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Cub biometry, litter size and reproductive period of giant otters (*Pteronura brasiliensis*) at the Balbina Hydroelectric Reservoir, Amazonas, Brazil

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Abstract: According to the literature, giant otters produce one to six cubs at each gestation, with birth peaks occurring from the end of the flood season to the beginning of the low-water period. With the aim of describing some reproductive parameters of the giant otters living in a hydroelectric lake, 56 field excursions to Balbina Hydroelectric Reservoir, hereafter Balbina Lake, were carried out between September 2001 and September 2010 in order to gather information about cub weight and length, litter size and reproductive period of the species in that area. About 80% of the birth records occurred between September and December, characterized by the receding water season and the beginning of the dry season. The number of cubs per gestation varied from one to three animals (mean = 2; n = 36) and average weight and length of neonates were 316.25 ± 64.21g (n = 4) and 31.75 ± 4.86cm (n = 4), respectively. The reproductive period and the litter size produced by giant otters in Balbina Lake were within the range reported in literature for non-dammed areas, indicating that these reproductive parameters were not changed by the reservoir. The weight of cubs analyzed in the reservoir was in average 35% greater than the weight of captive newborn cubs reported in the literature. However, as the animals here analyzed were healthy, it is reasonable to assume that they represent the weight of free-ranging newborn cubs. Artificial lakes had been reported in the literature as favorable environments for giant otters in Guyana, and the results obtained here seem to corroborate this hypothesis and show the plasticity of the species in its use of different habitats as long as the habitats are inside some category of protection, in this way minimizing additional impacts caused by an intense human occupation of the area.

Resumo: De acordo com a literatura, as ariranhas geram de um a seis filhotes a cada gestação, com pico de nascimento das crias entre o final da cheia e início do nível baixo das águas dos rios. Com o objetivo de conhecer alguns parâmetros reprodutivos da ariranha em lagos de hidrelétrica, foram realizadas 56 expedições ao lago de Balbina entre setembro 2001 e setembro 2010 e registradas informações sobre o peso e comprimento de filhotes, tamanho da prole e período reprodutivo da espécie no reservatório da Usina Hidrelétrica de Balbina. Cerca de 80% dos registros de nascimentos ocorreu entre os meses de setembro e dezembro, que correspondem às estações de vazante e início da seca na área de estudo. O número de filhotes por gestação variou de um a três animais (média = 2; n = 36) e o peso e comprimento médios de neonatos foram de 316,25 ± 64,21g (n = 4) e 31,75 ± 4,86cm (n = 4), respectivamente. A semelhança quanto ao período reprodutivo e número de filhotes gerados pelas ariranhas de Balbina quando comparados com áreas não represadas revela que, apesar dos distúrbios ambientais causados pelo represamento, estes aspectos reprodutivos da espécie não foram alterados. O peso dos filhotes analisados no reservatório foi em média 35% superior ao peso de neonatos nascidos em cativeiro. Como os filhotes aqui analisados eram animais saudáveis, acredita-se que representem o peso médio de nascimento em ariranhas de vida livre. Lagos artificiais já foram relatados na literatura como ambientes favoráveis às ariranhas na Guiana, e os resultados aqui apresentados parecem corroborar esta informação, revelando a plasticidade da espécie no uso de diferentes hábitats, desde que associados a alguma categoria de unidade de conservação, minimizando desta forma a exagerada ocupação humana da área.

Introduction

Giant otters (*Pteronura brasiliensis*) are gregarious animals that live in cohesive groups and use dens along watercourses' banks to sleep overnight and keep their offspring protected (Duplaix, 1980; Carter and Rosas, 1997; Staib, 2005). The group sizes are quite flexible, and are usually composed by two to 16 individuals, but having only one dominant breeding pair (alpha couple) that is apparently monogamous (Duplaix, 1980; Evangelista and Rosas, 2011; Oliveira *et al*., 2011). Solitary individuals (transients) can be observed, and are usually young adults that have reached sexual maturity or adults that have lost their mate (Duplaix, 1980; Carter and Rosas, 1997; Staib, 2005; Rosas *et al*., 2007; Evangelista and Rosas, 2011).

