of *Pteronura brasiliensis* (Zimmerman, 1780) (Mammalia, Carnivora) in Roraima, northern Brazilian Amazonia

Luciana Gosi Pacca^{1*}, Lara Gomes Côrtes², Lívia de Almeida Rodrigues³ and Ronaldo Gonçalves Morato³

1 Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio/MMA), Estação Ecológica de Maracá/CR2. Rua: Alfredo Cruz, Boa Vista, RR, Brazil

2 Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio/MMA), Coordenação de Análise e Prognóstico de Risco à Biodiversidade. COAPRO/CGESP/DIBIO. Complexo Administrativo - EQSW 103/104, Bloco C, 70670-350 Brasília, DF, Brazil

3 Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio/MMA), Centro Nacional de Pesquisa e Conservação de Mamíferos Carnívoros (CENAP). Estrada Municipal Hisaichi Takebayashi, 12952-011 Atibaia, SP, Brazil

* Corresponding author. E-mail: luciana.pacca@icmbio.gov.br

Abstract: A survey of the Giant Otter, *Pteronura brasiliensis* (Zimmerman, 1780), in the state of Roraima, northern Brazilian Amazonia, is presented. We include 52 new records, increasing the total geographic coordinate points for the species in this area by 360%. Additionally, this study reports the first occurrence of the *P. brasiliensis* in the *lavrado* region, a unique and endemic ecosystem of South America with high biodiversity, which claims for protection and adequate land use planning.

Key words: Giant Otter; Mustelidae; Carnivora; *lavrado*; species inventory; range extension; conservation

Pteronura brasiliensis (Zimmerman, 1780), known as the Giant Otter, is the largest species in the subfamily Lutrinae (Mustelidae, Carnivora). According to Groenendijk et al. (2015), this species lives in calm waters of rivers, streams, lakes, and swamps of tropical forests with low altitudes and high abundance of food (fishes), and uses ravines with little inclination for refuge or dense vegetation. *Pteronura brasiliensis* is also an indicator of the aquatic ecosystem's health and a keystone species, as it affects the food chain at different trophic levels (Groenendijk 1998).

Two subspecies of the Giant Otter are currently recognized: *Pteronura brasiliensis paraguensis* (Schinz, 1821), a smaller form that inhabits the Paraná and Paraguay river basins (Pantanal) and *Pteronura brasiliensis brasiliensis*, a larger form that inhabits the Amazon and Orinoco river basins (Harris 1968).

Pteronura brasiliensis is one of the largest predators of tropical forests and wetlands of South America (Utreras et al. 2005), where it is endemic (Carter and Rosas 1997), and it is currently one of the most endangered mammals on the continent (Pickles et al. 2012). This species is classified as Endangered, A3ce, by the International Union for Conservation of Nature (IUCN), indicating that the global population of *P. brasiliensis* is estimated to decrease by 50% or more over the next 25 years (three generations) (Groenendijk et al. 2016). In Brazil, Decree n° 444/2014 of the Ministry of Environment recognizes *P. brasiliensis* as endangered (vulnerable category), with a reduction in the population of at least 30% over the next 20 years under current pressures (Groenendijk et al. 2016).

Current threats to *Pteronura brasiliensis* are related to habitat destruction through logging activities, mining, deforestation, urban growth (Carter and Rosas 1997), soil erosion, reduced abundance of prey, dredging of waterways for navigation, pollution by fertilizers and fuel, and conflicts with fishermen (Duplaix et al. 2015). Additionally, there are issues related to fishing activities, human settlement along river banks, unregulated tourism (Groenendijk 1998), domestic animal diseases, and occasional hunting (Duplaix et al. 2015).

Historically, *Pteronura brasiliensis* occurred in all countries of South America, except Chile. The current total wild population size is unknown and further surveys are required to determine this. Giant Otters are gradually increasing in number in some parts of their range and returning to areas where they have been absent for many years, such as Bolivia and Peru. Despite the lack of precise distribution data for this species,

it is believed that their population levels are low in Ecuador, Colombia, Venezuela, and in the western part of Brazilian Amazonia (Duplaix et al. 2015). In fact, it is possible that the last strongholds of *P. brasiliensis* are in Brazil, Guyana, Suriname, and French Guiana, although further information and studies are needed. *Pteronura brasiliensis* populations are generally small, isolated, or declining in most of Brazil. However, they occur in larger populations in the Pantanal and Amazon basins (Rosas et al. 2008).

