NOTE FROM THE EDITOR

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Dear Friends, Colleagues and Otter Enthusiasts!

We have reached summer in Europe and issue 39/1 has been closed and we are opening issue 39/2. We are now in a changed world and after 2 years of a pandemic situation we experience a war in Europe. Something that has changed the life for many. I do hope that we come out of this situation in a good way.

This current issue is in fact already complete, and manuscripts will go online over the coming weeks. We have received interesting manuscripts so keep coming back every now and then.

I also want to urge all potential authors to carefully study the guidelines for authors before submitting manuscripts. Especially I want to stress that it is the responsibility of the authors to ensure completeness of the list of references used in the text and in the reference list. It is not the task on our side to try to identify missing references and we have now started to move papers down the pipeline of going online until the list is completed by the authors.

If you have not already made plans for September, you may consider now to attend the 15th IUCN/SSC OSG International Otter Congress (https://www.otterspecialistgroup.org/osg-newsite/15th-ioc/).

While it was really very exciting to see so many manuscripts arriving last year this also seriously increased the workload for Lesley. Without the efforts of Lesley, the IUCN OSG Bulletin would not be what it is today. Therefore I want to thank you Lesley for all your efforts on behalf of all of us!

ARTICLE

GROUP DYNAMICS AND HABITAT USE OF THE GIANT OTTER, *Pteronura brasiliensis* (ZIMMERMANN, 1780), IN SEASONALLY FLOODED FOREST IN THE ARAGUAIA RIVER, CENTRAL BRAZIL: A 10-YEARS STUDY

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Abstract: We carried out monthly surveys of the giant otter population between 2010 and 2020 in a study area comprised of 1,500 hectares of igapó flooded forest with oxbow lakes in the Cantão region of central Brazil. We recorded 16-32 resident adults in the study area each year, distributed in 4-8 groups. Resident groups exhibited extensive home range overlap, with each group using several lakes and larger lakes used in rotation by up to six groups. Dens and campsites were also shared by multiple groups, but lakes were used by only one group at a time, and encounters between groups were very rare. Twenty-four adult otters were observed to join an existing group. Some individuals changed groups multiple times. Resident adult turnover was high. Each year an average of 36% of resident adults were new immigrants, and 72% of groups left the area within two years. Resident groups had, on average, one litter every three years, and annual cub production showed high variability and a negative correlation to the number of new immigrants in the area. No pairs of giant otters reproduced successfully during the study. Groups of three otters formed through the recruitment of an adult individual by an existing pair and reproduced as successfully as larger groups. Group dynamics and territorial behavior in the Cantão flooded forest ecosystem, where optimal giant otter habitat is continuous in all directions, were found to be different from that reported in areas composed of patchy (isolated oxbow lakes) or linear (rivers) habitat. This suggests that giant otter social and territorial behavior is plastic and adapts to the spatial characteristics of the habitat.

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INTRODUCTION

The giant otter (*Pteronura brasiliensis*) is an endangered top predator of tropical South American lakes and rivers (Carter and Rosas, 1997; Duplaix et al., 2015; Evangelista and Rosas, 2011a; Rodrigues et al., 2013). Giant otters originally ranged broadly from the Andes to the coast of Brazil, but they were extirpated from much of their range by hunting for the pelt trade, primarily between 1940 and 1980. Today the easternmost remnant population of the species occurs in the Araguaia river basin of central Brazil.

The Cantão Ecosystem

The Cantão wetlands ecosystem is located at the confluence of the Javaés and Araguaia rivers, in the state of Tocantins in central Brazil (Fig. 1). The region is a

sharp ecotone between the Cerrado and Amazon biomes, with exceptional biodiversity (Tocantins, 2016). The Javaés, a large blackwater river, is a 400-km offshoot of the Araguaia that flows around the world's largest freshwater island, Ilha do Bananal. Where it flows back into the Araguaia it forms a 100,000-hectare inland delta named Cantão, an elongated triangular floodplain crisscrossed by meandering channels and dotted with over 900 oxbow lakes. This is the largest expanse of suitable habitat for giant otters in the Araguaia river basin, and the species is reported to be common in the area (Georgiadis et al., 2015; Tocantins, 2012).

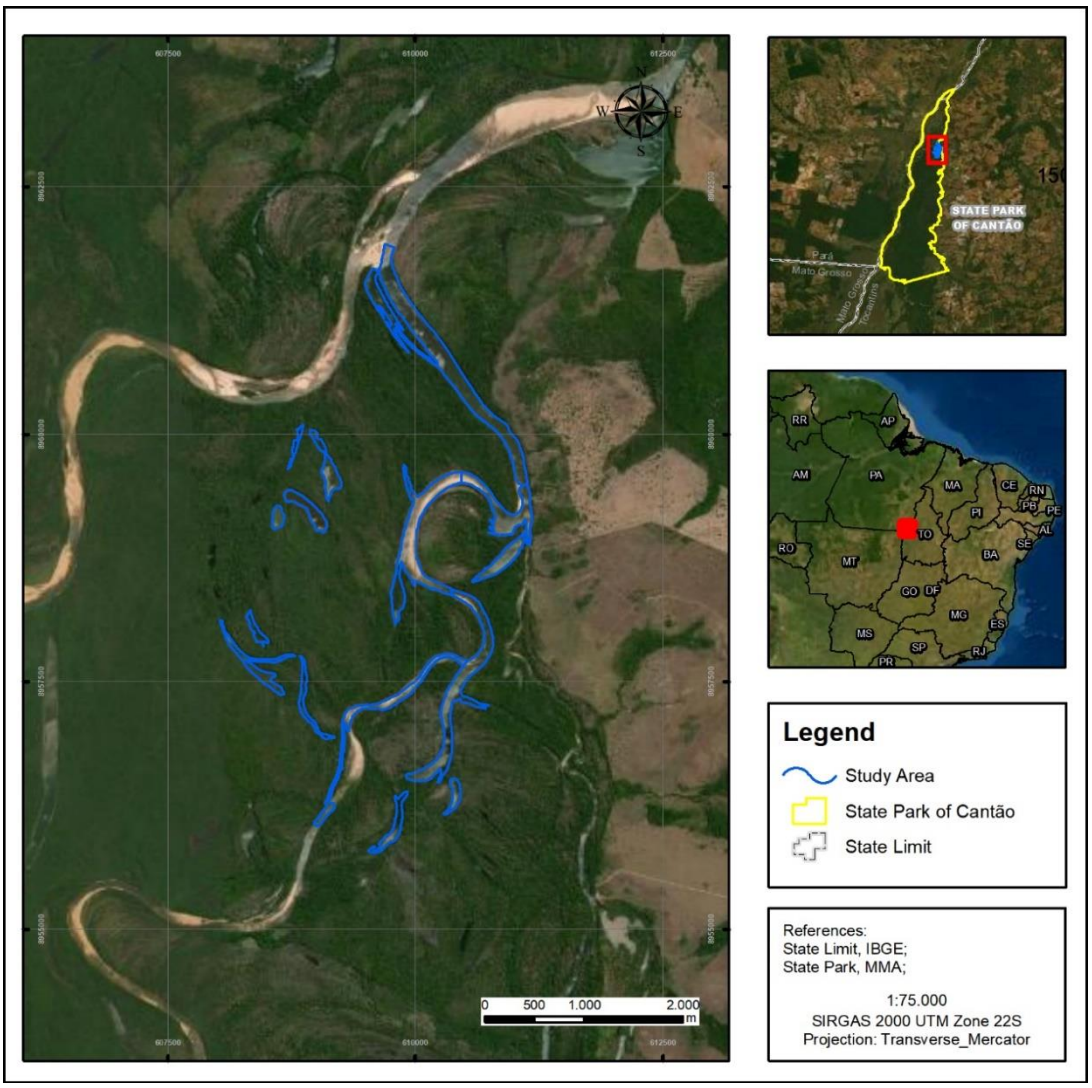

Figure 1. Study area in Cantão, Javaés river basin, Brazil

Between December and May, the rising waters of the Araguaia dam the Javaés, and the entire delta floods with dark acidic waters, connecting the lakes. The igapó flooded forest which grows in Cantão is adapted to this cycle, with most tree species growing and fruiting during the peak of the flood and dropping their fruit into the water, where they are consumed by a wide variety of frugivorous fish. The dominant tall tree species are the landi (*Callophylum brasiliensis*) and the piranheira (*Piranhea trifoliolata*), which grow to over 20 meters height. Non-forest habitat includes areas of shrubby vegetation characterized by sarã (*Sapium haematospermum*) and goiabinha (*Psidium riparium*), which turn into marshes where blatterwort (*Utricularia* sp.) and other floating vegetation proliferate in the wet season. Shrub

and marsh habitats occur on recently deposited sediment and cover less than 5% of the area of Cantão, but are sunlit and very productive during the floods, concentrating schools of fish like pacús (*Myloplus* sp.) and piranhas (*Serrasalmus* spp.).

In May water levels begin to drop quickly, and between June and September there is little to no precipitation. During the dry season the marshes and flooded forest dry out completely, and fish become concentrated in the lakes and in deep pools along river channels. Most fish predators, including giant otters, arapaima, peacock bass, caimans, and wading birds reproduce during this season.

To the east the Cantão floodplain is bordered by rolling plains of Cerrado vegetation, from which it is separated by the narrow Coco River, actually the easternmost channel of the Javaés delta. To the west it is bordered by the Araguaia river, which is up to three km wide here. Due to the very flat nature of the central Araguaia basin, seasonally flooded habitat similar to that found in Cantão also occurs in narrow strips and on river islands for hundreds of kilometers upstream along the Araguaia and Javaés rivers and their tributaries, although much of this has been altered by dams and irrigation projects in recent years.

Due to the abundance of nutrients made available by the annual flood, the aquatic ecosystem of Cantão is exceptionally rich and productive, hosting over 298 species of fish, whose abundance is among the highest known for Amazonia (Ferreira et al., 2011). At the base of the food chain are many species of pacú, which feed primarily on fruit dropping from the flooded vegetation; piranhas, which are omnivorous, eating fish and falling arthropods as well as vegetable matter; and piaus (*Schizodon vittatus*), whose specialized lips allow them to feed on the rich layer of mucus and microorganisms which cover the submerged vegetation. All of these are in turn preyed upon by an abundance of larger predators, including giant otters (Rosas-Ribeiro et al., 2012). Other large aquatic apex predators that are common in Cantão include black caiman (*Melanosuchus niger*), Araguaia river dolphins (*Inia araguaiaensis*), and arapaima (*Arapaima gigas*).

Most of the Cantão ecosystem is protected within 90,000-hectare Cantão State Park. The park is bordered by river channels on all sides and contains over 850 oxbow lakes with surface area greater than one ha, and over 240 km of channels meandering through its interior. Until 2017 the park was considered one of the best managed protected areas in the Brazilian Amazon (Brasil, 2017) and was relatively well funded and staffed. The park is completely uninhabited except for a small area near the town of Caseara, which has been used by local people for seasonal agriculture since before the creation of the park. Fishing is prohibited inside the park, and most of it is off limits to unauthorized persons. Despite this, much of the park is vulnerable to invasion by fish poachers, who seek high value species like arapaima and tucunaré (*Cichla* spp.) which have been depleted outside the protected area. These poachers set up clandestine camps and fish nearby lakes until they are depleted. They not only reduce availability of fish prey, but also scare away or shoot giant otters, which they blame for declining fish stocks. Policy changes starting in 2019 have weakened park management, with patrols becoming less frequent and poacher activity intensifying.

MATERIALS AND METHODS

We conducted our studies in the vicinity of Instituto Araguaia's research station. The station is located in Instituto Araguaia's 540-hectare private inholding within Cantão State Park, thus facilitating logistics for the fieldwork. This area includes 15 oxbow lakes and 9,300 m of river channels. During the low water season, the river channels themselves become a string of long deep pools, ecologically very similar to oxbow lakes, separated by shallow sandbanks. The study site includes one

of these stretches of river channel, totaling 16 lakes or lake-like bodies of water which retain water depths greater than two meters during the dry season. The largest lake, Lago Grande, is 2,220 m long and 110 m wide and remains connected to the river channel year-round. The other lakes range from 230 m to 1,218 m in length. These bodies of water are contained within a perimeter encompassing approximately 1,500 hectares of igapó flooded forest, with some marshes. The site is representative of the Cantão ecosystem as a whole, containing roughly proportionate samples of each of the park's natural communities. It is also one of the sectors of Cantão State Park least impacted by fish poachers, who are dissuaded by the year-round presence of Instituto Araguaia's researchers, rangers, and volunteers.

Surveys followed the 'Population Census Methodology Guidelines for the Giant Otter' (Groenendijk et al., 2005). In the dry season, lakes and river channels were surveyed using canoes, and isolated lakes were surveyed on foot. In the wet season, lakes, channels, flooded marshes, and igapó forests were surveyed by canoe. Traditional dugout canoes, as well as fiberglass canoes, were used, powered by 44-pound electric motors. We found that giant otters are less disturbed when approached with an electric motor than by paddling because with the electric motor the observer can remain silent and motionless.

Surveys were conducted between sunrise and 11:00h, and between 15:00h and sunset, which are the giant otters' peak hours of activity (Duplaix et al., 2015; Staib, 2005). When giant otters were sighted, the group was followed from a distance large enough to avoid alarming the animals (between 30 and 200 meters, depending on the behavior of the group). Panasonic DMC-FZ series cameras with 18-50x optical zooms were used to film and photograph the giant otters, allowing subsequent identification of individuals by their throat markings and accurate counts of group size. Data from direct observations were complemented with images from Reconyx and Bushnell camera traps (several models over the years), placed at the entrance of active dens, on campsites, and along giant otter trails between lakes.

Survey years were defined to extend from May 1 to April 30 of the following year to coincide with the period between peak floods and to encompass a full giant otter reproductive season. For survey purposes, two stretches of the river channel within the core area that remain deep enough in the dry season for giant otters to swim and forage were classified as "lakes". Both of them are isolated from other water bodies by extensive shallow areas during the dry season and are very similar to lakes in terms of dimensions and habitat characteristics.

Regular surveys started in September 2010 encompassing four lakes around Instituto Araguaia's research station. In 2011 surveys were carried out in eight lakes, in 2012 in 12 lakes, and from 2013 to 2019 surveys covered the entire core study area, defined to include 16 lakes and lake-like stretches of deep river channels. In 2020 it was not possible to adequately survey one group of three lakes on the eastern edge of the study area because armed fish poachers set up a permanent camp in the area during the dry season. Surveys were conducted monthly between August 2010 and April 2021, for periods varying between four and 23 field days. In the dry season (June-November) every lake in the core area was surveyed by researchers at least once a week, with camera traps left at active dens and campsites. In the wet season access to parts of the area was blocked during periods when water levels were too high for surveys on foot but not high enough to allow access by canoe. During these periods most lakes were surveyed at least once a month, and temporarily inaccessible lakes were surveyed using camera traps left at known wet season den sites for periods of up to two months. Additional data was obtained during annual expeditions to lakes in the region adjacent to the core study area, as well as to other sectors of Cantão Park.

A sighting catalog for individual giant otters was developed according to Groenendijk et al. (2005). Individuals were identified by their unique throat markings. Each individual entered into the catalog was given a name and an identifying number. Each group recorded also received a group number. Groups whose composition changed were considered to be the same group when at least 60% of the individual members remained constant (Groenendijk et al., 2005). Sex information was obtained when possible by the identification of sexual characteristics in videos and camera trap images.

Giant otters were considered to be resident in the core study area if they exhibited territorial behaviors (denning, use of latrines, or actively approaching intruders while periscoping) and were recorded within the study area on at least three separate days for a period of 30 or more days. Groups and solitary otters that did not fulfill these criteria were considered to be transient and were excluded from the analyses of habitat use and range overlap but were included in the analyses of group size and composition. Giant otter records obtained inside the flooded forest during the wet season were assigned to the nearest lake for home range evaluation.

Animals recorded were classified into three age groups: “Newborn cubs” were defined as animals up to around 60 days old, which remain inside the den and cannot enter the water on their own, although they may sometimes be seen briefly outside the den entrance, or while being carried by adults; “free-swimming cubs” are animals 60-180 days old which are able to enter the water on their own, initially for brief swimming lessons with the adults and later to follow the adults in their daily foraging, and which can be identified as cubs by their swimming behavior and size (Groenendijk et al., 2005); all other animals were classified as “adult-sized”.

It was often possible to distinguish juveniles up to one year old from older individuals but, to be able to use data from multiple observers, we did not use this information in our analysis. Only records of free-swimming cubs were included in the data analysis. Records of newborn cubs could only be obtained opportunistically and were excluded from the analysis because we had no way of determining the mortality rate of cubs before they became free-swimming and could be observed reliably. Litter sizes and cub survival rates were calculated based on the number of free-swimming cubs recorded each season that survived until the following year.

Annual turnover rate of resident adult individuals at the study site was calculated by dividing the number of resident adults that were not resident on the previous year by the total number of resident adults on the site each year. The same calculation was performed for resident groups. Dispersal distances were calculated both in a straight line and along the shortest water route, following meandering river channels and lakes.

Although we analyzed our results in the light of published material regarding giant otters, we did not identify many long-term continuous surveys similar to our study which could serve as a comparative parameter to our data.

RESULTS

We obtained 3141 records of giant otters during the study, 2651 through camera traps and 490 through direct observation. We were able to identify 168 individual giant otters. The total number of adult-sized otters recorded in the studied area each year varied from 16 to 32 (mean=23; SD=6), distributed between 4 and 8 groups (mean=5; SD=1.2) (Fig. 2).