The size of the litters varies from one to six cubs (usually two) per year, with the possibility of a second litter if the first one fails (Duplaix, 1980; Carter and Rosas, 1997; Rosas, 2004; Evangelista and Rosas, 2011; Duplaix *et al*., this issue). The gestation period varies from 65 to 70 days, and the birth peak occurs from the end of the flood period to the beginning of the low-water period in the Amazon region (Duplaix, 1980; Rosas *et al*., 2007; Evangelista and Rosas, 2011).

The species shows alloparental care (Rosas *et al*., 2009) and, according to Staib (2005) and Evangelista and Rosas (2011), large groups of giant otters tend to have higher reproductive rates, since they can count on greater cooperation from group members to raise their cubs, ensuring in this way greater success in reproduction.

The cubs are born with the eyes closed and spend approximately the first six or seven weeks inside the dens where they probably feed only on the mother's milk, until they start to follow the group in their daily activities (Duplaix, 1980; Laidler, 1984; Schweizer, 1992; Evangelista and Rosas, 2011). They start catching fish on their own by three and a half months of age (Evangelista and Rosas, 2011), and remain living in their groups until they are about two to three years old (Laidler, 1984; Davenport, 2010). There are, however, exceptions to this basic group structure, and some cubs can remain more than three years with their respective family groups (Staib, 2005), whereas other groups seem to have no relatedness between individuals (Ribas, 2012). Histological analysis of male testes revealed that giant otters reach sexual maturity at about two years of age (Oliveira *et al*., 2011), but no histological studies were carried out with ovaries in order to estimate age of sexual maturity in females. The species' life expectancy for captive animals is estimated to be around 20 years according to Oliveira *et al*. (2007), whilst for free-ranging animals life expectancy drops to about 15 years (Davenport, 2010).

The use of man-made lakes by giant otters has already been reported in the early 1980s by Laidler (1984) in Guyana. According to that author, such artificial lakes may prove to be an important element in giant otter conservation, not only because of the preponderance of easily catchable prey items but also because some of them already have a higher level of wardening or allow to implement wardening in an easier way than other habitats. However, until recently, no long-term studies had been carried out with giant otters in dams, and hydroelectric dams have been mentioned as a threat to the species[1].

According to Rosas *et al*. (2007) giant otters use the Balbina Lake throughout the year and display an annual reproductive cycle. Cabral *et al*. (2010) described the feeding habits of *P. brasiliensis* in Balbina Lake and observations on predation, mortality, behavior, internal layout of giant otter dens and detailed characteristics of the habitats used by the species in that reservoir have also been described by Rosas and De Mattos (2003*a, b*), Rosas *et al*. (2008; 2009) and Bozzetti (2011). The giant otter studies carried out at Balbina Lake revealed that the environmental changes originated by damming a river, such as the transformation of a lotic to a lentic system, the smaller water level variation between the flood and the low-water level seasons, as well as the modification in the ichthyofauna, do not preclude giant otters from inhabiting dams. What can be a real threat to giant otters when building a dam is that pristine areas, which were inaccessible before the dam, then become easily accessible by the lake. This, however, does not have any relationship to the environmental changes caused by the dam, but is related to the presence of humans, which can disturb and expel giant otters inside or outside reservoirs.

The main objective of this study was to describe some reproductive aspects of free-ranging giant otters, including information about newborn cubs weight and length, litter size, and reproductive seasonality of the species in a hydroelectric power plant lake in the Central Amazon.

Methods

Study area

The Balbina Lake (UHE Balbina) (01°55'00"S, 59°29'00"W) is formed by the inflow of waters from the Uatumã River and its tributaries (Figure 1). The area flooded after the damming of the Uatumã River was estimated at 4438km², operating with the maximum quota of 51m above sea level[2]. The flooding of the reservoir was completed over a period of 16 months, starting in October 1987 and ending in February 1989. Due to the fact that the lake is not very deep (average of 7.4m) (Fearnside, 1989), the highland areas that stayed above the water level resulted in the formation of a group of about 3500 islands, which, along with great amounts

[1]ICMBio (2010) Instituto Chico Mendes de Conservação da Biodiversidade. Sumário Executivo do Plano de Ação Nacional para a Conservação da Ariranha. Ministério do Meio Ambiente. Available online at <http://www.icmbio.gov.br/portal/biodiversidade/fauna-brasileira/plano-de-acao>. Consulted on 22 June 2012.

[2] Funcate/Inpe/Aneel (2000) Mapeamento por satélite das áreas inundadas por reservatórios de hidrelétricas brasileiras. Unpublished Report. Convênio Funcate/Inpe/Aneel, São Paulo, Brazil. Available online at http://www.inpe.br Consulted on 20 April 2006.

