R E P O R T

REESTABLISHMENT OF GIANT OTTERS IN HABITATS ALTERED BY THE FILLING OF THE TELES PIRES HYDROELECTRIC DAM IN THE AMAZONIA

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(Received 9th January 2017, accepted 5th February 2017)

Abstract: Studies evaluating the influence of river damming on the behavior and distribution of giant otters are still scarce. Here we present temporal data on the influence of the filling of the Teles Pires Hydroelectric Power Plant reservoir in Mato Grosso State, Brazil, on the records of giant otters. No recent evidence of the presence of giant otters was obtained in the first four months after the beginning of the reservoir's filling. Eight months later, the first direct record of a group of three individuals was documented; one year and six months later, different types of direct and indirect records were documented including that of an active den, which is the main indicative of environment colonization by the species. The giant otters in this reservoir may benefit from the abundance increase in fish species observed in the short term after the dam construction. However, a reduction in prey diversity over the years may be a critical factor for the species' maintenance and survival.

Keywords: Amazon basin, dam, distribution, *Pteronura brasiliensis*, reoccupation, hydroelectric reservoir.

The construction of hydroelectric dams, especially in the Amazon, has proliferated in an unprecedented way as a strategy for energy expansion in Brazil (Lees et al., 2016). Changes in river banks and flow regimes promote impacts of such magnitude that a new ecosystem with completely different properties can be formed (Baxter, 1977; Agostinho et al., 2008). The influence of hydroelectric power plants on the distribution and behavior of giant otters is still scarcely known. The longest study has been conducted since 2001 in the Balbina hydroelectric Power Plant in the Amazon (Rosas et al. 2007, 2009; Cabral et al. 2010). Rosas et al. (2007) observed that giant otters adapted well to the new environment by incorporating several elements of the landscape within their living area, including new formed channels and islands. However, Palmeirim et al. (2014) highlighted that although giant otters have

adapted to the environment, the quality of resources in these areas is inferior to that of non-impacted environments, which may negatively influence the abundance and fitness of the species.

Here we present data on the influence of the filling of the Teles Pires Hydroelectric Power Plant reservoir on records of giant otters along the Paranaíta River in Mato Grosso State, Brazil. The Teles Pires Hydroelectric Power Plant is located at the northern end of Mato Grosso State, on the border with the State of Pará, at 60 km from the municipality of Alta Floresta (Figure 1). It has the capacity of 1,820 MW of power and a lake of 152 km^2 whose filling began at the end of December of 2014 and extended until January of 2015. Giant otters have been studied through the Semi-aquatic Mammal Monitoring Program since June of 2012 in five sections covering the Teles Pires River and its tributaries including the Paranaíta River (Calaça et al., 2015). The sampled section of the studied Paranaíta River (between coordinates 09^{o}24'35'' S; 56^{o}43'46'' W and 09^o 35'15" S; 56^o 41'14" W) is 34 km long, was one of the areas most affected by the reservoir's filling, and had its margins completely suppressed where considerable extensions of land were flooded (Calaça et al., 2015).