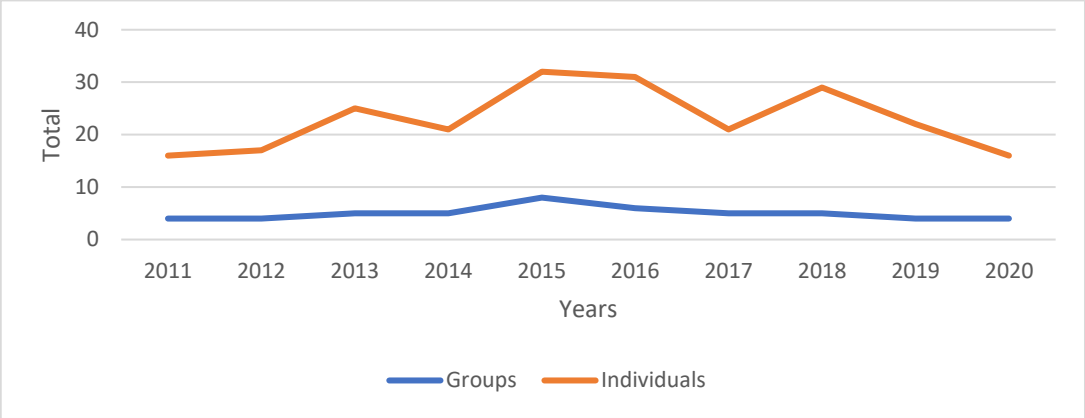

Figure 2. Total number of giant otter individuals and groups in the study area in Cantão, Brazil

The annual turnover of individuals and groups in the core study area was high. Between one and 17 of the resident adult giant otters recorded each year (or 5-68% of all resident adults recorded; mean=36%) were new residents that had not been present in the previous year (Fig. 3). These immigrants moved into the study area either as entire groups or as individuals that joined a resident group (Fig. 4). 72% of groups whose arrival date into the study area was known remained resident in the area for two years or less before moving elsewhere. A single group remained in the area for 8 years and is still present as of July 2021 (Fig. 5).

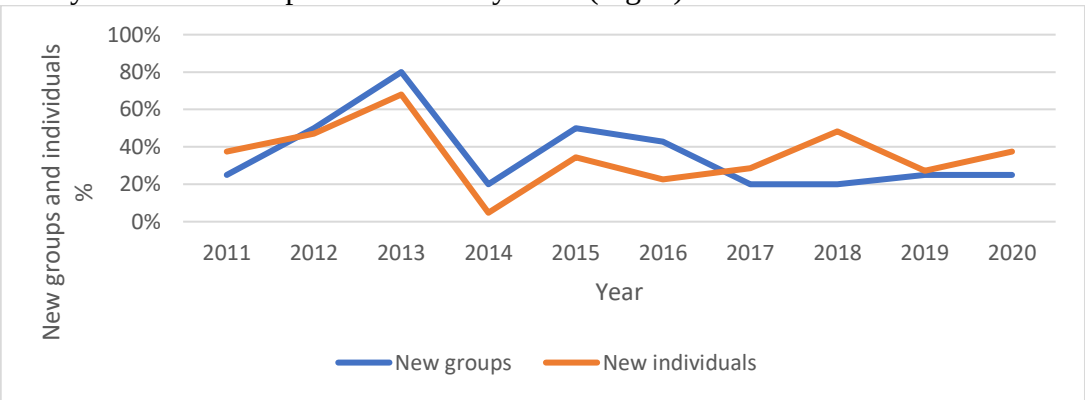

Figure 3. Annual turnover rate of individuals and groups (%) of giant otter in the study area in Cantão, Brazil

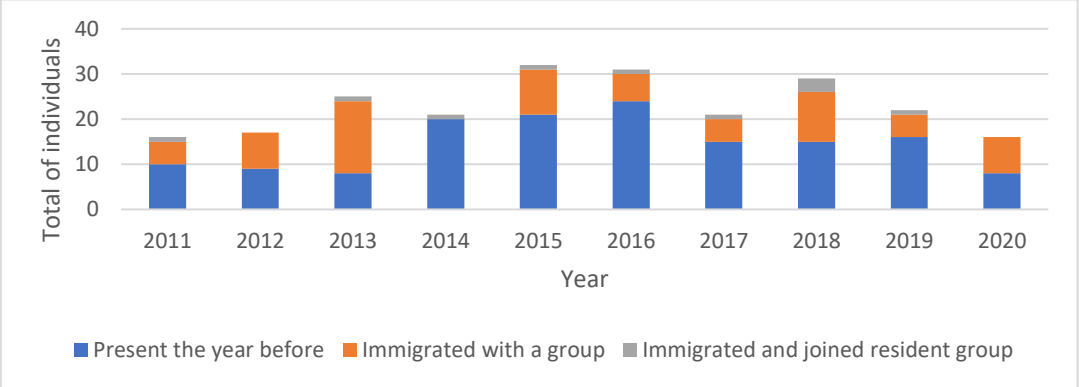

Figure 4. Number of individuals of giant otter recorded in the study area in Cantão, Brazil

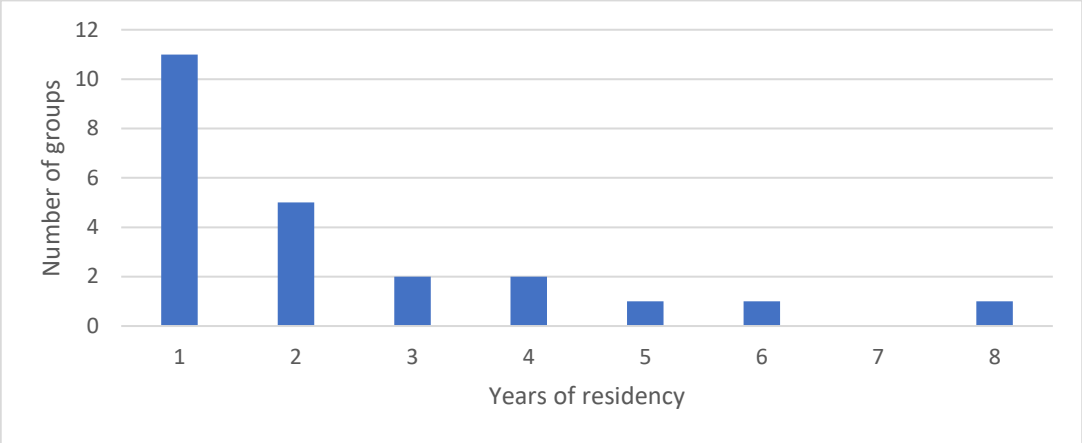

Figure 5. Years of residency of giant otter groups in the study area in Cantão, Brazil

Habitat Use and Range Overlap

Resident giant otter groups exhibited extensive home range overlap within the core study area. Most groups used several lakes throughout the year, but the set of lakes used by each group changed from year to year. Small, isolated lakes tended to be used by a single group each year. Over the ten years of the study, in the 11 monitored lakes that are less than 1,000 meters long, only five instances were recorded of a lake being used by more than one group during the same year. Three of these instances took place in lakes located within 100 meters of a larger lake which was also being used by one or more of the groups. Of the 5 monitored lakes longer than 1000 meters, two (Quebra-Linha and Lago do Estirão) are undergoing siltation due to natural processes and are significantly narrower and shallower than most large Cantão lakes. These were used by 1–3 groups each year. The remaining three bodies of water longer than 1000 meters (Lago Grande, Estirão, and Lago das Ariranhas) are relatively wide and deep over most of their lengths (Fig. 6). Throughout the survey, most (52 %) records of resident groups were obtained in these three lakes, with each lake being used by up to six groups at different times over a single year.

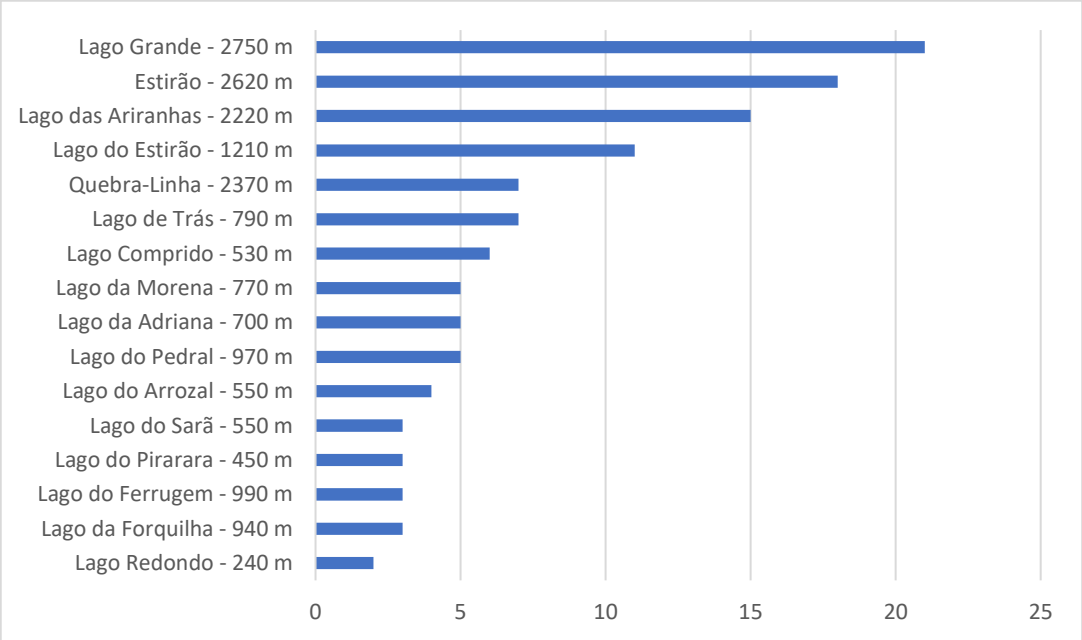

Figure 6. Total number of groups of giant otter recorded at each lake in the study area in Cantão, Brazil

Lake usage patterns observed were highly variable (Fig. 7). Groups rarely remained in each lake for more than a few hours before moving on. A group might

use a particular lake once or several times over a few days, and then not return to it for a period ranging from a few days to until the following year. Some groups returned to certain lakes regularly over multiple years, while other groups used them sporadically, with long intervals between visits.

During periods when two or more groups shared a lake, usage patterns varied from each group using the lake on different months to two or more groups using the lake on alternate days over 1-2 weeks. Only 16 times throughout the survey there was more than one group recorded in a given lake on the same day. While using lakes, groups tended to use the same dens and campsites as the previous groups. Denning sites and campsites in prime locations were used almost continually by as many as 11 different groups throughout the survey.

During the annual floods, giant otters extended their range into the flooded areas between lakes. Most giant otter encounters during this season occurred inside the flooded vegetation, although most records of throat markings were obtained while the animals were crossing open water or by camera traps. During the floods, groups were observed to use lakeside dry-season dens and campsites located on ground high enough to remain above water, but also campsites on patches of high ground within the flooded forest, far from open water.

Group Dynamics

Observed group size ranged from 2 to 8 individuals (mean=4.1, median=4, n=55) (Fig. 8). Group size and composition changed over time with births, adult individuals joining existing groups, and individuals disappearing.

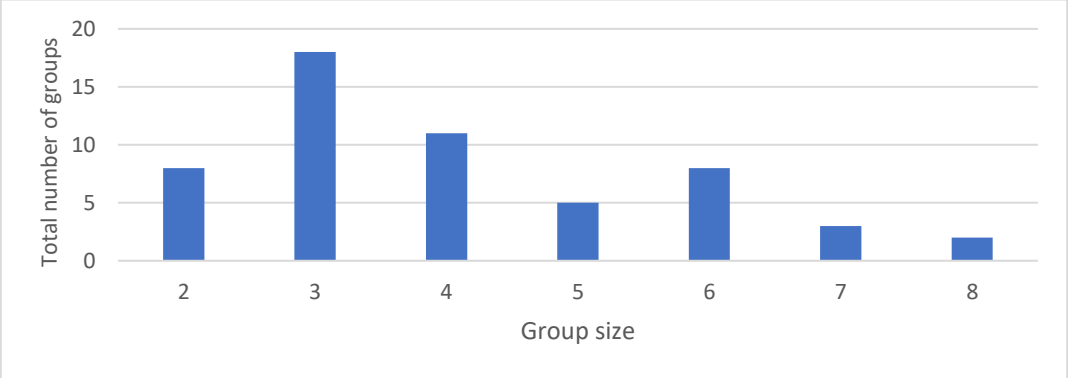

Figure 8. Size of groups of giant otter in the study area in Cantão, Brazil

We recorded 24 episodes of adult-sized giant otters joining a group of two or more animals. In 11 of these observations, the new otter was formerly a member of a resident group. Three otters joining groups were resident solitaries, and 10 were new to the area. In two cases the new group members subsequently left the group and joined a different group. Of 18 adult-sized individuals of known sex that joined existing groups, 13 (72%) were male. Of the individuals that were new to the study area and joined a resident group whose sex was determined, three were male and two were female. In 16 cases where we were able to determine the status within the group of the new member, three became the reproductive female, three became the reproductive male, and the remainder (two females, two males, and six of undetermined sex) became non-reproductive subordinate group members. One of the subordinate females became the breeding female of her group when the original breeding female disappeared after three years.

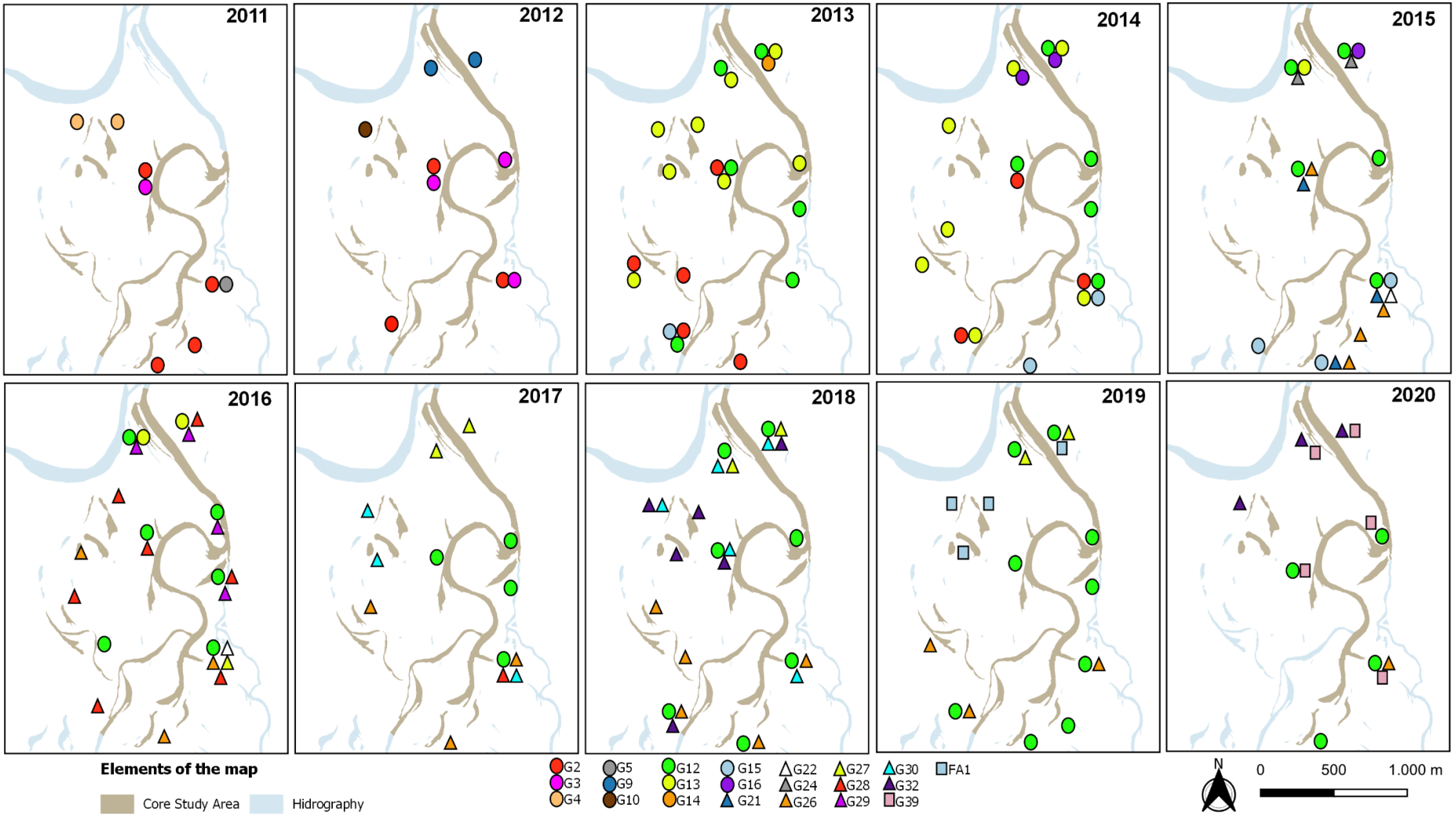

Figure 7. Lake usage by resident groups of giant otter in the study area in Cantão, Brazil

19 groups formed by three giant otters were recorded in the core study area. 18 of these trios (94%) were resident groups. Six groups of three otters were formed when a preexisting pair of giant otters was joined by a third adult-sized individual, and one group of three otters was composed of former members of three different resident groups. This group was first recorded after it had formed so it was not possible to determine whether it also started as a pair that was later joined by a third individual. Of the five individuals that joined a pair to form a group of three whose sex was determined, four were male. One group that was first recorded as a trio consisted of two males and one female. The remaining groups of three were either already formed when first recorded or were the remnants of a larger group that had lost members. We observed immigrant groups or individuals of giant otters dispersing distances up to 16.5 km of linear distance (Table 1).