Thus, the aim of this study is to present new data on the occurrence and distribution of *Pteronura brasiliensis* in Brazil, particularly along the upper Branco River in the extreme north of Brazilian Amazonia. We also report the first record of this species in the *lavrado* region, a non-forest environment in northwest Roraima.

Surveys of *Pteronura brasiliensis* were made in the Branco River basin in the state of Roraima in the extreme north of Brazilian Amazonia, where records of this species were unknown (Table 1). All field expeditions were made with boats travelling at an average speed of 10 km/h, allowing the sighting of animals and their tracks by applying the “stop-at-first-sign” method (Evangelista and Tosi 2015).

All direct and indirect sightings (i.e., tracks, burrows, and feces) were photographed and had their geographic coordinates collected with a Garmin™ 62s GPS receiver (datum: WGS84). To increase the number of records, we asked colleagues from the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) to record any sightings during field activities, enhancing the compilation of data and new records (Table 2). Moreover, we reviewed scientific literature, to search for studies that provide reliable records of this species in Roraima.

Pteronura brasiliensis is an easily recognizable species that can be confused only with the Neotropical Otter (*Lontra longicaudis* Olfers, 1818). However, the *P. brasiliensis* is much larger, reaching a mass of 35 kg and a total length of 180 cm, while the Neotropical Otter can weigh up to 15 kg and measure 130 cm in length (Eisenberg and Redford 1999). However, these statements are based only on visual observations, and a morphometric study involving a large geographical sample needs to be done in order to verify this hypothesis (Duplaix et al. 2015).

Pteronura brasiliensis also has, as its main features, white spots in the ventral portion of the neck, short

legs, large feet, and webbed digits, along with long and numerous facial whiskers that protrude from the nose, forehead, and temples (Duplaix 1980). In alarm situations, all group members expose their head and neck above the water, making repetitive wavering screams and growls, which is a territorial behavior (Emmons 1997; Figure 1).

Fifty-two new records of *Pteronura brasiliensis* were collected: 27 from direct sightings of individuals or groups and 24 from indirect sightings such as latrines, burrows, footprints, or camps (Figure 2). Of the total records, eight colleagues from the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) provided 21 records, and another 31 records were collected during field expeditions undertaken by the authors of the present study.



Figure 1. *Pteronura brasiliensis* in Estação Ecológica de Maracá (ESEC Maracá, Roraima) displaying alarm and territorial behavior. **A.** Two individuals exposing their heads and necks. **B.** One individual making repetitive noise.

Table 1. Field expeditions according to date, local, distance traveled, and hours of observation per day.

Field Expedition	Date	Local	Distance travelled (km)	Hours of observation
1	23–27 March 2013	Mostly in Maraca Ecological Station and in part of Uraricoera River, Alto Alegre and Amajari municipalities	280	40
2	8–10 July 2013	Parimé River and tributaries, Pacaraima Municipality	130	25
3	25 June 2013	Igarapé Preto (Roraima Nacional Forest), Alto Alegre Municipality	30	8
4	24–28 March 2014	Part of Tacutu and Branco Rivers, Pacaraima and Boa Vista municipalities	320	36

Table 2. New records of *Pteronura brasiliensis* collected in northwestern Roraima, Brazil.