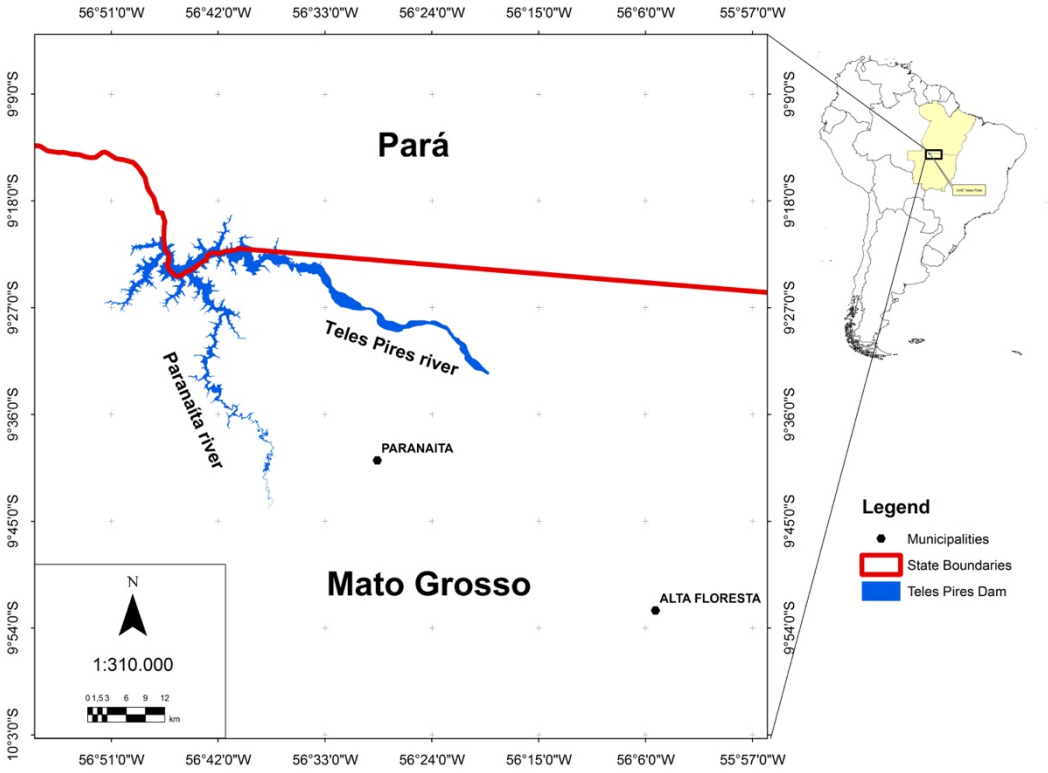

Figure 1. Map of study area at the UHE Teles Pires showing the stretches of the Paranaita and Teles Pires rivers where giant otters were surveyed, on the Northern Mato Grosso State, Brazil.

Sampling campaigns occurred on a quarterly basis during the pre-filling phase (from June of 2012 to December of 2014) and on a semester basis during the post-filling phase (from April of 2015 to the present). In both phases, campaigns last for 10 days and were distributed throughout five stretches with an average effort of 583.4 km per campaign. A 6 m long boat with a 25 HP engine and an average speed of 10 km/h was used to search for any type of evidence of the presence of giant otters.

An effort of 8,168.3 km was used throughout 14 monitoring campaigns in the search for direct and indirect records of giant otters, from which, 1,288 km were traveled in the Paranaíta River. The pre-filling phase included 11 campaigns and allowed the observation of indirect records and five visual records in this river,

including three records of solitary individuals, one record of a group of three individuals, and one of a couple (no offspring was observed in these incidents). However, individuals that were well-characterized by their neck marks were observed only in the last two described incidents because the solitary individuals rarely are able to periscope. The first monitoring campaign in the post-filling phase occurred in April of 2015, four months after the beginning of the filling, when only one inactive den was recorded in this period. The first visual record of a group of three individuals that had not previously been characterized was documented at the end of August of 2015, eight months after the beginning of the filling. At the time, the group was out of the water resting on tree branches originated from the lake's deforestation (Figure 2). In December of 2015, twelve months after the beginning of the filling, the same den recorded on the first post-filling campaign was recorded as still inactive. Finally, in June of 2016, we visualized a new group of three individuals in addition to indirect evidence of a resting site (n = 2), an inactive den (n = 1), and an active camping site (n = 1). We also recorded the reactivation of the monitored den, which was the main indicative of environmental recolonization by the species. Therefore, two new groups, composed of three adult individuals each, were visualized in the post-filling phase. The two groups characterized during the pre-filling phase, however, had not yet been visualized during the post-filling phase.