Table 1. Dispersal distances for immigrant groups of giant otter and individuals of known origin, in the study area in Cantão, Brazil

Individual or Group	Dispersal Year	Place of Origin	Dispersal Place	Linear Distance	Shortest Water Route
Pb_52	2014	Estirão	Lago da Sede do Parque	10.92 km	13 km
Pb_52	2015	Lago da Sede do Parque	Lago Grande	14.05 km	17.4 km
Pb_81	2015	Lago da Lua	Lago Grande	16.5 km	31.6 km
Pb_52	2016	Lago Grande	Paredão	5.93 km	9.44 km
FA1	2019	Lago do Pequizeiro	Lago Comprido	9.01 km	13.06 km

28 solitary giant otters were recorded in the core study area. Eleven of these met the criteria to be classified as a resident, and three of these were formerly members of resident groups. The remaining solitaries were transients. Resident solitaires were often observed to approach boats and periscope. Nine of the solitary otters recorded subsequently formed pairs or joined existing groups in the study area, and seven of these had been resident solitaries during the previous year. Of 12 solitary giant otters whose sex was determined, eight were male and four were female. Of 4 transient solitaries of known sex, three were male.

23 pairs of giant otters were recorded in the study area throughout the survey. Of these, nine were residents and 14 were transient. Only one resident pair remained in the area as a pair for more than one year. All other resident pairs either left the area or were joined by a third adult animal within one year. 21 pairs were formed during the study. All consisted of at least one member that was a former resident of the study area, and in five pairs both members were former residents. Only two pairs were formed by new members to the area. Of 28 individual otters of known sex that formed pairs, 17 (68%) were former residents (eight males and nine females) and eight were new to the area (six males and two females).

Figure 9 illustrates the changing composition and exchange of members over time of 17 giant otter groups monitored during the study. Group 2, a breeding resident group, was joined by an adult-sized female in 2011, which remained subordinate to the breeding pair. In 2013 the breeding male disappeared and was replaced by Pb 53, a new male arrival. In 2014 this new male bred with the 2011 female and was assisted in rearing the cubs by two remaining offspring of the original breeding pair. In 2015 the group left the core study area. Group 12 immigrated into the study area with three members in 2012, being two males and a female, and was soon joined by a female (Pb 30) whose parental group disappeared from the study area. Within a week one of

the males left G12 to become the breeding male of G13, a group of five otters. In 2014 G12 had a litter, and Pb 30 acted as a babysitter for the breeding pair. In 2013 Pb 30 left the group to form a pair with Pb 91, a new arrival to the study area. G12, now with three adult-sized members, had two more litters, and in 2019 was joined by a male giant otter that assumed a subordinate role to the breeding pair. Meanwhile, after an unsuccessful attempt to breed, individual Pb 30 disappeared from the area and her mate, Pb 91, formed a trio with two other animals, one of which was Pb 53, which had left G2 and returned to the study area after a year's absence.

Reproduction

We recorded 17 litter events that produced 42 cubs that reached the free-swimming stage. Litter size at the free-swimming stage ranged from 1-5 (mean=2.5; median=2) (Fig. 10). Seven cubs too young to enter the water on their own were also recorded, and five of these (71,5%) disappeared before reaching the free-swimming stage. All first records of free-swimming cubs occurred between June and December, suggesting that births took place between April and October.

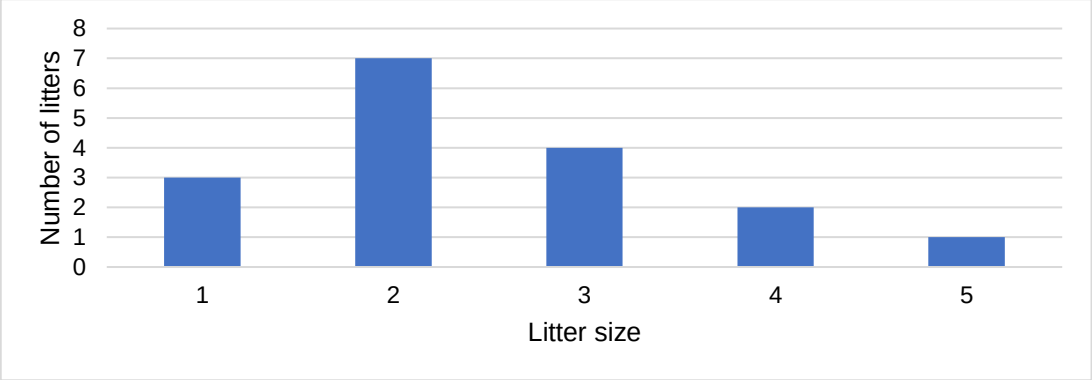

Figure 10. Number of litters and litter size of giant otters in the study area in Cantão, Brazil

The number of cubs produced per year in the core study area between 2012 and 2020 ranged from 0 to 12 (mean=4.2) and showed high annual variability (Fig. 11). Resident groups had, on average, one litter for every three years of residency (n=55). The average number of free-swimming cubs produced per year per resident adult (including both breeding and non-breeding group members) was 0.18 (n=228).

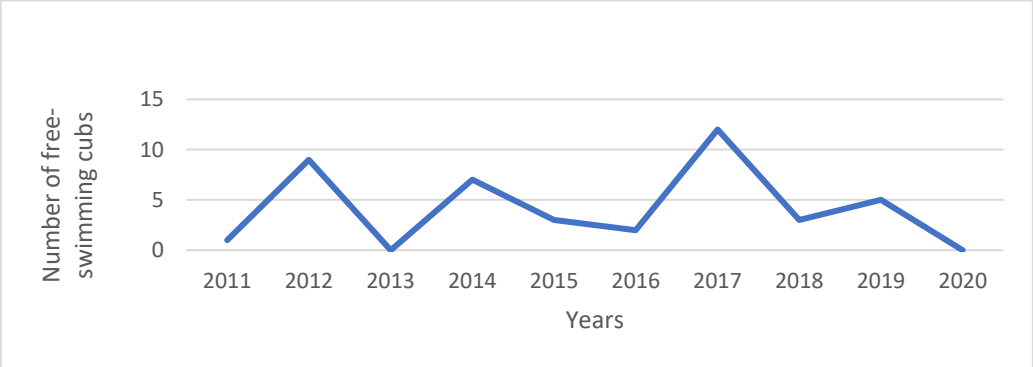

Figure 11. Annual number of free-swimming cubs (approx. 60 days old) of giant otters in the study area in Cantão, Brazil

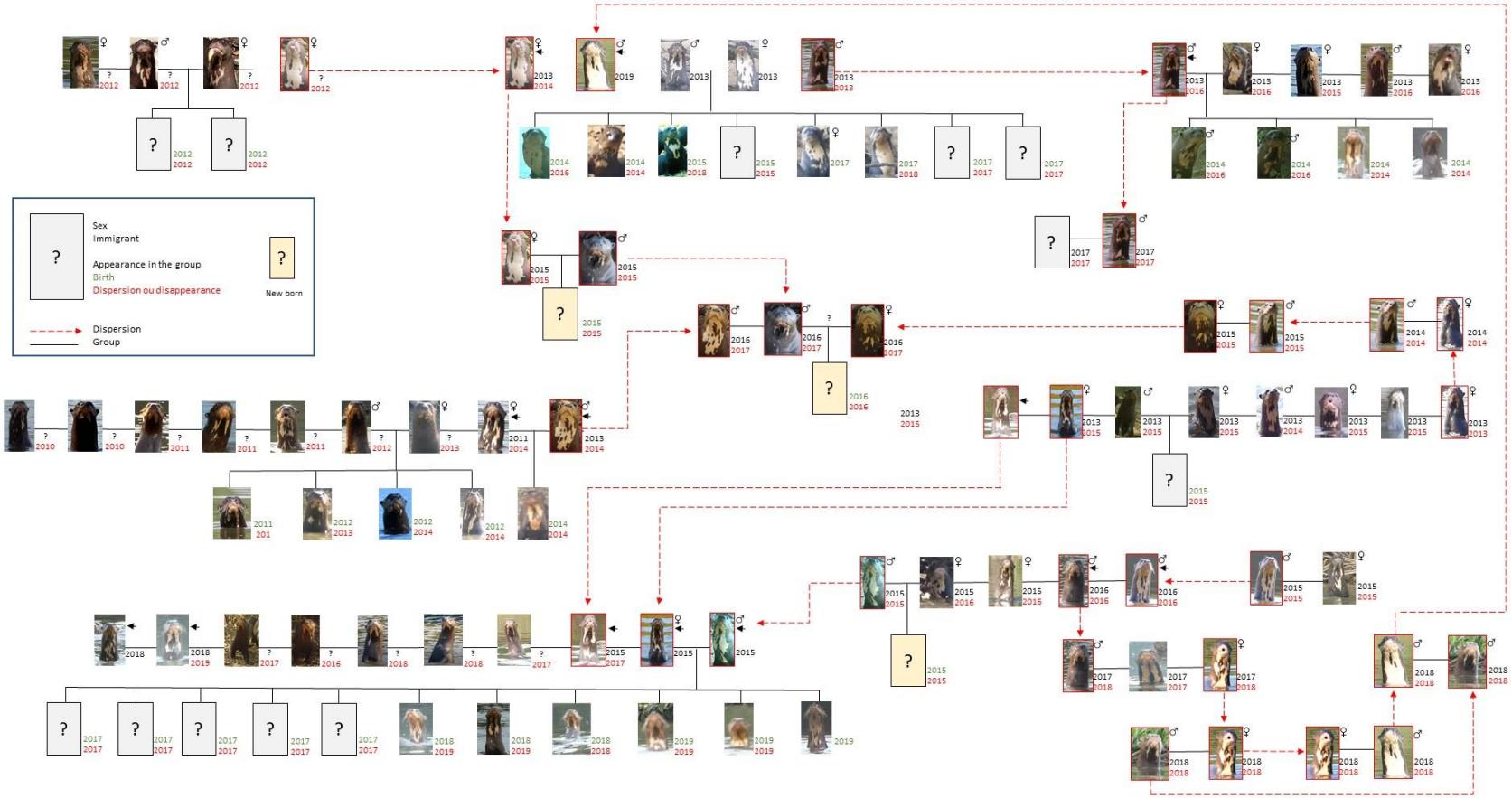

Figure 9. Member turnover and formation dynamics of giant otter groups in the study area in Cantão, Brazil

Only one pair was observed to have reared cubs to the free-swimming stage while residing in the core study area, and these cubs disappeared a few weeks later. Two other pairs were recorded to have produced newborn cubs that did not survive to the free-swimming stage (Table 2).

Table 2. Number of litters by group size of giant otter in the study area in Cantão, Brazil

Group Size	Number of Group-Years	Number of Litters	Litters per Group-Year	Total Free-Swimming Cubs	Cubs/Group	Free-Swimming Cubs/Adult (All Adults)
2	8	1	0.13	1	0.13	0.06
3	18	7	0.39	16	0.89	0.30
4	11	3	0.27	5	0.45	0.11
5	5	1	0.20	4	0.80	0.16
6	8	5	0.63	16	2.00	0.33
7	3	0	0.00	0	0.00	0.00
8	2	0	0.00	0	0.00	0.00
Total adults = 210	55	17	0.31	42		0.2

The mean number of free-swimming cubs born per resident group per year (including years when a resident group had no free-swimming cubs) was 0.76 (n= 55 group years). Pairs of giant otters had the lowest number of litters per group-year, while groups of three giant otters averaged as many free-swimming cubs produced per adult group member as larger groups. Ten groups that had free-swimming cubs were recorded again in the following year. Among these, the average cub survival rate after one year was 56%. The mean number of surviving cubs after one year per adult-sized group member was 0.37 (n=41) (Fig. 12).

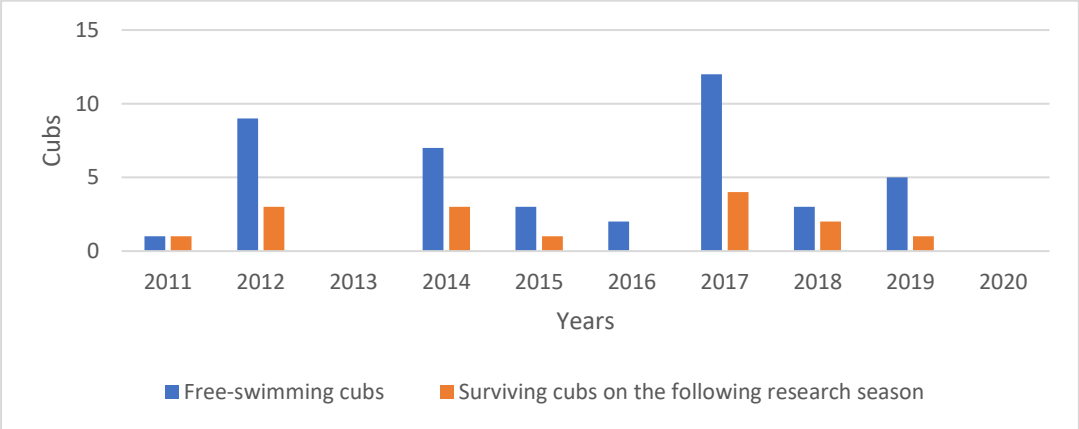

Figure 12. Survival of free-swimming cubs of giant otter after one year in the study area in Cantão, Brazil

Annual cub production did not seem to correlate with the height or duration of the annual flood but showed a negative correlation with the number of members of immigrant groups that moved into the area during each of these years (r=-0.56) (Fig. 13). Data from 2011 and 2012 were excluded from this calculation because part of the study area was not surveyed during those years.

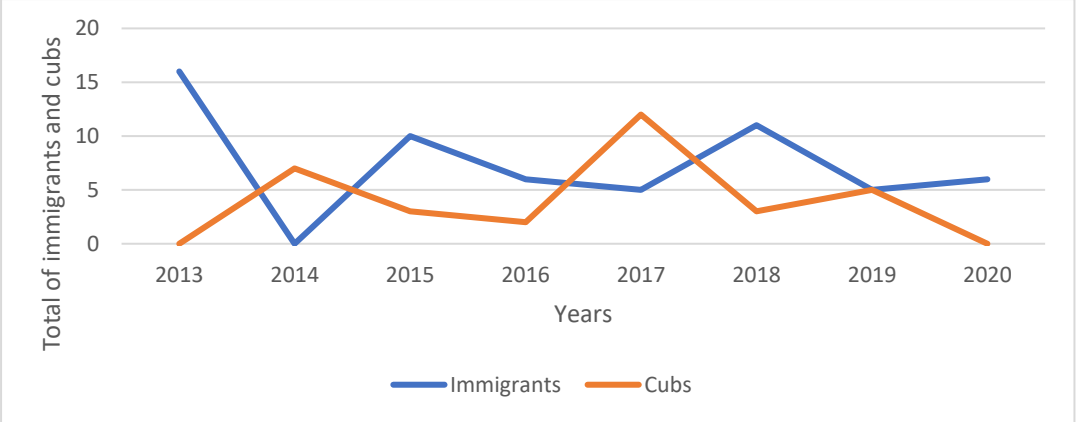

Figure 13. Correlation between number of free-swimming cubs and number of immigrant giant otters in the study area in Cantão, Brazil

DISCUSSION

Originally, giant otters were thought to live in stable family groups occupying stable home ranges (Carter and Rosas, 1997; Duplaix, 1980). More recent studies showed that groups sometimes include unrelated members (Ribas et al., 2016), and that group home ranges can overlap those of other groups (Evangelista, 2004; Leuchtenberger and Mourão, 2008). In Cantão we found giant otter group composition and home ranges to be very fluid. Group home ranges overlap extensively and shift from year to year, with multiple groups sharing the largest lakes, but not synchronically. Even dens are commonly used by different groups. Group composition also changes constantly, not only as cubs are born and adult members leave, but also as new adult-sized individuals join existing groups, eliciting a complex social system in the species.

In the Pantanal, Ribas et al. (2016) found that some groups included subordinate individuals that were not offspring of the breeding pair, whereas Leuchtenberger and Mourão (2008) also observed adult-sized animals entering new groups as subordinates. In southeast Peru, by contrast, Groenendijk et al. (2014) found that immigrants were only recruited into a resident group if they claimed the dominant breeding status. In our study we observed adult-sized individuals joining established groups as both subordinate and breeding members. Nine out of 23 resident groups recorded (39%) were observed to accept new members throughout the study. Of 36 adult-sized new group members whose origin was determined during the study, 15 were cubs that had survived their first year while 21 had joined the group as adults. This suggests that giant otter groups in Cantão may, on average, contain more immigrants than offspring of the breeding pair as subordinate members.

Despite sharing most or all of their home range with other groups, giant otter groups in Cantão are quite successful at avoiding one another. Only 16 times during the study we recorded different groups in the same lake on the same day. Agonistic encounters also appear to be rare. While we sometimes saw otters with bite marks from fights that quickly healed, we never saw a seriously injured otter, suggesting that individuals engaged in few agonistic encounters. Agonistic encounters also appear to be uncommon in southeast Peru (Groenendijk et al., 2014). These observations contrast with findings in the Pantanal, where agonistic interactions were frequently recorded (Leuchtenberger and Mourão, 2008; Mourão and Carvalho, 2001; Ribas and Mourão, 2004, Ribas et al., 2012).

Reproduction

Reproduction of giant otters in Cantão showed great annual variability, with resident groups producing free-swimming cubs on average once every three years. This contrasts with what was observed in southeast Peru (Groenendijk et al., 2014), where resident groups produced one litter per year. Variations in the annual number of cubs produced did not correlate with flood level or duration but showed an inverse relationship with the total number of resident adults and with the number of individuals in groups that immigrated into the area during the previous year. This suggests that successful reproduction of giant otters in Cantão may be depressed by an increase in the density of resident giant otters as well as by the disruptions provoked by the arrival of new individuals or groups into a patch of habitat (Groenendijk et al., 2014). Mourão and Carvalho (2001) observed infanticide and cannibalism in the species by a solitary male that was located close to the home range of a group formed by six adults, and agonistic behaviors were reported in areas with high individual density or where the territories of neighboring groups made contact (Rosas and Mattos, 2003; Ribas and Mourão, 2004). Males that enter in a new group, however, often adopt the former young and contribute to their raising (Ferreira et al., 2011).