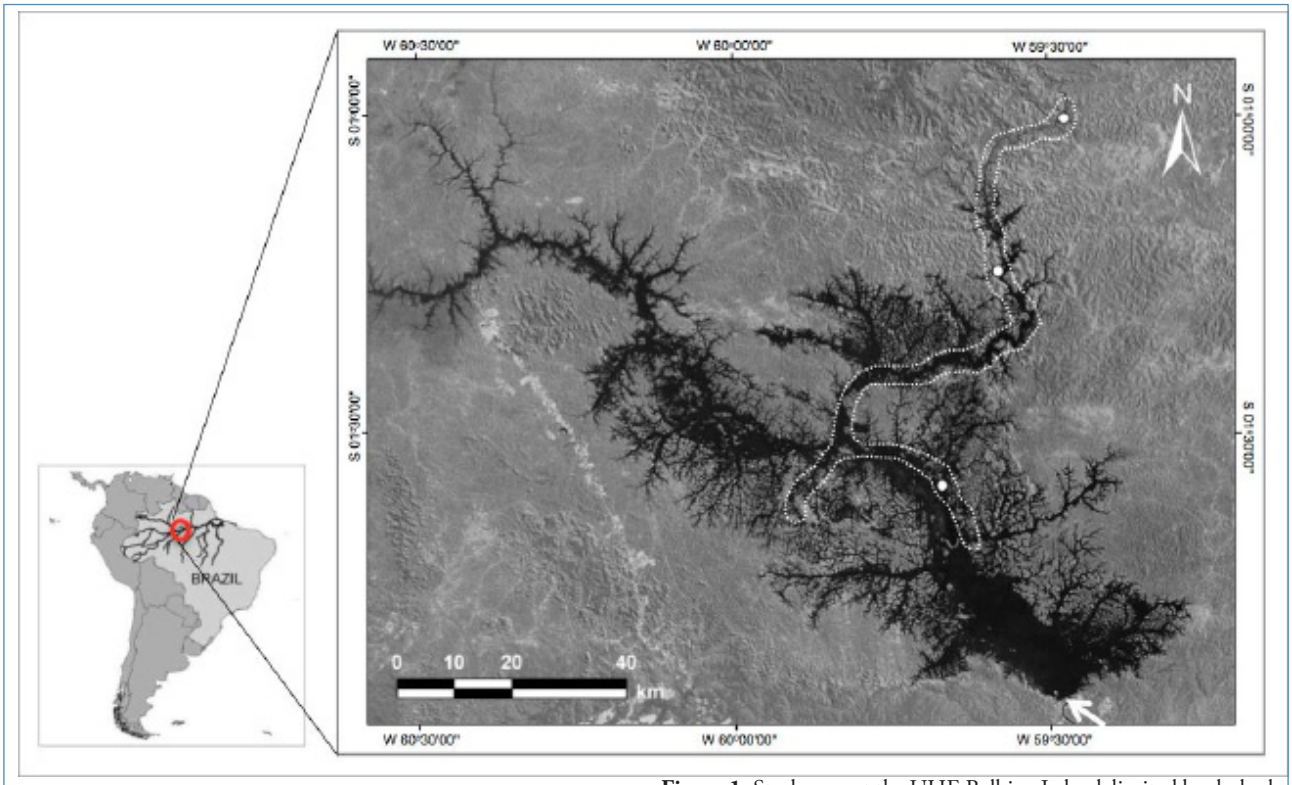

Figure 1. Study area at the UHE Balbina Lake delimited by dashed line. The arrow shows the location of the Uatumã River Dam. White dots indicate the dens where cubs used for biometry were found. Source: Projeto Ariranha/INPA

of dead trees, trunks and branches inside the lake, formed what is locally known as *cacaia*. This landscape restricted locomotion in the lake to the old course of the flooded rivers and small streams, which in turn facilitate the location and orientation inside the large lake (Rosas *et al*., 2007).

The left margin of the reservoir is found inside the limits of the Uatumã Biological Reserve (ReBio Uatumã), created on 6 June 1990 by the Decree No 99277. The remaining area is under permanent legal protection, together with the right margin of the lake. The ReBio's area of influence comprises 56000km^2 and has as main objective the protection of ecosystems in the basins of the Uatumã and Jatapu rivers[3].