Thus, it was possible to obtain the first evidence, even preliminary ones, of the presence of giant otters eight months after the beginning of the reservoir's filling, culminating with the return of this species and recolonization of the environment mainly observed through the reactivation of dens. Nevertheless, these observations do not allow stating that the environment is adequate for the maintenance of the species and are indications that individuals are trying to adapt to an environment going through significant changes (Calaça et al., 2015). Semi-aquatic mammals, including giant otter, are strongly influenced by the seasonality dynamics observed in their environments (Duplaix, 1980; Utreras et al., 2005; Leuchtenberger et al., 2013).

Figure 2. Giant otters recorded in the Teles Pires Hydroelectric lake, Mato Grosso State, Brazil. Photo: Luana Monteiro.

It is common for individuals to move to small rivers, lagoons, and streams during floods, following fish migration and considerably expanding their living area (Duplaix, 1980; Leuchtenberger et al., 2013). At least two factors may be related to the small number of the species' records observed in the reservoir in the initial phase of the post-filling period: 1) the change in river flow with a rising water column at the beginning of the filling, which may have triggered a dispersion behavior toward adjacent small rivers, which occurs naturally during flood periods and is also reported in other areas of study (Evangelista and Rosas, 2011; Leuchtenberger et al., 2013; Georgiadis et al., 2015). Therefore, many of these areas are of difficult access to researchers, which makes the recording of observations difficult (Rosas et al., 2007; Georgiadis et al., 2015); 2) relevant changes in water quality may also drive the dispersal of giant otters to adjacent small rivers where the water quality is usually less affected (Agostinho et al., 2015). The first few months after the filling of reservoirs represent the most critical phase for species living in aquatic environments because, in addition to physical and spatial alterations, they are affected by the decomposition of plant material, oxygen reduction, and release of large amounts of gases and these events lead to the death of tons of fish as the result of chemical and thermal water stratification (Agostinho et al., 2008). Fortuitous reports have been documented regarding the presence of groups of giant otters foraging in small rivers and marginal lagoons in farms that are located 3 km away from the studied reservoir area.

According to Rosas et al. (2007), the success in the colonization of environments by giant otters depends on their presence in the area before the disturbance, which was observed during the pre-filling stage in this study, in addition to a minimal degree of human occupation. Oliveira et al. (2015) have also shown that human density is a preponderant factor in the establishment of this species and can greatly influence the number of records. The density of dwellings and people is very small in the studied area, with no evidence of occupation on the reservoir's banks, which is predominantly comprised of pasture that belongs to farms located a few miles away. This aspect may contribute to the successful reestablishment of the species (Duplaix et al., 2015).

The main and largest environmental filter present since the beginning of the reservoir's filling is related to the quality of food resources (Palmeirim et al., 2014). Fish, which depend exclusively on the aquatic environment, are generally most affected by the construction of hydroelectric power plants, especially species with migratory habits that need to seasonally move upstream to complete their reproductive cycle at the headwaters of the great Amazonian rivers (Cella-Ribeiro et al., 2015). Relevant habitat alterations promote a spatial redistribution of fish species in the water column. A significant increase in their abundance is observed due to the high productivity observed in the first months after filling (heterotrophic phase), especially in those sedentary species inhabiting shallow water environments (Agostinho et al., 2008, 2015). Fish with these attributes are generally the most consumed by giant otters in impacted and non-impacted environments (Rosas et al., 1999; Cabral et al., 2010). Consequently, giant otters may benefit from this sudden increase in the abundance of these resources. A "boom" in these fish species has been observed in the studied reservoir after the filling, including in the monitored section of the Paranaíta River. Nevertheless, a pattern has been observed in the damming of some rivers in which, over the years, the phase of high productivity is succeeded by a period of resource depletion where there is a sharp fall in the quality and quantity of nutrients until the environment reaches the trophic equilibrium, period when fish diversity is reduced (Orsi and Britton, 2014; Agostinho et al., 2015). This transition phase will certainly be critical for the maintenance of giant otters in the Teles Pires reservoir.