In Cantão none of the eleven resident pairs recorded during the study reproduced successfully, and none of the 12 transient pairs observed were accompanied by cubs. In contrast, groups of six or three giant otters were more successful in the number of cubs produced per group-year and in terms of the total number of cubs produced throughout the study. Groups of four and five individuals had a slightly lower reproductive rate than groups of three. This suggests that pairs of giant otters were generally unsuccessful in reproducing in this environment and that the formation of trios of giant otters is critical to the reproduction of the species in Cantão. All six trios whose formation was observed were formed through the recruitment of an adult individual by an existing pair.

The observed cub survival rate after one year (55%, n=27) is comparable to that reported in other studies (Davenport, 2010). Groenendijk et al. (2014) found that 63% of cubs survived their first year in southeast Peru.

Dispersal and Group Formation

Observed group size in Cantão differs from that reported in other studies. In southeast Peru Groenendijk et al. (2014) reported groups of up to 13 individuals, with a mean group size of six otters. In the Xixuaú Reserve in Brazil, the mean group size was 4.5 individuals (Evangelista and Rosas, 2011a), whereas in the Pantanal mean group size was 4.8 (Tomas et al., 2015). The maximum group size reported has 15 individuals (Leuchtenberger et al., 2013). However, these studies did not report whether group size counts included cubs or only adults. Our group size counts excluded cubs, as the number of cubs accompanying a group is not stable, varying with new births and cub mortality. In Cantão the maximum group size observed was eight individuals, with a mean and median of four individuals per group. Only four groups with more than six members were recorded during the study and none of them reproduced. Three of these larger groups were reduced to six members in the following year, and one lasted for two years as a resident non-breeding group of eight members before losing two members, after which the group had a litter. This preponderance of groups of three otters in Cantão further underscores the importance of trios in the ecology of giant otters in the region.

Dispersing giant otters are believed to go through a solitary transient phase during which they search for a mate and an empty patch of territory (Duplaix et al., 2015). In

Cantão we recorded 17 transient and 11 resident solitary individuals, with observed periods of residency varying from two months to over a year. Nine of these resident solitaries (82%) eventually formed a pair or joined a resident group; only two transient solitaries (12%) were observed to do so during the same period. Seven out of eight solitary males recorded were new to the study area, while all solitary females (n=4) originated from resident groups.

Pairs of giant otters recorded during the study tended to be transient and unstable and were unable to reproduce successfully. In 95% of recorded pairs with known history (n=21) at least one member was a former resident of the study area. Ribas et al. (2016) reported that newly formed pairs in the Pantanal also tended to be in the vicinity of the territory of at least one of the original groups. Only one of the eleven resident pairs observed in our study remained a pair for longer than one year. Pairs either became a trio through the recruitment of an outside individual, separated, or left the study area. Individual otters often went through two or more pair and/or trio formation attempts before settling into a stable group or disappearing.

In contrast to pairs, trios of giant otters tended to be stable, resident, and to reproduce successfully. Trios accounted for 35% of all resident groups recorded during the study and for 38% of all free-swimming cubs produced. Cub survival after one year for trios was 55% (n=11), while for pairs it was 0% (n=2) and for larger groups, it was 64% (n=14). Once a group became a trio it was able to grow larger by the addition of surviving cubs from previous years as well as immigrant individuals. However, as group size increased, the tendency for members to leave or disappear from the group also increased. Of 14 trios recorded that were seen again in the following year, three (21%) had been reduced to two members, seven (50%) remained as a trio, and four (29%) had increased in size. Of 17 groups of four or more members seen again in the following year, nine (53%) decreased in size, six (35%) remained with the same number of members, and only two (12%) increased in size. By contrast, eight (36%) out of a total of 22 resident and transient pairs recorded became trios during the study. Additional transient pairs may have become trios and left the study area without being recorded as a trio. This suggests that the trio of adult-sized otters is a stable group configuration for giant otters in Cantão.

Home range shifting and overlap

Home range overlap observed for resident giant otters in Cantão was very common. Most groups shared their home range with at least one other group, and larger lakes were often shared by four or five groups at different times. Groups rarely used the same lake for more than a few days, and when they left, they were often replaced by other groups. Some groups used certain lakes for alternating periods of one to several days over a month or more, often sleeping in the same dens and using the same latrines used previously by other groups. Groups with small cubs sometimes remained in the same lake for a month or more, but generally moved the cubs to a different lake at least once before they became free-swimming. This contrasts with findings by Staib (2005) that indicate that giant otter ranges do not overlap at all in oxbow lake environments in southeast Peru. Evangelista and Rosas (2011b) observed partial range overlap in a tropical river habitat. Leuchtenberger et al. (2013) also observed partial range overlap along linear river habitat in the Pantanal. The home range of some groups in the Pantanal overlapped partially with that of neighboring groups, but each group appeared to have a core territory that is actively defended. Although groups in the Pantanal tended to not use overlapped areas at the same time, 12 agonistic encounters between groups were observed over a two-year study, including fights (Leuchtenberger et al., 2015). In

Cantão only three agonistic encounters were recorded over ten years, both limited to territorial vocalizations between groups, but without fights.

Almost all observed groups shifted at least part of their home range from year to year, and many shifted to a completely different set of lakes between years. The high turnover rate of resident groups within the core study area is indicative of the frequency of large-scale shifting of home ranges. Sometimes group home ranges drifted slowly over the years until they left the study area, and other times a group would move to a completely new home range from one year to the next. Only seven of 23 (30%) resident groups remained in the study area for more than two years, and only five (21.7%) remained for more than three years. Regardless of how much they shifted their home ranges, groups were faced with a new set of neighbors each year, often sharing some of the same lakes. In oxbow lakes in southeast Peru, resident groups tend to remain within the same home range indefinitely (Groenendijk et al., 2014; Schenck et al., 2003). In the continuous river habitat of the Pantanal, Leuchtenberger et al. (2015) observed shifting home ranges in a pattern similar to that observed in Cantão.

Plasticity of Giant Otter Social and Territorial Behavior

The observed differences in giant otter group dynamics and territorial behavior between Cantão and other sites can be explained by the spatial characteristics of the habitat. Previous long-term studies of the species were conducted in areas composed of patchy (isolated oxbow lakes) or linear (rivers) habitats. In the Cantão flooded forest ecosystem, as in some parts of the Brazilian Pantanal (Leuchtenberger and Mourão, 2008), optimal giant otter habitat is continuous in all directions. In the dry season, most of Cantão lakes are connected within a few hundred meters of several other lakes. We also observed that giant otters use the flooded forests during the flood season. This affects both dispersal opportunities and cost-benefit tradeoffs for territorial defense.

Every resident giant otter group in our study had several other groups residing within a few hundred meters of its home range, and most of them shared part or all of their home range with up to six other groups. High-quality habitats can favor individual propensity to emigrate (Stamps, 1987). Dispersing giant otters in Cantão not only have a hospitable and predictable environment in all directions, which they may explore before emigrating, they are also familiar with potential partners in the surrounding area, some of which may be scent-marking at the same sites as the potential disperser's group. In the isolated oxbow lake environments studied elsewhere, potential dispersers may have to transit large patches of a suboptimal environment with which they are unfamiliar and depend on chance to meet potential partners. In linear river habitats, the potential disperser may find optimal habitat extending in one dimension, and maybe familiar with potential partners belonging to upstream and downstream neighboring groups. This habitat effect can explain the observed increase in average group size as individuals move from continuous and bidimensional habitats (flooded forest with high oxbow lake density) to linear but continuous habitats (rivers), to patchy discontinuous habitat (isolated lakes).

The fact that optimal habitat in Cantão is continuous but also fragmented into individual lakes may explain the tolerance for home range overlap displayed by resident giant otter groups. A "dear enemy" effect (Fisher, 1954), where territorial animals direct less aggression toward established neighbors than toward strangers, maybe at play. Although the dear enemy effect is more common when neighbors had well-established territories (Erlinge, 1968; Hutchings and White, 2000; Rostain et al., 2004), the use of scent cues for individual and group recognition may act as a way to reduce aggressiveness in these fluctuating territories (Heinze et al., 1996; Leuchtenberger and

Mourão, 2009; Zenuto, 2010). The resource availability in Cantão also renders the circumstantial benefits toward aggressive behaviors between groups minimal. Fish prey is abundant in hundreds of Cantão lakes, but foraging giant otters are constantly on the move, rarely stopping for more than a few minutes even at the most productive sites, probably reducing disturbance effects of fishing on fish wariness. Foraging giant otter groups create considerable disturbance through splashing, jumping, and turbulent swimming, and groups are soon forced to move to a different lake to continue foraging, even if the lake they just traversed still has plenty of fish. If a group arrives at a lake and finds that another group is already there, it may derive little immediate benefit from chasing the other group away because the lake has been disturbed, providing few foraging returns, being more profitable just to move on to another lake. A group wishing to avoid conflict can easily avoid encountering other groups by simply moving to one of many nearby lakes. Since lakes in Cantão are not large enough to be occupied continuously by a single group, a group cannot secure exclusive use of a lake no matter how much energy is expended in territorial defense. The optimal solution appears to be to tolerate other resident groups sharing the lakes within its home range as long as fish prey availability does not become a limiting factor.

The "dear enemy" effect is facilitated by the ability to recognize familiar neighbors (Tumulty, 2018), and giant otters are particularly well adapted for this due to their individual throat markings, scent cues, familiar sounds, and periscoping behavior. This may also explain the tendency for the total number of adult otters in our research area to remain within a relatively narrow range even with a high annual turnover of resident groups.

The high annual variation in the number of cubs produced by giant otter groups in Cantão is also different from what was reported from other sites. This may also be explained by the specific territorial dynamics generated by the local landscape. We found a negative correlation between production of free-swimming cubs and the number of new adults moving into the area. A high proportion of newly arrived groups increases the likelihood of stressful encounters and/or costly avoidance behavior between groups. In captivity, stress caused by visitors can cause a giant otter mother to stop lactating (Sykes-Gatz, 2005). Londoño and Tigreros (2006) reported that stress caused by noise or the presence of strangers caused giant otters to carry pups under 30 days old into the water, where in the wild they would be at risk of drowning or encountering predators. Schenk and Staib (1994) observed that reproductive success was depressed for giant otters living in lakes heavily visited by tourists. Likely, increased stress caused by increased population density or the arrival of unfamiliar groups depresses the reproductive rate of giant otters in Cantão, and this may also contribute towards the maintenance of population density close to the environment's carrying capacity.

Implications for Conservation

The main bottleneck for successful colonization of new habitat by dispersing giant otters is whether a dispersing individual can meet a potential mate at the right time, in a suitable place (Schenck et al., 2003). If so, colonization of new areas may be more difficult in environments like Cantão, where it appears that the formation of a trio of giant otters is a prerequisite for successful reproduction. This possibility should be taken into account in reintroduction projects for the species, which currently assume that the introduction of pairs of animals into the unoccupied habitat is sufficient to start a new population (Zamboni et al., 2018). Our findings also indicate that giant otters may change partners several times before settling into a stable group and successfully

reproducing. This may be due to genetic or other incompatibilities between individuals, requiring trial and error to find a suitable partner for reproduction. Isolated reintroduced groups may not be able to reproduce successfully even if they were captured and relocated as a group.

If the hypothesis of depressed reproductive success caused by stress provoked by encounters with strangers is correct, it could mean that frequent encounters with humans may also reduce the rate of reproduction of giant otters. Even when intruding humans do not directly encounter giant otter groups, the disturbance of prey by fishing or other activity may have an effect analogous to an additional giant otter group foraging through the habitat, and if it occurs repeatedly, it may reduce reproductive success and decrease the area's giant otter population. We documented three episodes of giant otters relocating very young pups after brief encounters with intruders in Cantão. Two of these episodes were merely a motorboat passing by the breeding den. The same groups were largely indifferent to approaches by researchers with whom they were familiar, to the extent of bringing out the cubs for swimming lessons in the presence of five researchers observing without cover from less than 100 meters away. Breeding refuges where humans are excluded, or allowed only under strict regulation and monitoring, may be essential to the reproduction of giant otters. This reinforces the importance of the strict protected areas (IUCN Category 2 or higher) with zones where no visitation is allowed for the conservation of the species.

The Cantão ecosystem appears to sustain a high density of giant otters compared to other sites, mainly due to its abundance of fish prey and suitable habitat. Overall giant otter densities at other protected areas tend to be relatively low because these areas consist largely of unsuitable habitat, while all of Cantão State Park consists of habitat similar to that of the study area. If the density of resident groups in the 16 lakes of our study area is indicative of the density of the species throughout the park's 850 oxbow lakes, this may be one of the most important protected areas for the species today. Habitat similar to Cantão's, with large numbers of oxbow lakes within an igapó flooded forest matrix, also occurs at other sites in the Amazon basin, such as along the lower reaches of the Juruá, Purus, Tefé, and Jaú rivers. Identifying and surveying these sites, even if giant otters are currently rare or absent in some of them, may help to identify critical areas for the recovery and protection of the species.

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RESUME

DIX ANNEES D'ETUDE SUR LA DYNAMIQUE DE GROUPES ET L'UTILISATION DE L'HABITAT DE LA LOUTRE GEANTE, *Pteronura brasiliensis* (ZIMMERMANN, 1780), DANS LES FORETS INONDEES SAISONNIERES DE LA RIVIERE ARAGUAIA, AU CENTRE DU BRESIL

Nous avons effectué des relevés mensuels dans la population de loutre géante entre 2010 et 2020 dans une zone d'étude composée de 1.500 hectares de forêt inondée d'igapó avec des bras morts dans la région de Cantão au centre du Brésil. Nous avons enregistré chaque année 16 à 32 adultes vivant dans la zone d'étude, répartis en 4 à 8 groupes. Les groupes résidents présentaient un chevauchement important des domaines vitaux, chaque groupe utilisant plusieurs lacs et des lacs plus grands en rotation avec jusqu'à six groupes. Les tanières et les couches étaient également partagées par plusieurs groupes, mais les lacs n'étaient utilisés que par un seul groupe à la fois et les rencontres entre groupes étaient très rares. Vingt-quatre loutres adultes ont été observées rejoignant un groupe existant. Certains individus ont changé de groupe plusieurs fois. L'échange entre adultes résidents était élevé. Chaque année, une moyenne de 36 % d'adultes résidents était constituée de nouveaux immigrants et 72 % des groupes ont quitté la région dans les deux ans. Les groupes de résidents avaient, en moyenne, une portée tous les trois ans, et la production annuelle de loutrons présentait

une grande variabilité et une corrélation négative avec le nombre de nouveaux immigrants dans la région. Aucun couple de loutres géantes ne s'est reproduit avec succès au cours de l'étude. Des groupes de trois loutres se sont formés par recrutement d'un individu adulte à partir d'un couple existant et se sont reproduits avec autant de succès que des groupes plus importants. La dynamique de groupe et le comportement territorial dans l'écosystème forestier inondé de Cantão où l'habitat optimal de la loutre géante est continu de tout côté, se sont avérés différents de ceux signalés dans les zones composées d'habitats morcelés (bras morts isolés) ou linéaires (rivières). Ceci suggère que le comportement social et territorial de la loutre géante est plastique et s'adapte aux caractéristiques spatiales de l'habitat.

RESUMEN

DINÁMICA GRUPAL Y USO DEL HÁBITAT POR LA NUTRIA GIGANTE *Pteronura brasiliensis*, (ZIMMERMANN, 1780) EN BOSQUES ESTACIONALMENTE INUNDADOS EN EL RÍO ARAGUAIA, BRASIL CENTRAL: UN ESTUDIO DE 10 AÑOS

Llevamos a cabo relevamientos mensuales de la población de nutrias gigantes entre 2010 y 2020, en un área de estudio que abarcó 1.500 hectáreas de bosque inundado con lagos en herradura -igapó- en la región Cantão de Brasil central. Registramos 16-32 adultos residentes en el área de estudio cada año, distribuidos en 4-8 grupos. Los grupos residentes exhibieron extensiva superposición de las áreas de acción, con cada grupo usando varios lagos, y los lagos más grandes usados en rotación por hasta seis grupos. Las madrigueras y "campamentos" también fueron compartidos por múltiples grupos, pero los lagos fueron usados por solamente un grupo a la vez, y los encuentros entre grupos fueron muy raros. Se observaron 24 nutrias adultas unirse a un grupo existente. Algunos individuos cambiaron múltiples veces de grupo. El "turnover" o recambio de adultos residentes fue alto. Cada año, un promedio de 36% de los adultos residentes fueron nuevos inmigrantes, y 72% de los grupos abandonaron el área dentro de los dos años. Los grupos residentes tuvieron, en promedio, una camada cada tres años, y la producción anual de crías mostró alta variabilidad y una correlación negativa con el número de nuevos inmigrantes al área. Durante el estudio, ninguna pareja de nutrias gigantes se reprodujo exitosamente. Se formaron grupos de tres nutrias a través del reclutamiento de un individuo adulto por parte de una pareja existente, y se reprodujeron tan exitosamente como los grupos más grandes. La dinámica grupal y el comportamiento territorial en el ecosistema de bosque inundado de Cantão, donde el hábitat óptimo para nutria gigante es continuo en todas las direcciones, encontramos que fue diferente de lo reportado en áreas compuestas por hábitat en parches (lagos en herradura aislados) o lineales (ríos). Ésto sugiere que el comportamiento social y territorial de la nutria gigante es plástico y se adapta a las características espaciales del hábitat.