Index	Latitude	Longitude	Altitude (m)	Type of Record	Date (month/day/year)	Author
1	03.31866	-061.58721	122	Sighting, 5 individuals	3/24/2013	L. Pacca and L. Rodrigues
2	03.31886	-061.58712	123	Indirect, burrow	3/24/2013	L. Pacca and L. Rodrigues
3	03.35074	-061.49002	103	Indirect, latrine	3/24/2013	L. Pacca and L. Rodrigues
4	03.35256	-061.49362	98	Sighting, 5 individuals	3/24/2013	L. Pacca and L. Rodrigues
5	03.35276	-061.49679	97	Indirect, burrow	3/24/2013	L. Pacca and L. Rodrigues
6	03.34954	-061.49846	97	Sighting, 5 individuals	3/25/2013	L. Pacca and L. Rodrigues
7	03.34244	-061.51207	93	Indirect, camping	3/25/2013	L. Pacca and L. Rodrigues
8	03.34439	-061.53152	101	Indirect, camping	3/25/2013	L. Pacca and L. Rodrigues
9	03.31648	-061.52535	106	Sighting, 2 individuals	3/25/2013	L. Pacca and L. Rodrigues
10	03.31632	-061.52584	104	Indirect, footprints	3/25/2013	L. Pacca and L. Rodrigues
11	03.40116	-060.60954	74	Indirect, feces and burrow	3/27/2013	L. Pacca and L. Rodrigues
12	03.37066	-060.58935	78	Indirect, footprints	3/27/2013	L. Pacca and L. Rodrigues
13	03.36951	-060.58889	79	Indirect, footprints	3/27/2013	L. Pacca and L. Rodrigues
14	03.35609	-060.58657	85	Indirect, camping	3/27/2013	L. Pacca and L. Rodrigues
15	03.67244	-060.93709	88	Sighting, 2 individuals	8/7/2013	L. Pacca and R. Azevedo
16	03.67529	-060.93468	95	Indirect, latrine	9/7/2013	L. Pacca and R. Azevedo
17	03.6792	-060.93533	94	Indirect, 2 latrines	9/7/2013	L. Pacca and R. Azevedo
18	03.67674	-060.93415	93	Indirect, latrine	9/7/2013	L. Pacca and R. Azevedo
19	03.66971	-060.8974	90	Sighting, 3 individuals	9/7/2013	L. Pacca and R. Azevedo
20	03.59477	-060.81148	82	Indirect, camping	9/7/2013	L. Pacca and R. Azevedo
21	03.58873	-060.75183	87	Indirect, latrine	10/7/2013	L. Pacca and R. Azevedo
22	03.16375	-060.53373	84	Indirect, camping	3/24/2014	L. Pacca and L. Côrtes
23	03.11384	-060.40975	86	Indirect, latrine	3/24/2014	L. Pacca and L. Côrtes
24	03.38561	-060.30007	81	Indirect, latrine	3/25/2014	L. Pacca and L. Côrtes
25	02.88774	-060.55709	80	Indirect, latrine	3/26/2014	L. Pacca and L. Côrtes
26	02.70281	-060.71874	69	Indirect, burrow and latrine	3/27/2014	L. Pacca and L. Côrtes
27	02.70169	-060.71961	76	Indirect, latrine	3/27/2014	L. Pacca and L. Côrtes
28	02.61129	-060.78485	81	Indirect, latrine	3/27/2014	L. Pacca and L. Côrtes
29	02.46721	-060.84065	62	Indirect, latrine	3/28/2014	L. Pacca and L. Côrtes
30	02.45001	-060.83694	65	Indirect, latrine	3/28/2014	L. Pacca and L. Côrtes
31	02.43786	-060.86665	58	Indirect, latrine	3/28/2014	L. Pacca and L. Côrtes
32	01.42644	-060.98462		Sighting, 5 individuals	2013	H. Maduro (collaborator)
33	01.36569	-060.98237		Direct, 1 individual	2013	H. Maduro (collaborator)
34	02.93645	-061.62678		Direct sighting	2013	R. Mansur (collaborator)
35	02.9744	-061.56427		Direct sighting	2013	R. Mansur (collaborator)
36	02.93063	-061.55319		Direct sighting	2013	R. Mansur (collaborator)
37	00.81753	-061.65697		Direct sighting	2013	R. Briglia (collaborator)
38	00.72608	-061.67341		Direct sighting	2013	R. Briglia (collaborator)
39	01.23361	-061.68778		Direct sighting	2013	R. Briglia (collaborator)
40	00.83856	-061.65278		Direct, 1 individual	2013	E. Fujisaki (collaborator)
41	00.88794	-061.65333		Direct, 1 individual	2013	E. Fujisaki (collaborator)
42	-00.96821	-061.87447		Direct sighting	2013	T. Laranjeiras (collaborator)
43	-01.32247	-061.88142		Direct, 2 individuals	2013	T. Laranjeiras (collaborator)
44	-01.34452	-061.87721		Direct sighting	2013	T. Laranjeiras (collaborator)
45	-01.36723	-061.74024		Direct, 2 individuals	2013	T. Laranjeiras (collaborator)
46	-01.10433	-061.87178		Direct sighting	2013	T. Laranjeiras (collaborator)
47	-00.97903	-061.85622		Direct sighting	2013	T. Laranjeiras (collaborator)
48	-00.14092	-061.79630		Direct, 3 individuals	2013	T. Laranjeiras (collaborator)
49	00.29543	-061.76900		Direct sighting	2013	T. Laranjeiras (collaborator)
50	01.07006	-061.85036		Direct, 1 individual	2013	R. de Azevedo (collaborator)
51	01.17386	-061.96150		Direct, 1 individual	2013	R. de Azevedo (collaborator)
52	00.96891	-061.36259		Direct, 7 individuals	2013	M. de Carvalho (collaborator)