The present study was conducted in the Balbina Lake, inside the influence area of the ReBio Uatumã. The focal area of the study (see dashed line in Figure 1) covered about 450km^2, which represents about 10% of the total reservoir area.

Data collection

Aiming to describe some reproductive aspects of the giant otter population living in the Balbina Lake, 56 field excursions (450 days) were conducted between September 2001 and September 2010. During the excursions, a total of 164 giant otter dens were monitored along the study area. These dens were observed monthly (between September 2001 and August 2002) and bimonthly from October 2002 on. The areas were classified as 'in use', if recent paw marks and feces remains were found in the banks, as well as trampled vegetation and/or presence of animals, and 'not in use', if old signs left by giant otters were found (Groenendijk *et al.*, 2005; Rosas *et al.*, 2007). The dens' geographical coordinates and the direct observations of animals were recorded by GPS (global positioning system) (GPS Garmin map 76 csx). To facilitate the logistics and ensure a minimum effort of 10 hours/day of sampling, we set campsites at the margins of the islands and remained in the study area for about eight days per excursion. Furthermore, two sites were used as support bases: the WABA Patrolling Base facilities in the Uatumã River, and a wooden shack located at the junction of the Pitinga and Pitinguinha rivers, both belonging to the ReBio Uatumã/ICMBio. The water courses' margins were traversed using an aluminum boat with a 40HP outboard engine, at an average speed of 15km/h. Giant otters were followed and monitored with the use of binoculars (Konus 8x40w.a.), and photographed and/or filmed using digital camera (Panasonic DMC-FZ20 and Canon EOS-20D, with lens 75-300mm) and video camera (Sony, DCR TRV50).

When females were sighted with protruding mammary glands, it was interpreted as indication of the presence of newborn cubs inside the dens, and, in these cases, greater

[3]IBAMA/Eletronorte (1996) Relatório do plano de manejo fase 1 da reserva ecológica do Uatumã (AM). Brasília, DF, Brazil. 68 pp.

efforts were made (monitoring the animals' daily routine, constant monitoring and observation of the den from a distance of about 40-50m over a period of up to 10 hours/day). The presence of small cubs in the groups allowed the identification of the birth season, litter size and reproductive seasonality of the species. According to Rosas *et al.* (2009), at the moment of the cubs' transference from one den to another, the cubs are usually brought from the bottom of the den to near the entrance, where one of the adults starts the transfer itself. During this process, the access to the cubs is facilitated and it is possible to weigh and measure them. This situation was observed three times in the Balbina Lake, allowing the biometry of five cubs. Hand dynamometers with precision varying from 0.10g to 0.25g were used to weigh the cubs. The animals were wrapped in a piece of cloth, which was fixed to the dynamometer. The weight of the cloth was later subtracted to obtain the real cub weight. To obtain the total body length, cubs were measured in a straight line from the tip of the snout to the tail's distal extremity. After biometry was finished, the cubs were returned to the den as fast as possible in order to minimize the stress to the animal and its group. We considered as newborn cubs (neonates) only those animals that either had an umbilical cord and/or their eyes closed. In one case, however, despite having its eyes closed, the cub was 1.5kg and therefore we did not consider this animal as a newborn and its biometry was not included to calculate the mean total body length and weight of newborn cubs.

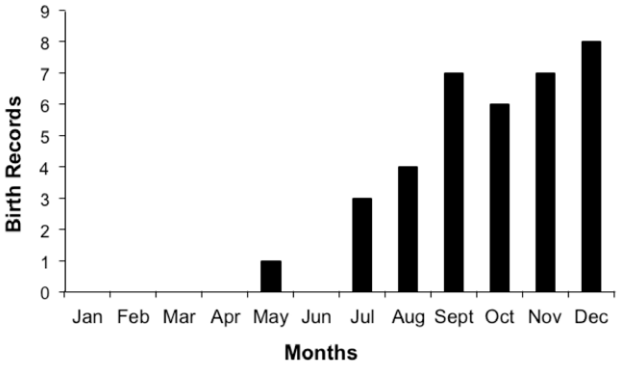

Figure 2. Number of giant otter birth records per month observed from September 2001 to September 2010 at Balbina Hydroelectric Reservoir.