A R T I C L E

GIANT OTTERS (*Pteronura brasiliensis*) AT THE AQUIDAUANA RIVER

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Abstract: *Pteronura brasiliensis* is one of the two otters recorded in the Aquidauana River, Pantanal of Mato Grosso do Sul. The present study was carried out to map and catalog giant otter's groups' distribution from March to October 2014. Expeditions along the 120 km of the Aquidauana River were conducted, totaling 346.2 hours of observation. Altogether, more than 4 thousand km were covered within the 120 km study area, including bays and meanders. A 40 Hp motorboat was used to run on the main river for longer distances. Another 15 Hp motorboat was used for shorter distances. Finally, an electric motorboat was used in the bays along the river. A binocular with camera video - Bushnell 8x30 Mds and a binocular Ir optics 10x50 were used to observe and identify the giant otters' individuals. A GPS Garmin map 62s was used to register the coordinates. Photographic equipment consisted of a Canon Mark III 5D, with a 70-200 mm lens and a 100-400 mm lens. Photographs were used to take the pictures of the patterned patches on the throat of the animal. Satellite images were used to extract information and data from the study area. Forty direct observations of giant otters were obtained, 15 in the bays along the river, and 25 in the river. The average number of observed individuals ranged between 1 and 9. Ten different groups of giant otters were identified in the study area. Groups can be found in the main river and in the oxbow lakes along the river. The giant otters group catalog of the Aquidauana river can result in a positive impact on the citizens, contributing to public policies towards the conservation and protection of the species.
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INTRODUCTION

This work's main objective is to present the groups of giant otters living in the Aquidauana river. There are few studies regarding giant otters in the Aquidauana River. Tomas et al. (2000) found 30 groups of giant otters along 258 km of the river during a survey of 18 days in 2000. Each group was distributed along 10.8 km of the river. However, the groups were not identified. For the first time, the distribution and identification of the groups are realized in this river. In this work, 120 km of the river

was monitored. The main objective was to identify and define the number of giant otter's groups in the study area, subsidizing public policies and social mobilization to conserve the species.

The Aquidauana River is part of the Paraguay's watershed that drains an area of 1,1 million of km^2. It is a calm water environment without many rapids, which favors high productivity and, therefore, a higher concentration of fish. Food availability affects the success and distribution of giant otter groups (Carter and Rosas, 1997; Tomas et al., 2015). Carvalho Junior (2017) highlights that the giant otter is part of a complex energy network, including the environmental and economic system. The presence of groups of giant otters are impermanent and dynamic, reflecting the health of the system in a time delay. The giant otter, as the top of the trophic chain, depending on the various energy paths within the system, may reflect the past or current impact, only in the future, due to the trophic cascade (Jorge et al., 2013; Terborgh and Estes, 2013; Galetti et al., 2017).

Pantanal houses one of Brazil's largest populations of giant otters (Tomas et al., 2015), but, at the same time, with serious conflicts with fishermen and deforestation of marginal areas along the river, close to urban centers. The estimated population in the Pantanal is believed to be reaching it carrying capacity in some areas (Leuchtenberger and Mourão, 2008; Ribas et al., 2012). However, this might not be what reality shows, but just a picture of a moment of the timeline (Bogoni et al., 2020; Portela and Dirzo, 2020).

Predatory tourism and conflicts with fishermen are preoccupying (Tomas et al., 2000; Carvalho Junior et al., 2017; Carvalho Junior and Birolo, 2022). As a top predator, the species can be responsible for the carbon stock into the ecosystem due to the cascade effect on the trophic chain, and this is one of the reasons why the specie is not a good health indicator in the timeline. Not to mention the threats that the Pantanal Biome faces with the proliferation of hydroelectric plants, waterway projects for grain transport, expansion of agricultural areas, such as soy cultivation, in addition to climate change (Alho, 2008; Bergier and Resende, 2010; Silva et al., 2015; Observatório Pantanal, 2020).

Pantanal is well known by its pulse, characterized by a dry and rainy season (Silva et al., 2015). The groups' territory size may be affected by drivers and pressures of change by the river basin (Utreras et al., 2005; Leuchtenberger et al., 2013; Leuchtenberger et al., 2015; Carvalho Junior and Birolo, 2022). In seasonally flooded areas, the space used by giant otters can be affected by water level oscillations and pulses (Duplaix et al., 2015).

Giant otter represents an important environmental asset, as a flag species, for the development of conservation tourism and protection of aquatic ecosystems (Carvalho Junior et al., 2017). On the other hand, there is a negative perception that certain sectors of society have about the species, such as fishermen and fish farmers who see the giant otter as a competitor (Staib and Schenck, 1994; Barocas et al., 2021; Carvalho Junior and Birolo, 2022).

The presence of groups of giant otters, close to Aquidauana and Anastácio, may represent the beginning of a community-based conservation tourism program. This could change the adverse reality in which the specie is seen as a competitor to be eliminated by man and become an ally to promote the local economy. This research hope to contribute to the application of public policies aimed at the development of sustainable community-based tourism in the region with biodiversity conservation.

METHODS

From March to October 2014, 83 expeditions along the 120 km of the Aquidauana River, Mato Grosso do Sul state, were conducted, totaling 346.2 hours of observation (Figure 1). More than 4 thousand kilometers were carried out, within the 120 km study area. The trips usually started at 7:00 hours in the morning, finishing at 18:00 hours in the afternoon.

Figure 1. Location of Mato Grosso do Sul state, Brazil

Three boats were used. A bigger boat (Fishing Marajó 17 feet - 40 Hp motor) was used to run on the main river for more considerable distances with five people's capacity. A smaller boat for three people, with 15 Hp motor, was used for shorter distances and access some bays from the river. A third one, for two people, was used in the bays along the river, with an electric motor and two batteries, allowing 2 hours of navigation. A binocular with camera video - Bushnell 8×30 Mds and a classical binocular Ir optics 10×50, were used to observe and identify the giant otters' individuals. Navigation of the main course of the river was made at a constant speed of 10 - 15 km/h. A GPS Garmin map 62s was used to register the coordinates. Photographic equipment consisted of a Canon Mark III 5D, with a 70 - 200 mm lens and a 100 - 400 mm lens. Photographs were used to take the pictures of the patterned patches on the throat of the animal.

Satellite images were used to extract information and data from the study area. The images used in the Aquidauana River region were obtained free of charge from INPE's image catalog (Image catalog: http://www.dgi.inpe.br/CDSR/ Source: National Institute of Space Research). The main criteria used for the choice of scenes were based on the date of the most recent images, with little or no presence of clouds and recorded simultaneously. The methodological procedures applied to the images consisted of applying different image processing: a visual interpretation for identification of the image component classes, enhancement of the contrast, and classification. All files were adjusted according to the geographic coordinate system adopted in the project: South American Datum, 1969.

Groups of giant otters, identified in the study area, were plotted in the images as a particular class. Each group was identified by photographs taken in the field. The coordinate locations were plotted for each identified group, and the distances were calculated, having the Aquidauana bridge as a reference. The distance matrix was generated by vector analysis of the distance between points calculated by QGIS software. From the photograph, a draw was made, thanks to the software CorelDRAW X8, creating a figure pattern to have a catalog of the identified individuals.

RESULTS

Forty direct observations of giant otters were obtained, 15 in the bays along the river, and 25 in the river. The average number of observed individuals per event ranged between 1 and 9 (mean=3,6 ±1,9). Forty-six locations with giant otter indirect signs such as dens, campsites, trails, resting, and marking sites were also recorded. Ten different groups of giant otters were identified in the study area, but only five could be sighted more than once. Furthermore, on thirteen occasions (38% of sightings), it was not possible to observe the throat marks and, consequently, it was not possible to identify the group. Only one of the groups observed within a bay was also observed in the river. Table 1 shows the ten groups' coordinates and the number of individuals for each group.

Table 1. Location of the identified giant otter groups in the Aquidauana River.

Group number	X coordinate	Y coordinate	Number of individuals
1	621072	7735557	3
1	621072	7735557	3
1	621024	7739355	3
2	613871	7765542	5
2	613883	7765689	6
2	614740	7764268	6
2	614334	7762203	1
2	614785	7764273	6
3	609926	7774590	6
3	609926	7774590	6
3	609828	7774455	8
4	616933	7747320	2
5	616225	7751210	3
6	619383	7742334	8
7	618740	7755375	4
7	619125	7753820	4
7	618768	7755559	4
8	627234	7732596	2
8	627345	7732272	2
9	619431	7741169	2
10	621303	7735227	3
19	621297	7734963	2

Figure 2 presents the spatial distribution of identified groups within the study area. Groups 1, 8, and 10 represent the closest groups of Aquidauana City, ranging from 2.6 to 6.5 km. Two of these groups are in a near bay, and the other one is in the Taquaruçu River, a close tributary of the Aquidauana River.

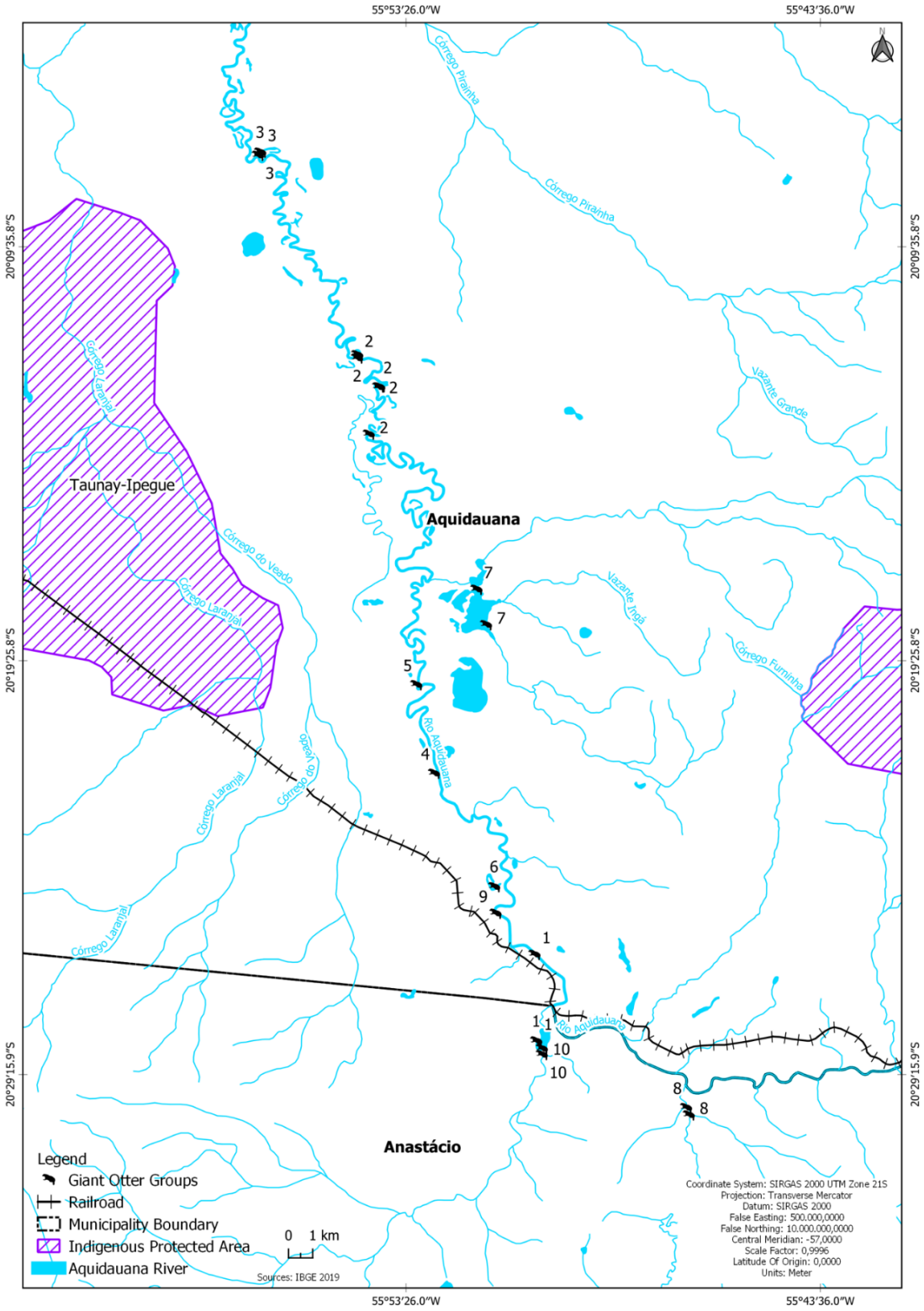

Figure 2. Giant otter group locations in the Aquidauana River, MS. Ten groups were identified along 120 km of river and bays. The number of the groups with coordinates are exhibited in Table 1.

On average, the distance between the points of giant otters and the urban center was 22.7 km (± 14.5), with a minimum of 1.1 km. Identifying the ten groups and distributing them linearly along the 120 km of the river, resulted in 1 group of a giant otter every 12 km. The ten groups identified along the Aquidauana River are shown in Figure 3. Patches on the throat of the animal are different for each group. Some groups present more than one individual with different patches. In Figure 3, the dominant individual or the one who was more evident from the others was considered.

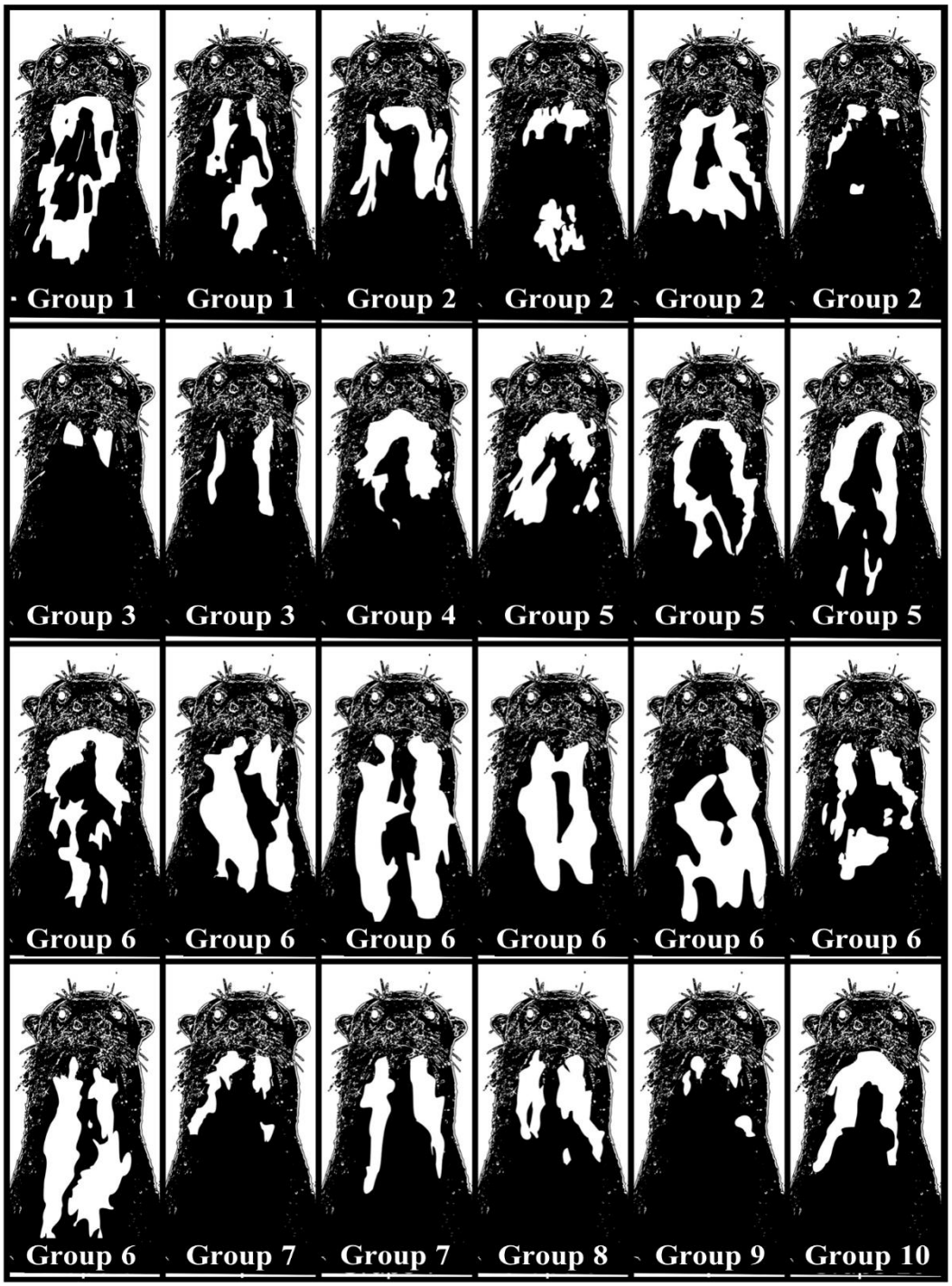

Figure 3. Giant otter groups identified in the Aquidauana River. The number of the groups, location and distribution are shown in Table 1 and Figure 2.

DISCUSSION

Distance interval between groups agrees with a census-based on one expedition of 18 days, along 324 km of river, from Aquidauana City to Passo do Lontra, that found one group of the species for each 10.8 km (Tomas et al., 2000). In other rivers, with similar size to the Aquidauana River, in Pantanal, as well as in Suriname and the Brazilian Amazon, several authors found a linear distribution varying from 2 to 12 km (Duplaix, 1980; Laidler, 1984; Leuchtenberger and Mourão, 2008; Evangelista and Rosas, 2011; Leuchtenberger et al., 2015).