A literature review revealed that only two studies have provided precise coordinates of the distribution of *Pteronura brasiliensis* in the state of Roraima (Restrepo 2009; Evangelista and Tosi 2015). Evangelista and Tosi (2015) collected seven records of this species from southeastern Roraima, while Restrepo (2009) added

another 13 direct sightings on the lower Branco River. Adding to the 52 records presented in this study (Figure 3), the *P. brasiliensis* is now known from 72 locality records in Roraima. Notably, our study increases the number of records in the state by 360%.

Despite information being available for more than



Figure 2. Direct and indirect sightings of *Pteronura brasiliensis*. **A.** Direct sighting of an adult individual in Estação Ecológica de Maracá. **B–E.** Indirect sightings: **(B)** footprint (scale represented by 15 cm pen), **(C)** latrine, **(D)** camp, and **(E)** burrow. Photos by Luciana Pacca.

75% of the total distribution of the *Pteronura brasiliensis*, there are still gaps in the knowledge of this species' distribution in Brazil (Evangelista and Tosi 2015), confirming the importance of this study. Although there is great difficulty in observing *P. brasiliensis* in the Brazilian Amazon, particularly owing to the complex logistics in this region, this work presented the first record of this species in the *lavrado* ecosystem, an ecosystem of diverse non-forest vegetation types and the largest contiguous

area of savannas in the Brazilian Amazon (Campos et al. 2008). Drainage networks exist in interconnections denominated as “veredas” (paths) of buritizais (meaning stands of Buriti Palm, *Mauritia flexuosa* L.) which are nothing more than streamsthat connect the lakes to the larger rivers (Barbosa et al. 2007) that are important to maintain the gene flow among species.

This region, in northeastern Roraima, eastern Guyana, and southern Venezuela, is one of the endemic,