Results

During the study period, 36 litters were recorded in Balbina Lake. From this total, 78% (n=28) occurred between September and December, which characterize the receding water and the beginning the low-water season in the study area, followed by 19% (n = 7) between the months of July and August (flood season), and only 3% (n = 1) in the month of May (rising-water period). Giant otter birth records per month observed during the study period are presented in Figure 2. The size of the reproductive groups varied from three to 12 animals (average of 6 ± 2 animals per group; n = 23 groups) and the number of cubs per gestation varied from one to three animals (mean of two cubs per group; n = 36). The estimated ages of observed cubs varied from newborn animals (about one week old) to approximately three to four months old.

It was possible to weigh and measure five cubs estimated to be under 30 days old in three occasions (September 2006, n = 1, December 2007, n = 3, September 2010, n = 1 cub). The weight of these cubs varied from 265g to 1500g, and the lengths varied from 29cm to 54cm. All cubs still had their eyes closed, and only two of the five had already lost the umbilical cord. One of the latter was estimated to be 10-12 days old, while the other was about 25-30 days old according to data presented by McTurk and Spelman (2005). The three cubs with umbilical cord were less than one week old. The cub biometry and sex data are shown in Table 1. The mean total body weight and length of the four neonate cubs less than 15 days old were 316.25 ± 64.21g and 31.75 ± 4.86cm, respectively.

Table 1. Date, month and year of birth, biometry, sex, estimated age and litter size of giant otter cubs measured at the Balbina Hydroelectric Reservoir.

Date	Weight (g)	Total Length (cm)	Sex*	Litter size	Estimated age	Umbilical cord	Observations
Sep. 2006	410	39	F	2	10-12 days	no	eyes closed
Dec. 2007	300	29	F	3	newborn	yes	eyes closed
Dec. 2007	265	30	F	3	newborn	yes	eyes closed
Dec. 2007	290	29	M	3	newborn	yes	eyes closed
Sep. 2010	1500	54	M	1	25-30 days	no	eyes closed

*F = female, M = male

Discussion

Among the 36 litter records observed in the Balbina Lake over nine consecutive years, 97.2% occurred between the end of the flood season and the beginning of the low-water period in the study area (July to December), which corroborates data presented by Duplaix (1980) in Suriname, Laidler (1984) in Guyana, Evangelista and Rosas (2011) in the border between the Amazonas and Roraima states in Brazil, and Rosas *et al*. (2007) in the same area of the present study. These results suggest that the condition of artificial lake (hydroelectric lake) did not change the reproductive seasonality of the species. Based on these data it seems quite clear that *P. brasiliensis* shows, with few local variations, a reproductive period well defined in the Amazon region, irrespective of habitat type.

The giant otter is a top predator and feeds especially on benthic and demersal fishes, which usually have nocturnal habits and slow movements during the day, making them easier to be captured (Schweizer, 1992; Rosas *et al*., 1999; Cabral *et al*., 2010). During the receding water period, fishes that were previously dispersed over flooded areas (*igapós*) move towards the larger lake or rivers and streams, which are environments with more open and deeper waters (Santos *et al*., 2006). According to Duplaix (1980), Rosas *et al*. (2007) and Cabral *et al*. (2010) giant otters are induced to move towards these areas searching for prey. This behavior has a special meaning for females at the end of their gestation and beginning of lactation period, since it allows them to meet the energetic and nutritional needs during these phases of their reproductive cycle. The reproductive seasonality also seems to play a fundamental role for the cubs, which are usually weaned during the low-water period and therefore find it easier to catch their own food during this period when water volume is lower than during the flood season.

According to Duplaix (198), Carter and Rosas (1997), Rosas (2004), Staib (2005), Evangelista and Rosas (2011) and Duplaix *et al.* (this issue), giant otter litter size varies from one to six cubs per gestation. The number of cubs per gestation observed at the Balbina Lake (between one to three cubs, with average of two cubs per gestation) fits the variation mentioned for the species in other areas where there is no influence from hydroelectric power plants. The similarity in reproductive period and in litter size for giant otters in Balbina and in non-dammed areas suggests that environmental changes caused by damming did not interfere with the reproductive biology of the species.