The consequent changes in the quantity and quality of resources in a temporal sequence can lead to a cascade of alterations, including the medium and long-term population dynamics of otters such as those observed by Palmeirim et al. (2014) in the Balbina Hydroelectric Reservoir where population growth has considerably reduced when compared to a non-impacted environment. Unfortunately, the small number of visual records obtained in the study area does not allow inferring the rate of births and deaths between the implementation and operation phases of the hydroelectric plant. Nevertheless, the data allows monitoring the overtime variance of the rate of records and composition of groups according to resource abundance and depletion in the post-filling phase. Thus, alterations in the composition of ichthyofauna and in the consequent food diet of giant otters will predict the impact of the formation of this reservoir on the maintenance and survival of this species. These data will only be obtained in the medium and long-term. We can state that the return and reestablishment of the species have occurred in the short-term after eight months from the reservoir's filling. The giant otters in the studied area might at least temporarily benefit from the high abundance of fish observed in the reservoir.

Acknowledgments - We thank the Teles Pires Energy Company (CHTP), Biota Projects and Environmental Consulting, and CP+ Environmental Consulting Services for the logistic support. We are also thankful to Diego Silva and Rafael Grisostenes for their assistance in data collection, Luana Monteiro for valuable information on post-filling records, and the technicians Edson Dias, Ozebio de Souza, and Joaci Batista for their assistance in the field.

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RESUMÉ

RÉESTABLISSEMENT DES LOUTRES GÉANTES (*Pteronura Brasiliensis*) DANS DES HABITATS ALTERÉ PAR LE REMPLISSAGE DU BARRAGE HYDROÉLECTRIQUE TELES PIRES EN AMAZONIE

Les études évaluant l'influence du barrage de rivière sur le comportement et la distribution de la loutre géante sont toujours peu abondantes. Nous présentons ici des données temporelles sur l'influence du remplissage du réservoir de la centrale hydroélectrique de Teles Pires sur la détection des loutres géantes dans l'état de Mato Grosso au Brésil. Aucune preuve récente sur la présence de loutres géantes n'a été obtenue au cours des 4 premiers mois après le début du remplissage du réservoir. Huit mois plus tard, le premier enregistrement direct d'un groupe de trois animaux a été documenté ; 1 an et demi plus tard, différents types d'enregistrement directs et indirects ont été documentés incluant celui d'une tanière active, qui constitue la principale preuve de colonisation de cet environnement par cette espèce. Dans ce réservoir, la loutre géante pourrait bénéficier de l'augmentation de l'abondance d'espèce de poisson observé après la construction du barrage. Cependant, une réduction de la diversité des proies au cours des années pourrait être un facteur critique pour le maintien des espèces et leurs survies.

RESUMEN

RE-ESTABLECIMIENTO DE LA NUTRIA GIGANTE (*Pteronura brasiliensis*) EN HÁBITATS ALTERADOS POR EL LLENADO DEL EMBALSE HIDROELÉCTRICO DE TELES PIRES, AMAZONIA

Los estudios que evalúen la influencia del represamiento de ríos en el comportamiento y distribución de las nutrias gigantes son aún escasos. Aquí presentamos datos temporales acerca de la influencia del llenado del reservorio de la Planta Hidroeléctrica de Teles Pires, estado de Mato Grosso, Brasil, en los registros de nutria gigante. En los primeros cuatro meses después del comienzo del llenado del reservorio, no se obtuvo evidencia de la presencia reciente de nutrias gigantes. Ocho meses después, se documentó el primer registro directo de un grupo de tres individuos; un año y seis meses después, se documentaron diferentes tipos de registros directos e indirectos, incluyendo una madriguera activa, que es el principal indicador de colonización del ambiente por esta especie. Las nutrias gigantes en este reservorio se pueden beneficiar del incremento en la abundancia de especies de peces que se observó en el corto plazo luego de la construcción de la represa. Sin embargo, una reducción en la diversidad de presas a lo largo de los años puede ser un factor crítico para el mantenimiento y supervivencia de la especie.