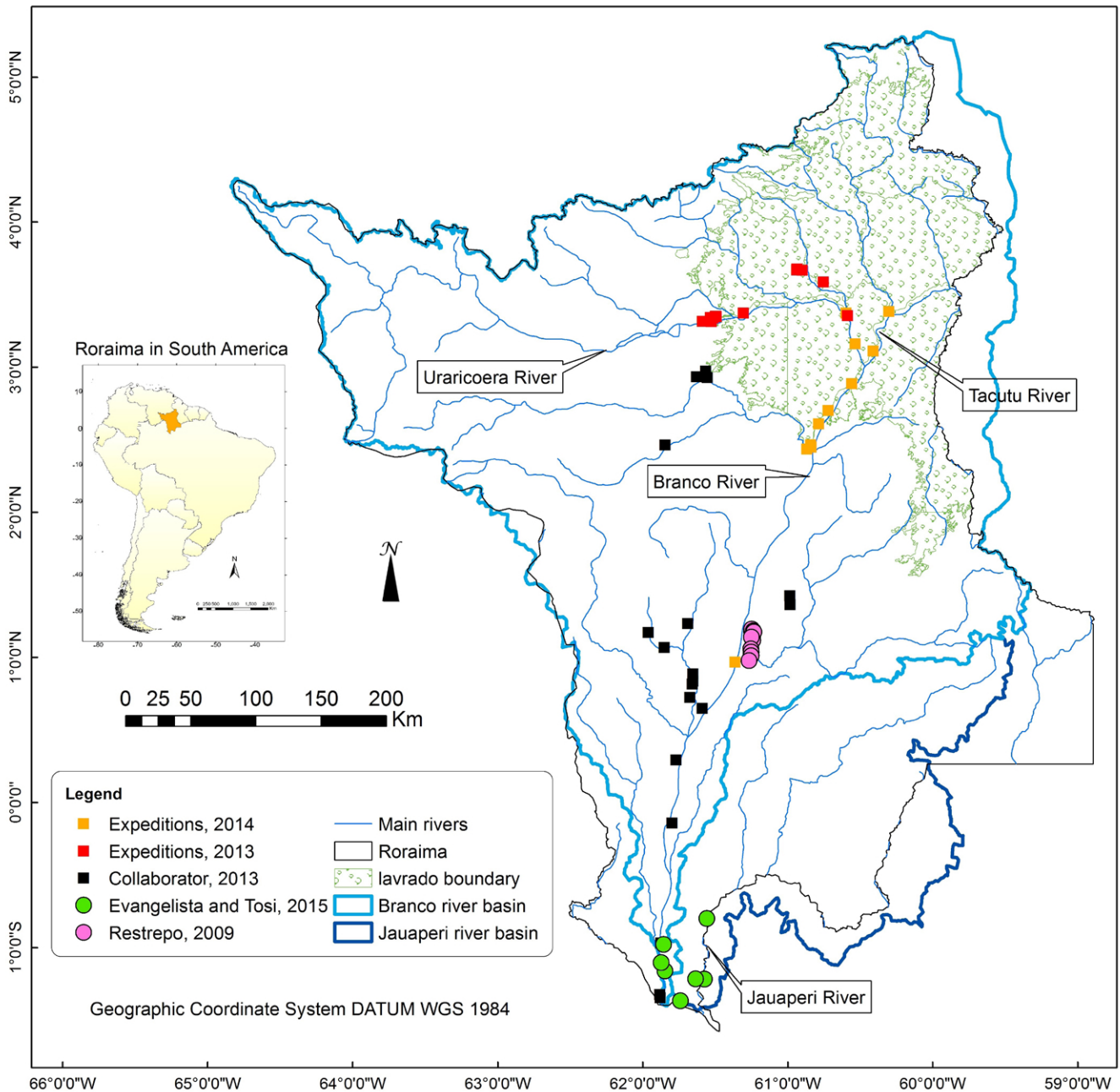


Figure 3. Current geographic records of *Pteronura brasiliensis* in Roraima. Circles represent literature records; squares are the new records, this study.

highly biodiverse ecosystems of South America (Barbosa et al 2005), yet little is known about the distributions of its species.

Human occupation of the *lavrado* region has accelerated in a short time and requires a rapid response from public authorities for the protection this region. Among the main drivers of growth are plans to build hydroelectric dams and increase agricultural areas (Campos et al. 2008). The fact that more than half of the *lavrado* area of Roraima is indigenous land illustrates the fundamental role of these communities in the conservation of the region. However, according to Barbosa and Campos (2011), the growth of the indigenous population also increases human density in the area, and consequently,

is a threat to the ecosystem. Thus, we highlight the urgent need to implement participatory program management and environmental monitoring in indigenous territories in this region.

Given this concern, the *lavrado* region needs urgent conservation measures such as the immediate creation of protected areas covering significant areas of the ecosystem to ensure the protection and study of its still unknown biodiversity. Despite its ecological importance, protected areas of *lavrado* are presently restricted to small natural enclaves in Estação Ecológica de Maracá (ESEC, Maracá) and Floresta Nacional de Roraima (FLONA, Roraima). Together, these two conservation units protect less than 0.5% of the entire *lavrado* area

(Barbosa et al. 2007).

According to Pickles et al. (2012), although *Pteronura brasiliensis* population has recovered in a few locations within its range, its distribution remains fragmented. It is unlikely that gene flow is currently occurring among the populations of northern South America, mostly within the *lavrado* area. Therefore, we recommend the re-establishment and maintenance of metapopulation connectivity that will allow for the dispersal of the species through corridors between the Orinoco, Amazon, and Guianas. It is necessary to prioritize the creation and preservation of ecological corridors that connect conservation areas in order to avoid habitat fragmentation of *P. brasiliensis* and the isolation of populations. This is possible by integrating protected areas with permanent preservation areas through territorial land-use planning.