There are few records of giant otter newborn cub weight and length, and all of those come from animals born in captivity (Autuori and Deutsch, 1977; Duplaix, 1980). According to Autuori and Deutsch (1977) in a study conducted at the São Paulo Zoo (Brazil), the average weight and length of giant otter newborn cubs were 200g and 33cm (n = 5), respectively. Duplaix (1980) at the Paramaribo Zoo, Suriname, recorded the weight and length of unsuccessfully weaned cubs approximately six weeks old and obtained an average of 1300g and 54cm, respectively. More recently, McTurk and Spelman (2005) estimated the weight and age of 34 giant otter orphans that were taken between 1985 and 2002 to a rehabilitation center in the margins of the Rupununi River, Guyana. The authors divided the orphan cubs into four different age groups according to their size, estimated age, real or estimated weight, dental development, and feeding habits. In their great majority (79%), estimated ages and weights varied between 8-10 weeks of life and 2-5kg, respectively.

Our weight and length results for Balbina giant otter cubs were compared to the results presented by Autuori and Deutsch (1977) and Duplaix (1980), and, although they had similar body lengths, the captive cubs measured by these authors weighed less than the cubs from Balbina Lake. Considering that the cubs analyzed at Balbina Lake were in good body condition, it seems reasonable to assume that their body length and weight values represent the normal body size and weight of newborn free-ranging giant otter cubs.

The use of artificial lakes by otters seems to be much more frequent than previously thought, as the presence of several otter species in dams have been reported in Europe, Africa and India (Pedroso and Santos-Reis, 2009). Although the studies with giant otters in Balbina Lake represent the first long-term project with this species in a hydroelectric reservoir (Rosas *et al*., 2007), the presence of giant otters in artificial lakes had already been mentioned by Laidler (1984) in Guyana and by R. Ghilardi Jr. (pers. comm.) who recently reported that giant otters also inhabit the Tucuruí Hydroelectric Reservoir (03°45'03"S, 49°40'03"W) in Pará State, Brazil. Nevertheless, it is recommended that otter population censuses be carried out before and after damming a river in order to document the real impact of these dams on their populations.

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References

Autuori, M.P. and Deutsch, L.A. (1977) Contribution to the knowledge of the giant Brazilian otter (*Pteronura brasiliensis*) (Gmelin 1788), Carnivora, Mustelidae. *Zoologische Garten* 47: 1-8.

Bozzetti, B.F. (2011) *Caracterização de Habitat e Aspectos Reprodutivos da Ariranha* (Pteronura brasiliensis, *Zimmermann, 1780*) *no lago da Usina Hidrelétrica de Balbina, Amazonas, Brasil*. M.Sc. Thesis. Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil. 76 pp.

Cabral, M.M.M., Zuanon, J.A., De Mattos, G.E. and Rosas, F.C.W. (2010) Feeding habits of giant otters (*Pteronura brasiliensis*) (Carnivora: Mustelidae) in the Balbina hydroelectric reservoir, Central Brazilian Amazon. *Zoologia* 27(1): 47-53. http://dx.doi.org/10.1590/S1984-46702010000100008

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

Davenport, L.C. (2010) Aid to a declining matriarch in the giant otter (*Pteronura brasiliensis*). *PLoS ONE* 5(6): e11385. http://dx.doi.org/10.1371/journal.pone.0011385

Duplaix, N. (1980) Observations on the ecology and behavior of the giant river otter (*Pteronura brasiliensis*) in Suriname. *Revue Écologique (Terre et Vie)* 34: 495-620.

Duplaix, N., Evangelista, E. and Rosas, F.C.W. (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. http://dx.doi.org/10.5597/lajam00200

Evangelista, E. and Rosas, F.C.W. (2011) Breeding behaviour of giant otter (*Pteronura brasiliensis*) in the Xixuaú Reserve, Roraima, Brazil. *IUCN Otter Specialist Group Bulletin* 28(A): 5-10.

Fearnside, P.M. (1989) Brazil's Balbina Dam: Environment versus the legacy of the pharaohs in Amazonia. *Environmental Management* 13(4): 401-423. http://dx.doi.org/10.1007/BF01867675

Groenendijk, J., Hajek, F., Duplaix, N., Reuther, C., Van Damme, P., Schenck, C., Staib, E., Wallace, R., Waldemarin, H., Notin, R., Marmontel, M., Rosas, F.C.W., De Mattos, G.E., Evangelista, E., Utreras, V., Lasso, G., Jacques, H., Matos, K., Roopsind, I. and Botello, J.C. (2005) Surveying and monitoring distribution and population trends of the giant otter (*Pteronura brasiliensis*) – Guidelines for a standardization of survey methods as recommended by the giant otter section of the IUCN/SSC Otter Specialist Group. *Habitat* 16: 1-100.