In the Aquidauana River, groups of giant otters can be found in the main river and the river's oxbow lakes. The species was found in the main river where the mean depth was between 5 and 7 meters, and the velocity of the river ranged between 0.56 to 0.8 m.s-1. Other authors found giant otters in similar depths (Staib, 2005; Carrera-Ubidia, 2006; Evangelista and Rosas, 2011).

Published papers do not mention or describe in detail perpendicular movements of *Pteronura brasiliensis* regarding the longitudinal axis of the river. During the rainy season, the giant otters might disperse laterally looking for fish and dry areas through the forest (Duplaix, 1980; Utreras et al., 2005; Leuchtenberger et al., 2013; Leuchtenberger et al., 2015). Leuchtenberger et al., 2013 mentions the use of freshwater ponds and artificial ponds beside roads during the dry season in the Vermelho and Miranda rivers. In the present work, it was common to observe the species walking along the margins and on the riverbanks. It was also found that isolated bays, separated from the Aquidauana river by natural geographic barriers, are equally frequented during the dry season.

Only one of the groups observed within a bay was also observed in the river. Groups found in the bays may remain longer in these places, moving little to the main watercourse. Therefore, bays along the Aquidauana River can have greater ecological importance in preserving the giant otter in the area. It is possible to say that the species can walk considerable distances from the river to reach a bay or another watercourse. It is essential to consider that during the high flood pulse, it can be challenging to define the main river course in many areas. During this period, the species can travel away from the main course, making them more challenging to be sighted (Leuchtenberger et al., 2013).

The nearest bay to Aquidauana and Anastácio cities where the species was found is the Acogo, next to a slaughterhouse. Many giant otter sightings are within 5 km from the center of Aquidauana City. However, most encounters did not last for more than a few minutes, as the animals would quickly swim away and be out of sight. Reports from locals indicate that they are often harassed by people or by the boat noise.

As expected, the dry season is favored to obtain records of giant otter presence, which reinforces the importance of conducting more intense monitoring at this time of year. Most of the direct observations of giant otters were made downstream of Aquidauana city. In August 2014, a couple of giant otters were recorded upstream of the bridge connecting the two cities (Aquidauana and Anastácio). This couple, so close to town, shows the importance of long-term monitoring of giant otter populations in the study area, because the sites used by the species can vary throughout the year, according to the seasonal dynamics of flood pulse in the region.

The giant otter group catalog of the Aquidauana river can result in a positive impact on the citizens, contributing to public policies towards the conservation and protection of the species. To protect, it is crucial to know and learn about the subject. The catalog, associated with information about the species, can be used in the local

schools, providing teachers and students with information about a local species. It is also essential for developing conservation tourism and ecotourism in the region.

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RESUMÉ : LES LOUTRES GÉANTES (*Pteronura brasiliensis*) DE LA RIVIÈRE AQUIDAUANA

Pteronura brasiliensis est l'une des deux espèces de loutres répertoriées dans la rivière Aquidauana, au Pantanal du Mato Grosso do Sul. La présente étude a été réalisée de mars à octobre 2014 pour cartographier et estimer la distribution des groupes de loutres géantes. Des campagnes de terrain ont été menées le long des 120 km de rivière de l'Aquidauana, totalisant 346,2 heures d'observation. Au total, plus de 4.000 km ont été parcourus dans la zone d'étude de 120 km, y compris les baies et les méandres. Un bateau à moteur de 40 CV a été utilisé pour naviguer sur le cours principal de la rivière sur les plus longues distances. Un autre bateau à moteur de 15 CV a été utilisé pour des distances plus courtes. Enfin, un bateau à moteur électrique a été utilisé dans les baies le long du fleuve. Des jumelles avec caméra vidéo - Bushnell 8x30 Mds et Ir optique 10x50 ont été utilisées pour observer et identifier les individus de loutres géantes. Une carte GPS Garmin 62s a été utilisée pour enregistrer les coordonnées. Le matériel photographique consistait en un Canon Mark III 5D, avec un objectif 70-200 mm et un objectif 100-400 mm. Des photos ont été utilisées afin d'avoir les motifs des taches de la gorge de l'animal. Des images satellites ont permis d'extraire des informations et des données de la zone d'étude. Quarante observations directes de loutres géantes ont été obtenues, 15 dans les baies le long du fleuve, et 25 dans le fleuve. Le nombre moyen d'individus observés variait entre 1 et 9. Dix groupes différents de loutres géantes ont été identifiés dans la zone d'étude. Des groupes peuvent être trouvés dans le cours principal ainsi que dans les bras morts le long de la rivière. L'inventaire du groupe de

loutres géantes de la rivière Aquidauana peut avoir un impact positif sur les citoyens, contribuant aux politiques publiques de conservation et de protection de l'espèce.

RESUMEN: NUTRIAS GIGANTES (*Pteronura brasiliensis*) EN EL RÍO AQUIDAUANA

Pteronura brasiliensis es una de las dos nutrias registradas en el Río Aquidauana, Pantanal de Mato Grosso do Sul. El presente estudio fue llevado a cabo para mapear y catalogar la distribución de los grupos de nutrias gigantes desde Marzo hasta Octubre de 2014. Fueron conducidas expediciones a lo largo de 120 km del Río Aquidauana, totalizando 346.2 horas de observación. En total, fueron cubiertos más de 4 mil km dentro del área de estudio de 120 km, incluyendo bahías y meandros. Se utilizó un bote a motor de 40 Hp para desplazarnos por el río principal a distancias mayores. Utilizamos otro bote a motor de 15 Hp para distancias más cortas. Finalmente, usamos un bote a motor eléctrico para las bahías a lo largo del río. Se utilizaron un binocular con videocámara - Bushnell 8x30 Mds y un binocular Ir optics 10x50 para observar e identificar los individuos de nutria gigante. Se utilizó un GPS Garmin map 62s para registrar las coordenadas. El equipamiento fotográfico consistió en una Canon Mark III 5D, con una lente 70-200 mm y una 100-400 mm. Se utilizaron las fotografías para extraer información y datos del área de estudio. Se obtuvieron cuarenta observaciones directas de nutrias gigantes, 15 en las bahías a lo largo del río, y 25 en el río. El número promedio de individuos observados estuvo entre 1 y 9. Identificamos diez grupos diferentes de nutrias gigantes en el área de estudio. Los grupos se pueden encontrar en el río principal y en los lagos de herradura a lo largo del río. El catálogo de los grupos de nutrias gigantes del río Aquidauana puede resultar en un impacto positivo en los ciudadanos, contribuyendo a las políticas públicas tendientes a la conservación y protección de la especie.

RESUMO : ARIRANHAS (*Pteronura brasiliensis*) NO RIO AQUIDAUANA

Pteronura brasiliensis é uma das duas espécies de lontras registradas no Rio Aquidauana, Pantanal de Mato Grosso do Sul. O presente estudo foi realizado para mapear e catalogar a distribuição dos grupos de ariranhas no período de março a outubro de 2014. Foram realizadas expedições ao longo de 120 km do Rio Aquidauana, totalizando 346,2 horas de observação. Ao todo, foram percorridos mais de 4 mil km na área de estudo de 120 km, incluindo baías e meandros. Uma lancha de 40 Hp foi usada para percorrer o rio principal por distâncias maiores. Outra lancha de 15 Hp foi utilizada para distâncias mais curtas. Por fim, uma lancha elétrica foi utilizada nas baías ao longo do rio. Um binóculo com câmera de vídeo - Bushnell 8 × 30 Mds e um binóculo ótico Ir 10 × 50 foram usados para observar e identificar os indivíduos das ariranhas. Um mapa GPS Garmin 62s foi usado para registrar as coordenadas. O equipamento fotográfico consistia em uma Canon Mark III 5D, com uma lente de 70 – 200 mm e uma lente de 100 – 400 mm. Fotografias foram usadas para registrar as fotos das manchas estampadas na garganta do animal. Imagens de satélite foram usadas para extrair informações e dados da área de estudo. Foram obtidas 40 observações diretas de ariranhas, 15 nas baías ao longo do rio e 25 no rio. O número médio de indivíduos observados variou entre 1 e 9. Dez grupos diferentes de ariranhas foram identificados na área de estudo. Os grupos podem ser encontrados no rio principal e nos lagos marginais ao longo do rio. O catálogo do grupo de ariranhas do rio Aquidauana pode resultar em impacto positivo para os cidadãos, contribuindo para políticas públicas de conservação e proteção da espécie.

A R T I C L E

WHAT DOES A DISCOVERY TELL US? CAMERA-TRAPPING INSIGHT INTO THE ASIAN SMALL-CLAWED OTTER IN NORTH-EASTERN BANGLADESH

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Abstract: For three of the four Oriental otters that live in Bangladesh, as of early 2022, four pertinent peer-reviewed studies were conducted in the country. The distribution of the country's otters, because of the dearth of empirical evidence, is made of guesswork and yet to be scientifically understood. Subsequently, eastern forests although a part of the globally recognized range of the small-clawed otter (*Aonyx cinereus*) are not accredited in Bangladesh for the species and are not receiving any conservation investment. This study, for the first time, provided evidence of the relict populations of small-clawed otters in eastern Bangladesh. A survey on terrestrial carnivore mammals was carried out between January and October 2021 in four north-eastern forest reserves that found the species in three reserves, with 132 notionally independent events from a sampling effort of 3629 camera-trap nights. The activity rhythm of nocturnal–crepuscular otters leaned more towards dawn. The work highlights (i) the potential of the small-clawed otter as an umbrella species for the traditionally ignored, trans-border riparian mixed-evergreen forests of north-eastern Bangladesh; (ii) a great inconsistency between sources concerning its distribution in the country; (iii) the necessities to investigate the lack of this survey's records of smooth-coated otter (*Lutrogale perspicillata)* and Eurasian otter (*Lutra lutra*, no evidence in Bangladesh for 30 years) although the surveyed forest reserves are widely noted for both species; and (iv) the stark absence of any recent information on otter status in the adjacent Indian states (Meghalaya, Tripura, Mizoram, and southern Assam) that, together with eastern Bangladesh, belong to an ecologically uncharted territory and form the western limit of the Indo-Burma Biodiversity Hotspot.

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Keywords: *Aonyx cinereus*, circadian rhythm, Lathitila forest, Lawachara national park, Rema-Kalenga wildlife sanctuary, riparian reserves

INTRODUCTION

Bangladesh, one of the smallest Asian countries, is reportedly home to nearly half of the Indian Subcontinent's species of the mammalian order Carnivora, i.e., 27 species,

including three of the four Oriental otter species (Menon, 2014; Khan, 2015a, 2018). Not adhering to the remarkable assemblage, carnivore conservation efforts are strongly skewed in the country, tilted toward the tiger (*Panthera tigris*) (Akash and Zakir, 2020). Studies on almost every other carnivore that followed a systematic framework are non-existent (Akash and Zakir, 2020). Otters are no different. To date, only four peer-reviewed works are available specifically on the otters of Bangladesh (Feeroz et al., 2011 a,b; Aziz, 2018; Shashoto and Yoxon, 2020).

The absence of studies has long been considered a hurdle to the conservation mainstreaming of Asian otters (Foster-Turley and Santiapillai, 1990; Basnet et al., 2020). The challenge becomes glaring while considering the Asian small-clawed otter (*Aonyx cinereus*). The appraisal by Basnet et al., (2020) showed that, out of 244 research works on Asian otters, only 16 exclusively studied the species. Also, simply known as the small-clawed otter or short-clawed otter, it is the smallest of 13 known otter species and is present in multiple range countries in South and Southeast Asia (Fig. 1A). According to The International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Wright et al., 2021), this species is globally Vulnerable, facing threats such as poaching for pelt, and extraction for the pet trade. The IUCN Bangladesh Red List of Threatened Species (Begum, 2015) evaluated the small-clawed otter as endangered.

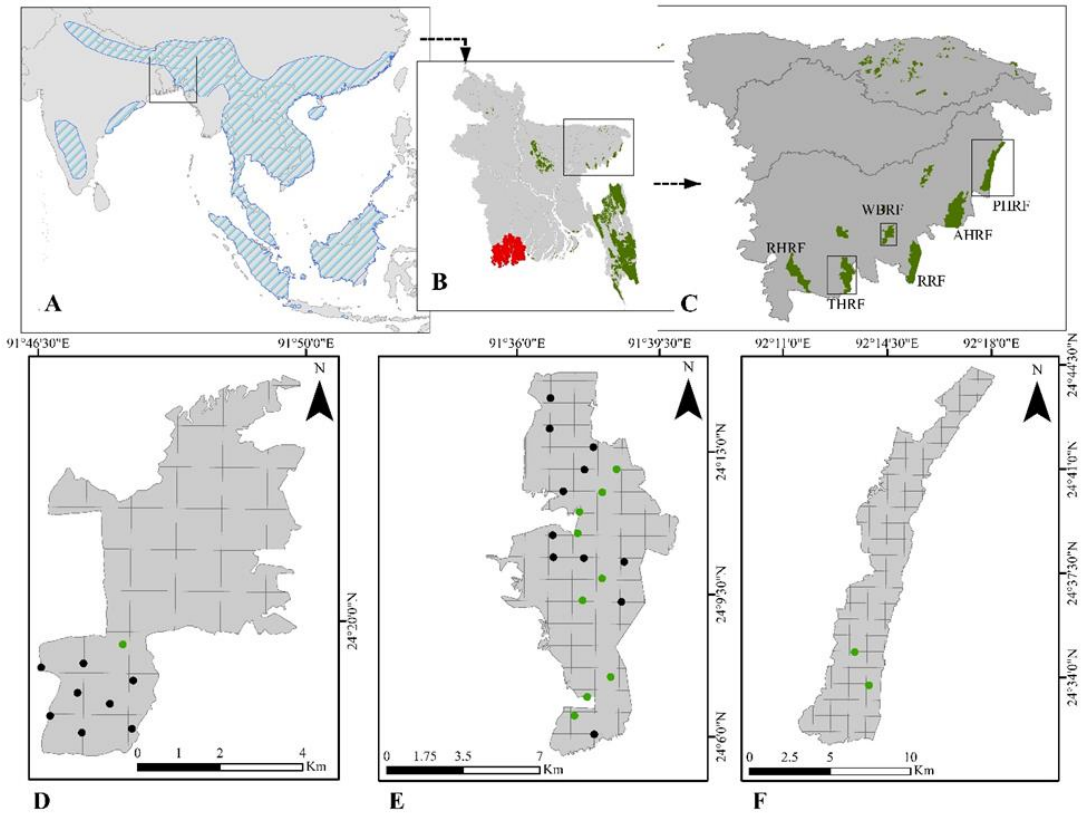

Figure 1. Proposed global range (blue cross-hatched area) of the Asian small-clawed otter (*Aonyx cinereus*) (after Wright et al. 2021) (A); Forest cover (green patches) of Bangladesh with the species' known extent of occurrence [red patch; adapted from Begum (2015)] (B); North-eastern Bangladesh and its six trans-border, riparian, mixed-evergreen forest reserves (C); Raghunandan Hill Reserve Forest (D); Tarap Hill Reserve Forest (E); Patharia Hill Reserve Forest (F). Each square grid is 1000×1000 m. Green dots denote the areas where evidence (camera-trap image or track) was obtained. Black dots denote the remaining trap stations. RHRF, Raghunandan Hill Reserve Forest; THRF, Tarap Hill Reserve Forest; WBRF, West Bhanugach Reserve Forest; RRF, Rajkandi Reserve Forest; AHRF, Atora Hill Reserve Forest; PHRF, Patharia Hill Reserve Forest.

Accounts of the distribution of this species in Bangladesh reflect the paucity of accurate and precise information. There are great inconsistencies between sources concerning the perceived distribution of the species in the country (Table 1). Local assessments and works recognised only the Sundarbans as a species range in the country but not the forests of eastern Bangladesh. In contrast, global assessment and most of the recent studies did the opposite.

Table 1. A brief review of major forests of Bangladesh that are regarded as the Asian small-clawed otter (*Aonyx cinereus*) habitat in different literature. Tick-mark (✓) refers to that the region is stated as the species range while cross-mark (×) indicates that the region is not presented as the species range in the concerned study.

	North-eastern Bangladesh	South-eastern Bangladesh	Sundarbans
Global assessment and books			
Hussain et al. (2011)	✓	✓	✓
Menon (2014)	✓	✓	✓
Duplaix and Savage (2018)	✓	✓	×
Hunter and Barrett (2018)	✓	✓	×
Wright et al. (2021)	✓	✓	×
Assessments and studies carried out in Bangladesh			
Begum (2015)	×	×	✓
Khan (2015a)	×	✓	✓
Aziz (2018)	×	×	✓
Khan (2018)	×	✓	✓

Wright et al., (2021) considered the riparian, mixed-evergreen, rugged forests of eastern Bangladesh as within the extant range of this species (Fig. 1A,B), as did Akash and Zakir (2020) (Fig. 1C). These forests belong to ecologically uncharted territory and form the western limit of the Indo-Burma Biodiversity Hotspot (Myers et al., 2000).

On the other hand, only the Sundarbans, the largest continuous mangrove network in the world straddling the south-western border of Bangladesh and the state of West Bengal, India, was shown as the range of the species in the national Red List assessment (Begum, 2015; Fig. 1B). All the existing inventories on mammals in Bangladesh followed a similar approach, e.g., Khan (2015a) and Khan (2018). The recently published sole research on small-clawed otters in Bangladesh also made a similar remark. Aziz (2018) studied the population size and feeding behaviour of the species in the Sundarbans and regarded the mangrove as its only extant range in Bangladesh. However, in Hunter and Barrett (2018), Duplaix and Savage (2018), Wright et al., (2021), there is no mention of the Sundarbans as a small-clawed otter habitat (Fig. 1A).