For Duplaix et al. (2015), local residents are key factors in promoting the conservation of *Pteronura brasiliensis*. The local human population shares the rivers and the habitat with Giant Otters; encouraging participation in conservation initiatives will enhance conservation outcomes. However, this can only be achieved through education, consensus building, and alternative economic incentives.

Therefore, urgent actions for the maintenance of environmental quality and faunal and floral populations may rely on spatial planning measures, environmental monitoring, participatory planning with local communities, creation of conservation units, and especially creation of new financial incentives to relieve economic pressures to explore natural resources and encourage alternative livelihoods. These actions would ensure not only the integrity of the ecosystem, but also the maintenance of *Pteronura brasiliensis* populations that still need study to gain a better knowledge of their local and regional conservation status.

ACKNOWLEDGEMENTS

We thank the ICMBio/MMA for the financial support, and “Biodiversidade em Unidades de Conservação” Program from Instituto de Pesquisas Jardim Botânico do Rio de Janeiro/Mestrado Profissional for the opportunity to conduct this study. We also would like to express our thanks to Renata Bocorny de Azevedo, Claudiomiro Parente, Maracá Ecological Station’s crew, all collaborators who provided Giant Otter records in Roraima, and reviewers of our manuscript.

LITERATURE CITED

Barbosa, R.I., S.P. Nascimento, P.A.F. Amorim and R.F. Silva. 2005. Notas sobre a composição arbóreo-arbustiva de uma fisionomia das savanas de Roraima, Amazônia Brasileira. *Acta Botanica Brasílica* 19(2): 323–329. doi: [10.1590/S0102-33062005000200015](https://doi.org/10.1590/S0102-33062005000200015)

Barbosa R.I., C. Campos, F. Pinto and P.M. Fearnside. 2007. The “lavrados” of Roraima: biodiversity and conservation of Brazil’s

Amazoniansavannas. *FunctionalEcosystemsandCommunity*1(1): 29–41. [http://www.globalsciencebooks.info/Online/GSBOOnline/images/0706/FEC_1\(1\)/FEC_1\(1\)29-41o.pdf](http://www.globalsciencebooks.info/Online/GSBOOnline/images/0706/FEC_1(1)/FEC_1(1)29-41o.pdf)

Barbosa, R.I. and C. Campos. 2011. Detection and geographical distribution of clearing areas in the savannas (‘lavrado’) of Roraima using Google Earth web tool. *Journal of Geography and Regional Planning* 4(3): 122–136. http://www.academicjournals.org/article/article1381833635_Barbosa%20and%20Campos.pdf

Campos, C., F. Pinto and R.I. Barbosa. 2008. O “Lavrado” de Roraima: importância biológica, desenvolvimento e conservação na maior savana do bioma Amazônia. Diagnóstico. Boa Vista-Roraima, INPA/Núcleo de Pesquisas de Roraima. 8 pp. http://agroeco.inpa.gov.br/reinaldo/RIBarbosa_ProdCient_Usu_Visitantes/2008Diagnostico_LAVRADO_MMA.pdf

Carter, S.K. and F.C.W. Rosas. 1997. Biology and conservation of the giant otter *Pteronura brasiliensis*. *Mammal Review* 27: 1–26. doi: [10.1111/j.1365-2907.1997.tb00370.x](https://doi.org/10.1111/j.1365-2907.1997.tb00370.x)

Duplaix, N., E. Evangelista and F.C.W. Rosas. 2015. Advances in the study of Giant Otter (*Pteronura brasiliensis*) ecology, behavior, and conservation: a review. *Latin American Journal of Aquatic Mammals* 10(2): 75–98. doi: [10.5597/lajam00200](https://doi.org/10.5597/lajam00200)

Duplaix, N. 1980. Observations on ecology and behaviour of the Giant Otter *Pteronura brasiliensis* in Suriname. *Revue Ecologique (Terra vie)* 34: 495–620. <http://hdl.handle.net/2042/55014>

Eisenberg, J. and K. Redford. 1999. *Mammals of the Neotropics: the central Neotropics*. Vol. 3: Ecuador, Peru, Bolivia, Brazil. Chicago and London: University of Chicago Press. 281 pp.

Emmons, L. 1997. *Neotropical rainforest mammals*. Chicago: University of Chicago Press. 609 pp.