Laidler, L. (1984) *The behavioural ecology of the giant otter in Guyana*. Ph.D. Thesis. University of Cambridge, Cambridge, UK. 296 pp.

McTurk, D. and Spelman, L. (2005) Hand-rearing and rehabilitation of orphaned wild giant otters (*Pteronura brasiliensis*) on the Rupununi River, Guyana, South America. *Zoo Biology* 24:153-167. http://dx.doi.org/10.1002/zoo.20042

Oliveira, G.C., Barcellos, J.F.M. and Rosas, F.C.W. (2007) Age estimation in giant otters (*Pteronura brasiliensis*) (Carnivora: Mustelidae) using growth layer groups in canine teeth. *Latin American Journal of Aquatic Mammals* 6(2): 155-160. http://dx.doi.org/10.5597/lajam00120

Oliveira, G.C., Barcellos, J.F.M., Lazzarini, S.M. and Rosas, F.C.W. (2011) Gross anatomy and histology of giant otter (*Pteronura brasiliensis*) and neotropical otter (*Lontra longicaudis*) testes. *Animal Biology* 61(2): 175-183.

Pedroso, N.M. and Santos-Reis, M. (2009) Assessing otter presence in dams: A methodological proposal. *IUCN Otter Specialist Group Bulletin* 26(2): 97-109.

Ribas, C.P. (2012). *Grau de parentesco e relações sociais em ariranhas* (Pteronura brasiliensis). Ph.D. Thesis. Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil. 83 pp.

Rosas, F.C.W. (2004) Ariranha (*Pteronura brasiliensis*) (Carnivora: Mustelidae). Pages 265-269 *in* Cintra, R. (Coord.) *História Natural, Ecologia e Conservação de Algumas Espécies de Plantas e Animais da Amazônia.* EDUA, Manaus, Brazil.

Rosas, F.C.W. and De Mattos, G.E. (2003*a*) Natural deaths of giant otters (*Pteronura brasiliensis*) in Balbina Hydroelectric lake, Amazonas, Brazil. *IUCN Otter Specialist Group Bulletin* 20(2): 62-64.

Rosas, F.C.W. and De Mattos, G.E. (2003*b*) Notes on giant otter (*Pteronura brasiliensis*) behaviour in the lake of Balbina Hydroelectric Power Station, Amazonas, Brazil. *Latin American Journal of Aquatic Mammals* 2(2): 127-129. http://dx.doi.org/10.5597/lajam00042

Rosas, F.C.W., Cabral, M.M.M. and De Mattos, G.E. (2008) Predation or scavenging of giant otter (*Pteronura brasiliensis*) cubs by lizards? *IUCN Otter Specialist Group Bulletin* 25(1): 100–103.

Rosas, F.C.W., De Mattos, G.E. and Cabral, M.M.M. (2007) The use of hydroelectric lakes by giant otters (*Pteronura brasiliensis*): Balbina lake in Central Amazonia, Brazil. *Oryx* 41(4): 520-524. http://dx.doi.org/10.1017/S0030605307005121

Rosas, F.C.W., Zuanon, J.A.S. and Carter, S.K. (1999) Feeding ecology of the giant otter (*Pteronura brasiliensis*). *Biotropica* 31(3): 502-506. http://dx.doi.org/10.1111/j.1744-7429.1999.tb00393.x

Rosas, F.C.W., Cabral, M.M.M., De Mattos, G.E. and Silva, R.E. (2009) Parental and alloparental care of giant otters (*Pteronura brasiliensis*) (Carnivora, Mustelidae) in Balbina hydroelectric lake, Amazonas, Brazil. *Sociobiology* 54(3): 1-6.

Santos, G.M., Ferreira E.J.G. and Zuanon, J.A. (2006) *Peixes comerciais de Manaus*. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA). Pró-Várzea, Manaus. 144 pp.

Schweizer, J. (1992) *Ariranhas no Pantanal: Ecologia e Comportamento da* Pteronura brasiliensis. Edibran-Editora Brasil Natureza Ltda, Curitiba, PR, Brazil. 202 pp.

Staib, E. (2005) *Eco-Etología del Lobo de Río* (Pteronura brasiliensis) *en el sureste del Perú*. Ayuda para Vida Silvestre Amenazada, Sociedad Zoológica de Francfort, Perú. 195 pp.