Only Hussain et al., (2011) and Menon (2014) considered both the Sundarbans and the forests of eastern Bangladesh as habitats of the Asian small-clawed otter.

Although eastern forests are widely ruled out for small-clawed otter, they have been regarded to hold the country's other two (and similarly little-studied) otter species: the smooth-coated otter (*Lutrogale perspicillata*) and Eurasian otter (*Lutra lutra*) [IUCN Bangladesh Red List of Threatened Species: Khan (2015b), Feeroz (2015)]. The basis for this perspective has not been detailed anywhere. Here, we provide camera-trapped evidence of the small-clawed otter in eastern Bangladesh and discuss its activity rhythm there. These findings are the outcome of an ongoing camera-trapping programme to understand terrestrial mammalian carnivore assemblage in the region.

We also discuss the potential of small-clawed otters to be an umbrella species for the mixed-evergreen, stream-fed, trans-border forests of north-eastern (NE) Bangladesh.

METHODOLOGY

Study area

The trans-border forests of NE Bangladesh are the northernmost fringes of the anticlinal Baramura-Atharamura-Longtharai-Jampui Hills situated in the states of Tripura and Assam, India (Saigal, 2005). These hill ranges, then, re-enter Bangladesh, gain elevation, and form the Chattogram (previously spelt as Chittagong) Hill Tracts (CHT), south-eastern Bangladesh. Southward, CHT forests are continuous with the Rakhine Yoma mountain range, Myanmar; on the east, these are also trans-border, continuous with the Dampa Tiger Reserve, the state of Mizoram, India (Akash et al., 2021).

In total, eastern Bangladesh possesses around 5000 km² of forested landscape, of which about 500 km² are located in the NE region. These landscapes are largely defined as reserve forests, which are oriented towards the sustainable use of forestry resources (Chakma, 2016). North-eastern Bangladesh has six reserves that are low in elevation [highest above sea level (a.s.l.) altitude 335 m], composed of mosaics of plantation forests and secondary natural mixed-evergreen growths, crisscrossed by seasonal and perennial streams, and surrounded by tea gardens (Zakir et al., 2020). The SE reserves are heavily rugged (highest a.s.l. altitude 1055 m), fed by stream systems, and still retain some old-growth dipterocarp-dominated patches (Chakma, 2016; Akash et al., 2021).

Three of the six NE reserves were selected for camera-trapping survey comprising about 114 km² of protected forests viz., Raghunandan Hill Reserve Forest (RHRF; 26.3 km²; Fig. 1C), West Bhanugach Reserve Forest (WBRF; 26 km²; Fig. 1D), and Tarap Hill Reserve Forest (THRF, 62 km², Fig. 1E). These are mostly flat, with an average a.s.l. altitude of 50–150 m. The scarcity of water is a prominent feature of RHRF; all streams there have turned into dried-out sand-beds with small pools available only throughout the monsoon. WBRF has streams but most of them are not perennial. Only THRF holds the ideal riparian characteristics. At least five major stream networks are spread throughout the forests with numerous interconnecting branches. The other three NE reserves are Rajkandi Reserve Forest (RRF; 60 km²; Fig. 1C), Atora Hill Reserve Forest (AHRF, 100 km²; Fig. 1C), and Patharia Hill Reserve Forest (PHRF, 60 km²; Fig. 1C, F). The riparian characteristics of RRF, AHRF, and PHRF are similar to that of THRF. However, compared with the other three NE reserves, RRF, AHRF and PHRF are more hilly (average a.s.l. altitude is 90–220 m) and streams are strewn with boulders forming small but steep cascading slopes (Talukdar and Choudhury, 2017; Haque et al., 2018).

To protect wildlife, around 5.2 % of these reserves have been notified as IUCN-designated protected areas (one IUCN category II national park each in RHRF and WBRF; one IUCN category IV wildlife sanctuary in THRF) (Khan, 2018).

Camera-trapping and sign survey

A 1×1 km grid system was followed in each of the three reserves. A total of 43 trap stations were deployed (22 in THRF, 12 in RHRF, and 9 in WBRF). We aimed to assess the diversity of ground-level carnivore mammals in the study area. Camera-traps were kept operational 24 hours a day, with a single camera-trap (used models: *Bushnell Trophy Cam*, *Bushnell Core Low Glow*, and *Browning Dark Ops*) at each station. We put one station in each of the selected grid cells. Cells were chosen randomly and sprawled across forest peripheries to cores, but precise positions of trap stations were

optimized based on the findings of mammalian signs from reconnaissance visits. Camera-traps were installed on forest streams, and trails; on average, these were 25–100cm above the ground. In case of an elevated position, the angle of view of the camera-trap was always tilted down to the ground for about 20 to 40 degrees relevant to its vertical axis. No attractant, lure or bait was used. The average camera-trapping night across the stations was 84.

Between August 2021 and September 2021, two reconnaissance trail- and stream-mapping attempts were made at PHRF (Fig. 1C, F). We looked for animal signs e.g., tracks, scats, feeding stations, kills, etc. In total, we trekked 18 km of forest trails and 8.5 km of streams.

Data analysis

Camera-trapping data were organized following Niedballa et al., (2016). A capture event was considered notionally independent if at least 30 minutes had elapsed after the previous photograph of the same species at the same station (O'Brien et al., 2003). The identification of the animal was made visually based on size and distinctive coat pattern following Menon (2014), and Hunter and Barrett (2018). In addition, the camera-trap images and tracks were shared with the members of the IUCN Otter Specialist Group as well as the Facebook-based group *Otters of Himalayas*. We did not make any attempt to identify individuals or bevvies i.e., separate groups.

Data obtained from THRF were incorporated into activity pattern analysis; here, 11 out of 22 trap stations were considered, as they had been installed on streams. Average camera-trap days at these 11 stations were 90. Thus, for analyzing diel activity, we considered data from a trapping effort of 1000 camera-trap days. The diel cycle was classified into four periods: night, dawn, day, and dusk. Considering regional sunrise and sunset time, the dawn and dusk time bands were set as 1.0–1.5 hours at sunrise and 1.5-1.5 hours at sunset respectively (Gerber et al., 2012; Noor et al., 2017; Zakir et al., 2020).

We observed diel activity patterns of the small-clawed otter in kernel density analysis (Sollmann et al., 2013). Electivity indices were calculated to understand the relative preference for different periods of a diel cycle. Following Lechowicz (1982) and Garrote et al., (2020), we considered four different indices viz., Ivlev's electivity index, E; Jacob's modified electivity index, D; Strauss' electivity index, and Vanderploeg and Scavia's relativized electivity index, E*. We tested the indices on the bootstrapped samples. We resampled the notionally independent events 1000 times using the original sample.

All analyses were carried out in R statistical software version 4.1.0 using packages *camtrapR* (Niedballa et al., 2016), *astroFns* (Harris, 2012), and *electivity* (Quintans, 2019). Distribution maps were prepared using ArcMap 10.5 using the geo-datum WGS 1984.

RESULTS

The small-clawed otter was found at two of three camera-trapped reserves (Fig. 2). At WBRF (885 camera-trap nights, of which 800 were in streambeds), three individuals appeared at 01h01 on 21 June 2021 (Figs. 1D, 2A).

In THRF (1472 camera-trap nights, of which 1000 were in streambeds), nine camera-trap stations provided 131 notionally independent events (total 930 images and 54 5-second-long video clips) (Fig. 1E). Each event had an average of 3–6 otter individuals. Pups were identified (Fig. 2). A total of 20 other mammals, 15 birds, and three reptile species also visited the otter-positive stations, including several other

carnivore mammals: The leopard cat (*Prionailurus bengalensis*), common palm civet (*Paradoxurus hermaphroditus*), masked palm civet (*Paguma larvata*), large Indian civet (*Viverra zibetha*), yellow-throated marten (*Martes flavigula*), and crab-eating mongoose (*Urva urva*); all frequently visited the otter-positive stations. In WBRF, we found the Asiatic golden cat (*Catopuma temminckii*) at the same station that the otters had visited. We found no evidence of otters in RHRF (active camera-trap night 1272, of which 1100 were in streambeds). We observed multiple otter footprints and a feeding station in PHRF from two locations (Figs. 3B, C).

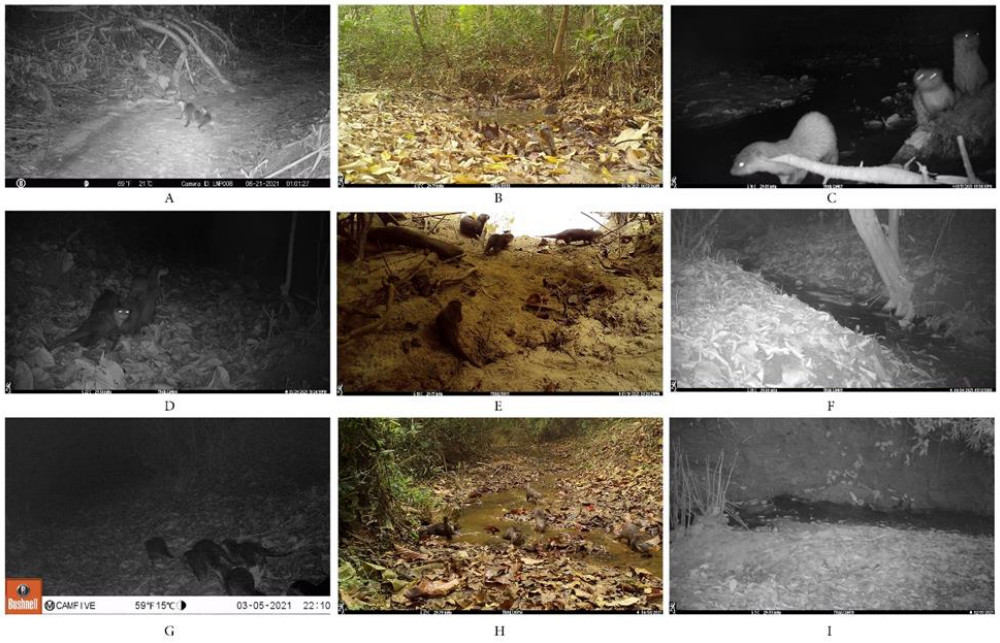

Figure 2. Camera-trapped photographs of the Asian small-clawed otter (*Aonyx cinereus*) in West Bhanugach Reserve Forest (A) and Tarap Hill Reserve Forest (B–I) of north-eastern Bangladesh.

Figure 3. Tracks and feeding stations at Tarap Hill Reserve Forest (A) and Patharia Hill Reserve Forest (B–C), and the stream where the feeding station was observed (D). Photograph by Azizul Islam Barkat and Muntasir Akash/Northeast Bangladesh Carnivore Conservation Initiative.

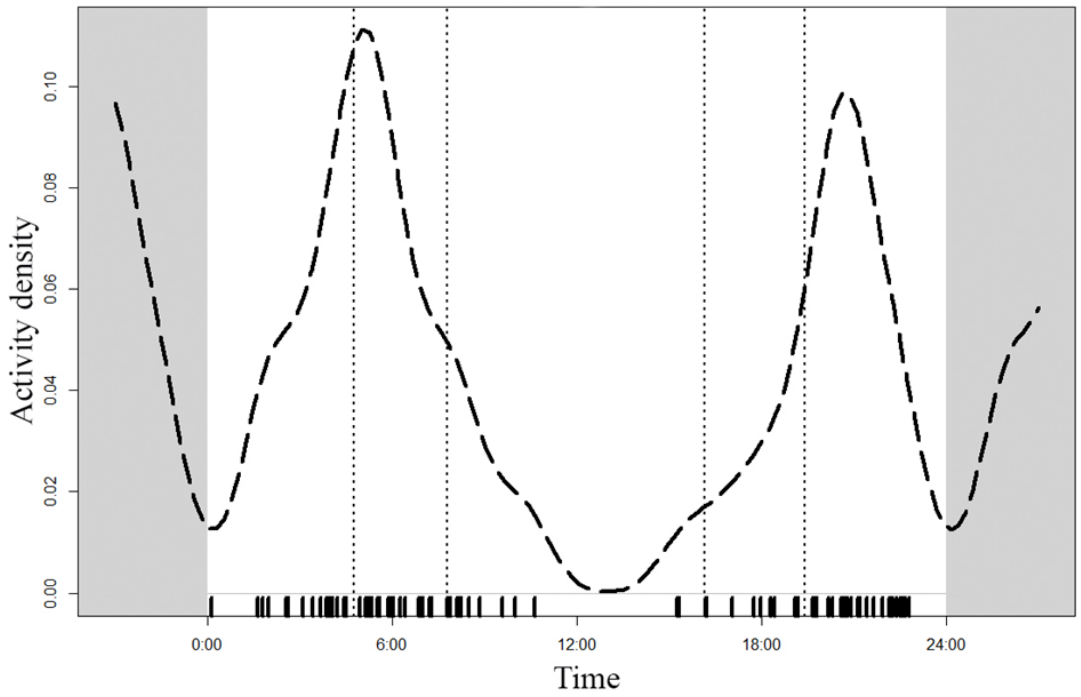

Figure 4. Activity pattern of the Asian small-clawed otter (*Aonyx cinereus*) observed in 2020–2021 survey in Tarap Hill Reserve Forest. The vertical dashed (---) lines indicate the time band separating ranges of three activity periods: twilight, day, and night. Independent detection events for each species are indicated by the short vertical lines appended below the x-axis.

Otters of THRF were primarily active during dawn (04h45–07h48) and night (19h25–04h45) (Fig. 4). However, dawn-time activity reached its highest peak (Fig. 4). During the night, activity peaked around 2000 hours following a short peak around nautical dusk (1900 hours). Although we found 12 day-time events, the indices (obtained separately from original and bootstrapped samples) showed that otters of THRF had an avoiding tendency toward dusk and day periods of the diel cycle (Table 2).

Table 2. Electivity indices of the Asian small-clawed otter (*Aonyx cinereus*) in north-eastern Bangladesh (based on the survey result in Tarap Hill Reserve Forest).

Period	Electivity Indices			
	Ivlev's (E)	Strauss' (L)	Vanderploeg and Scavia's (E*)	Jacbo's modified (D)
	based on original sample (n = 131)			
dawn	0.3293	0.1248	0.2882	0.3963
day	-0.5055	-0.234	-0.5386	-0.6108
dusk	-0.1929	-0.0438	-0.2364	-0.2167
night	0.1645	0.1531	0.1199	0.3006
	based on bootstrapped sample			
dawn	0.3434	0.1329	0.2952	0.4141
day	-0.5860	-0.2576	-0.6201	-0.6848
dusk	-0.1554	-0.0364	-0.2071	-0.1754
night	0.1716	0.1611	0.1191	0.3152

DISCUSSION

What does the discovery tell us?

Comparing the topography and habitat of the NE reserves, and the identified habitat requirement of the small-clawed otters (Hussain et al., 2011), it seems extremely likely that all of the six reserves (three camera-trapped and three not camera-trapped) hold otter populations. These reserves are surrounded by tea gardens or paddy-field mosaics and have 2–5m wide meandering streams with moderate to dense bank vegetation (Haque et al., 2018). Except for RHRF and WBRF, streams of THRF, RRF, PHRF, and AHRF become torrential in monsoons. Large or small, these streams are also rich in riparian fish and invertebrates (Fig. 5). According to Hussain et al., (2011), small-clawed otters are known to exist in these habitats and feed on similar prey species.

Figure 5. Streambeds observed in the surveyed forest reserves: Tarap Hill Reserve Forest (A), West Bhanugach Reserve Forest (B); Raghunandan Hill Reserve Forest (C); and Patharia Hill Reserve Forest (D). Photograph by Muntasir Akash/Northeast Bangladesh Carnivore Conservation Initiative.

The absence of otter records from RHRF may not indicate that it does not hold the species. Based on the presence of tea gardens on the periphery of RHRF, its trans-border connectivity and the finding from WBRF, we suggest not to discard RHRF as an otter range. Although otters might cease to exist inside RHRF (as its streams are largely dried up; Fig. 5C), they can survive in the peripheral and the bordering areas. The conjecture subjects for further research, however, is strengthened by the findings from WBRF. It is the most disconnected (from the Tripura Hills) of the six NE reserves (Fig. 1C), and its streams are not perennial anymore but hold large natural water reservoirs within the forest boundary (Hakim et al., 2020) which might be supporting a few surviving families, and the plausible reason behind the obtained event.

The species is considered the least aquatic otter (Hussain et al., 2011). Our observation corroborated this trait. In THRF, we found otters on camera-traps (in January–February) placed near pools that were about 1 m in depth formed at the otherwise dried-up streambeds (Fig. 1B). However, otter records from camera-trap

stations became significantly reduced in the dry season (April-May) and subsequently resumed with the commencement of the monsoon (June-July).

The existence of the small-clawed otter highlights the NE forests' conservation significance. Regardless of their connectivity with the forests of Tripura Hills, Bangladesh's NE reserves are viewed largely as 'empty forests' in literature (Akash and Zakir, 2020; Akash et al., 2021). Nonetheless, recent camera-trapping indicated a higher value (e.g., Zakir et al., 2020 found 17 terrestrial mammals including 10 carnivores). These riparian reserves still receive insufficient conservation attention and investments (Pianzin et al., 2021). Given the home-range size, threatened status, and global appeal for otters, promoting research and conservation of this species can create an umbrella effect for these reserves.

In a regional context, the adjacent Indian states, i.e., Tripura, Meghalaya, Mizoram, and the southern part of Assam, are assessed as otter habitats (Duplaix and Savage, 2018), but concerted studies are lacking. Peer-reviewed carnivore studies are absent in Tripura. There seems to be no published literature on otters in Meghalaya and Mizoram. Although Talukdar and Choudhury (2017) mentioned the presence of the small-clawed otter in the forests of southern Assam (bordering PHRF; Fig. 1C), we found no ecological study conducted on the otters of this region. Thus, this work stands as a head start necessitating otter research in the north-eastern Indian subcontinent.