Evangelista, E. and C. Tosi. 2015. First Giant Otter distribution survey in the southeast of Roraima, Brazil, with notes on the *OSG Guidelines for a Standardization of Survey Methods*. *Latin American Journal of Aquatic Mammals* 10(2): 143–146. doi: [10.5597/lajam00206](https://doi.org/10.5597/lajam00206)

Groenendijk, J. 1998. A review of the distribution and conservation status of the Giant Otter (*Pteronura brasiliensis*) with special emphasis on the Guayana Shield Region. Amsterdam: Netherlands Committee for IUCN. 55 pp.

Groenendijk, J., N. Duplaix, M. Marmontel, P. Van Damme and C. Schenck. 2015. *Pteronura brasiliensis*. The IUCN Red List of threatened species 2015: e.T18711A21938411. doi: [10.2305/IUCN.UK.2015-2.RLTS.T18711A21938411.en](https://doi.org/10.2305/IUCN.UK.2015-2.RLTS.T18711A21938411.en)

Harris, C.J. 1968. *Otters. A study of the Recent Lutrinae*. London: Weidenfeld and Nicolson. 397 pp.

MMA (Ministério do Meio Ambiente). 2014. Portaria N° 444 de 17 de dezembro de 2014.

Olfers, I. von. 1818. Bemerkungen zu Illiger’s Ueberblick der Säugthiere, nach ihrer Vertheilung über die Welttheile, rücksichtlich der Südamericanischen Arten (Species); pp. 192–237, in: W.L. Eschwege (ed.). *Journal von Brasilien, oder vermischte Nachrichten aus Brasilien, auf wissenschaftlichen Reisen gesammelt*; in: F.I. Bertuch (ed.). *Neue Bibliothek der wichtigsten Reisebeschreibungen zur Erweiterung der Erd- und Völkerkunde; in Verbindung mit einigen anderen Gelehrten gesammelt und herausgegeben*. Weimar, German: Verlage des Landes-Industrie-Comptoirs. https://archive.org/stream/DELTA54086_1FA/BSG_DELTA54086_1FA

Pickles, R.S.A., J.J. Groombridge, V.D. Zambrana Rojas, P. Van Damme, D. Gottelli, C.V. Ariani and W.C. Jordan. 2012. Genetic diversity and population structure in the endangered giant otter, *Pteronura brasiliensis*. *Conservation Genetics*, 13 (1): 235–245. doi: [10.1007/s10592-011-0279-9](https://doi.org/10.1007/s10592-011-0279-9)

Rosas, F.C.W., H. Waldemarin and G.E. de Mattos. 2008. *Pteronura brasiliensis* (Zimmermann, 1780); pp. 800–801, in: A.B.M. Mach-

- ado, G.M. Drummond and A.P. Paglia (eds.). Livro vermelho da fauna brasileira ameaçada de extinção. MMA, Fundação Biodiversitas. 2: 1420 pp.
- Schinz, H.R. 1821. Das Thierreich eingetheilt nach dem Bau der Thiere als Grundlage ihrer Naturgeschichte und der vergleichenden Anatomie von dem Herrn Ritter von Cuvier. Erster band. Säugethiere und Vögel. Stuttgart/Tübingen: J.G. Cotta'schen Buchhandlung. 1: xxxviii + 894 pp.
- Utreras, B.V., R.E. Suárez, G. Zapato-Ríos, G. Lasso and L. Pinos. 2005. Dry and rainy season estimations of giant otter, *Pteronura brasiliensis*, home range in the Yasuní National Park, Ecuador. LAJAM 4(2): 191–194. doi: [10.5597/lajam00085](https://doi.org/10.5597/lajam00085)
- Zimmermann, E.A.W. 1780. Geographische Geschichte der Menschen, und der allgemein verbreiteten vierfüßigen Thiere. Zweiter Band. Leipzig: Wenganschen Buchhandlung, 2:6. <https://archive.org/details/geographischege00zimmgoog>
- Author contributions:** LGP, LGC, and LAR collected the data; LAR and LGP identified the specimens; LGP, LGC, RGM, and LAR wrote the text.
- Received:** 20 March 2016
Accepted: 28 June 2016
Section Editor: Guilherme Garbino