Activity rhythm

The nocturnal-crepuscular behaviour of the small-clawed otter in THRF corroborated the description provided by Hussain et al., (2011) and Duplaix and Savage (2018) but little primary information seems to be available from anywhere in its range. However, we looked for similar work that dealt with the diel rhythm of the species with camera-trapping techniques but did not find any. Thus, the species' preference over dawn to dusk that we obtained from this study adds new information to its ecology.

Bimodal activity peak (during dawn and night) is known in African *Aonyx* species although the number of pertinent published literature on *Aonyx* genus is few. Njoroge et al., (2014) studied the African clawless otter (*Aonyx capensis*) in Kenya although did not differentiate between the dawn and the dusk band. We looked into similar studies made on other otters. A similar activity rhythm was found for the neotropical river otter (*Lontra longicaudis*) in the Orinoco River, Colombia (Garrote et al., 2020). The pattern we found, however, differs from that of the smooth-coated otter (the same would potentially be found for other tropical otter species if there were more studies): Palei et al., (2020) and Wai et al., (2020) found smooth-coated otters to be diurnally active. Hussain (2013), in the National Chambal Sanctuary, India, observed the overall nocturnality of smooth-coated otters with substantial daytime activity during winter.

Otter research in Bangladesh

To our knowledge, Bangladesh is among the tropical Asian countries that barely have any scientific data on its otters. The paucity of empirical evidence on the otters of Bangladesh is highlighted in multiple works in regular intervals, for example, Conroy et al., (1998), de Silva (2011), Yoxon and Yoxon (2019), Duplaix and Savage (2018), and Basnet et al., (2020).

Bangladesh is considered a range country for the Eurasian otter (Roos et al., 2015; Khan, 2018) but a valid and documented record is lacking since 1995, if not since the post-independence period (Yoxon and Yoxon 2019; Basnet et al., 2020). Three of the four existing studies on the otters of Bangladesh featured the smooth-coated otter. Feeroz et al., (2011a,b) studied its breeding activities and the traditional fishing

practices in the wetlands of west-central Bangladesh. Recently, Shashoto and Yoxon (2020) documented smooth-coated otters from riverine grassland-sandbar mosaics of the Ganges, a previously undescribed locality and provided insight into the size of the population residing there. In comparison with the known ecology of the smooth-coated and Eurasian otters (Roos, et al., 2015; Khoo, et al., 2021), although Khan (2015b) and Feeroz (2015) considered the possibility, plausibility might be slim for NE reserves to harbour these two species.

CONCLUSION

Our study not only proves the existence of otters in NE Bangladesh but also points out the exact species residing in these forests. The study poses several critical research questions. For example, understanding the population size of otters residing in the six NE reserves, and the driving ecological and anthropogenic factors that help or hamper these populations are of immense significance. Although we observed that the local people of THRF are generally reluctant toward otters, we noticed the usage of irrigation engines in fishing (to pump out water from certain blocks of stream) and heard of instances of poison fishing. The secretive and less-demanding small-clawed otters might not be in conflict with the local people but a silent victim of these practices; threat measures that need to be assessed.

Lastly, the absence of two larger otter species from our camera-trapping effort also demands urgent attention. We suggest systematic studies involving camera-trapping and other contemporary techniques to overcome the information deficiency and initiate conservation mainstreaming of these long-neglected small carnivores in Bangladesh.

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RESUME

QUE NOUS APPREND UNE DÉCOUVERTE ?
APERÇU DU PIÉGEAGE PAR CAMÉRA DE LA LOUTRE CENDREE DANS LE NORD-EST DU BANGLADESH

Au début de l'année 2022, quatre études pertinentes évaluées par des pairs ont été menées sur trois des quatre espèces de loutres orientales qui vivent au Bangladesh. La répartition des loutres dans le pays, en raison du manque de preuves empiriques, est faite de conjectures et n'a pas encore été scientifiquement prouvée. Par la suite, les forêts de l'Est - bien qu'elles fassent partie de l'aire de répartition mondialement reconnue de la loutre cendrée (*Aonyx cinereus*) - ne sont pas accréditées au Bangladesh pour l'espèce et ne reçoivent aucun investissement de conservation. Cette étude a fourni, pour la première fois, des preuves de la présence de populations reliques de loutres cendrées dans l'est du Bangladesh. Une enquête sur les mammifères carnivores terrestres a été réalisée entre janvier et octobre 2021 dans quatre réserves forestières du nord-est, ce qui a permis de trouver l'espèce dans trois réserves, avec 132 événements théoriquement indépendants à partir d'un effort d'échantillonnage de 3.629 nuits de pièges photographiques. Le rythme d'activité des loutres nocturnes-crépusculaires s'orientait davantage vers l'aube. Le travail met en évidence (i) le potentiel de la loutre cendrée en tant qu'espèce parapluie pour les forêts mixtes ripicoles transfrontalières

traditionnellement ignorées du nord-est du Bangladesh ; (ii) une grande incohérence entre les sources concernant sa répartition dans le pays ; (iii) la nécessité d'investiguer sur l'absence d'enregistrements de loutre à pelage lisse (*Lutrogale perspicillata*) et de la loutre eurasienne (*Lutra lutra*, aucune preuve de sa présence au Bangladesh depuis 30 ans) durant cette enquête bien que les réserves forestières étudiées soient largement répertoriées pour ces deux espèces ; et (iv) l'absence flagrante de toute information récente sur le statut de la loutre dans les États Indiens adjacents (Meghalaya, Tripura, Mizoram et sud de l'Assam) qui, avec l'est du Bangladesh, appartiennent à un territoire écologiquement inexploré et forment la limite ouest d'un point chaud de la biodiversité indo-birmane.

RESUMEN

¿QUÉ NOS PUEDE DECIR UN DESCUBRIMIENTO? INDAGACIÓN CON CÁMARAS-TRAMPA SOBRE LA NUTRIA ASIÁTICA DE UÑAS PEQUEÑAS EN EL NORESTE DE BANGLADESH

Para tres de las cuatro nutrias Orientales que viven en Bangladesh, hasta principios de 2022 se habían conducido en el país cuatro estudios pertinentes revisados por pares. La distribución de las nutrias del país, a causa de la carencia de evidencias empíricas, se construyó a partir de conjeturas y está pendiente conocerla científicamente. En consecuencia, los bosques orientales, aunque son una parte del rango de distribución globalmente reconocido de la nutria de uñas pequeñas (*Aonyx cinereus*) aún no están acreditados en Bangladesh para la especie, y no están recibiendo inversiones de conservación. Este estudio, por primera vez, proveyó evidencias de poblaciones relictuales de nutrias de uñas pequeñas en Bangladesh oriental. Llevamos a cabo un relevamiento de mamíferos terrestres entre Enero y Octubre de 2021 en cuatro reservas forestales del noreste, encontrando a la especie en tres reservas, con 132 eventos nocionalmente independientes a partir de un esfuerzo de muestreo de 3629 noches-cámara trampa. El ritmo de actividad de las nutrias nocturnas-crepusculares se inclinó más hacia el amanecer. Este trabajo destaca (i) el potencial de la nutria de uñas pequeñas como especie paraguas para los bosques trans-fronterizos ribereños mixtos-siempreverdes de Bangladesh nor-oriental; (ii) una gran inconsistencia entre las fuentes, en lo relacionado con su distribución en el país; (iii) las necesidades de investigar la ausencia de registros, durante éste relevamiento, de nutria lisa (*Lutrogale perspicillata*) y nutria Eurasiática (*Lutra lutra*, sin evidencias en Bangladesh por 30 años) aunque las reservas forestales prospectadas son ampliamente reconocidas por contener a ambas especies; y (iv) la impactante ausencia de cualquier información reciente acerca del status de las nutrias en los estados Indios adyacentes (Meghalaya, Tripura, Mizoram, y el sur de Assam) que, junto con Bangladesh oriental, pertenecen a un territorio ecológicamente inexplorado, y forman el límite occidental del Hotspot de Biodiversidad Indo-Burma.

REPORT

DISTRIBUTION OF THE ASIAN SMALL-CLAWED OTTER (*Aonyx cinereus*) IN CHHATTISGARH, INDIA

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Abstract: The Asian small-clawed otter (*Aonyx cinereus*) is the smallest among 13 species of otters. Very little information is available about the status and distribution of Asian small-clawed otters in Chhattisgarh. The current study reports the presence of otters at 20 different sites in 5 districts of Chhattisgarh. To confirm the presence of the otters in this region, we used camera traps, sign surveys, and direct sightings. Threats like habitat destruction, sand mining, and extensive fishing were identified. Systematic otter surveys are needed in this region to make an accurate population assessment and to create an otter-specific conservation plan.

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Keywords: *Aonyx cinereus*, Chhattisgarh, Otter distribution, Conservation.

INTRODUCTION

Otters have obtained noticeably little interest for field-based studies throughout Asia, regardless several species of otters occurring in the region (Foster-Turley, 1992). As a result, scientific information on otters in Asia has generally been lacking (Nawab and Gautam, 2008). Among the 13 species found across the world, three species of otters: the Smooth-coated otter (*Lutrogale perspicillata*), the Asian Small-clawed Otter (*Aonyx cinereus*), and the Eurasian Otter (*Lutra lutra*) have been reported from India (Menon, 2014).

The Asian small-clawed otter is the smallest otter in the world (Harris, 1968; Foster-Turley and Santiapillai, 1990). The IUCN Red List classifies the Asian or Oriental Small-clawed Otter as Vulnerable, and it is protected under Schedule I of the Wildlife (Protection) Act, 1972, and Appendix I of the Convention on International Trade in Endangered Species (CITES). The Asian small-clawed otter primarily preys on aquatic animals such as crabs, fish, frogs, arthropods, mammals, and snails (Kruuk et al., 1994; Aadrean et al., 2010; Hon et al., 2010). Rivers, streams, peat swamps, mangrove forests, rice fields, ditches, and fishponds are among the natural and human-altered habitats used by small-clawed otters (Hussain et al., 2011). The destruction or

degradation of important habitat as a result of shifting land-use patterns and other development activities are potential threats to the survival of Asian small-clawed otters throughout Asia (Wright et al., 2015). Loss of habitat from the cultivation of tea and coffee plantations in higher altitudes, loss of mangroves in coastal areas due to aquaculture and expanding human settlements, and siltation of smaller hill streams due to deforestation are the main threats to these otters in India (Wright et al., 2015).

In the year 2000, the state of Chhattisgarh was created out of undivided Madhya Pradesh. Chhattisgarh is one of India's most heavily forested states, with a total land area of 135,198 square kilometers, of which 44 percent is forested. Biogeographically, Chhattisgarh is straddled in between India's central highlands and the Eastern Ghats. The state's northern and southern regions are hilly, while the center is a rich plain (Chandrakar and Dhuria 2021) The Asian small-clawed otter was reported for the first time from Chhattisgarh at the Udanti Sitanadi Tiger Reserve (Suraj et al., 2020). However, there is little available information about their current distribution across the entire state of Chhattisgarh. This study assessed the status, distribution, and potential threats to Asian small-clawed otters in Chhattisgarh.

METHODOLOGY

During an extensive field survey for bird study in the Kanger Valley National Park led by the first author, opportunistic data was collected based on a direct sighting and indirect signs of Asian Small-clawed otters in 2017. Later on, otter-specific field surveys were conducted on foot by the authors across various areas of Chhattisgarh to collect evidence for the presence of otters. Between 2017 and 2020, fieldwork was undertaken in the winter (November - February) and summer (March - May) months. Information regarding otter sightings was collected from local villagers, fisherfolks, forest department staff, etc. as a primary data. All the suggested location and nearby potential sites were visited by the team to confirm the presence of otters in the area. As per the primary data collection, random approach was followed to collect any sign of otter's presence (spraints and tracks) in the study sites. It included a spraint survey and camera trapping across the otter's range, which provided a reliable picture of the otter's distribution.

During monsoon, certain field sites were inaccessible, furthermore, the chances of indirect signs such as spraint and tracks getting washed away in the rains were high hence, the survey was avoided during monsoon season. We recorded geographic coordinates of direct sightings, otter tracks, and spraint of otters, using hand-held Garmin GPS eTrex10. Three Cuddeback X Change model camera trap with infrared flash was used to collect photographic evidence at few sites. Species confirmation was done with the help of available standard literature from Menon (2014).

RESULTS

Otter tracks (n = 16), spraints (n = 48), dens (n = 13), and direct sightings (n = 1) were reported from 20 different sites between March 2017 and November 2020; among 5 out of 27 districts of Chhattisgarh (Fig. 1). The study showed distribution of Asian small-clawed otters mainly near freshwater streams in hilly terrain (Fig. 2). Seventeen sites with tracks (Fig. 3) and spraints (Fig. 4) of otters were rock or sand bank while the remaining three sites were paddy fields. Cavities in the rocky banks were utilized as a den by the otters (Fig. 5). Spraint was the most common indirect sign of otter presence reported at all 20 sites. During the survey, informal social interviews were conducted to collect information about otters in their respected areas. Respondents were shown photographs of otters to confirm their identification. The social survey showed frequent

interactions between otters and fishermen while fishing in the water streams. Otters were also reported to damage the fishing nets of fishermen. As per one of the respondents, two otters were killed by the fishermen in the past for damaging their fishing nets while predating on fishes. It was also reported that in certain sites, traps were laid to catch otters. We assume the traps were laid to eliminate otters from the area or for poaching them. Otter presence was also documented at three sites through camera traps installed based on indirect signs (Fig. 6). See Table 1.

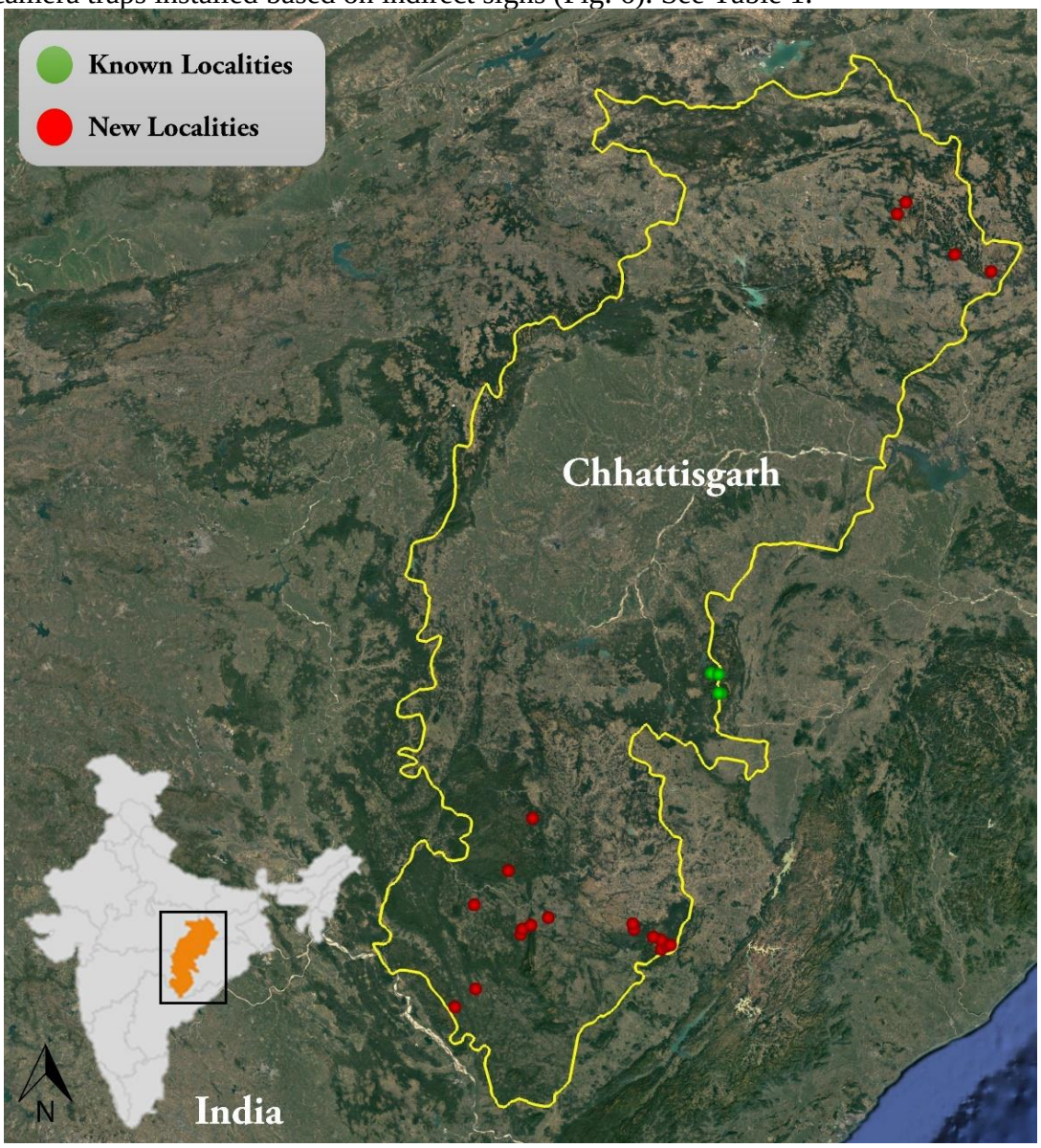

Figure 1. Locations in which Asian small-clawed otter presence was identified in Chhattisgarh.

Figure 2. Habitat of Asian small-clawed otters in Chhattisgarh.

Figure 3. Tracks of Asian small-clawed otters at one of the study sites.

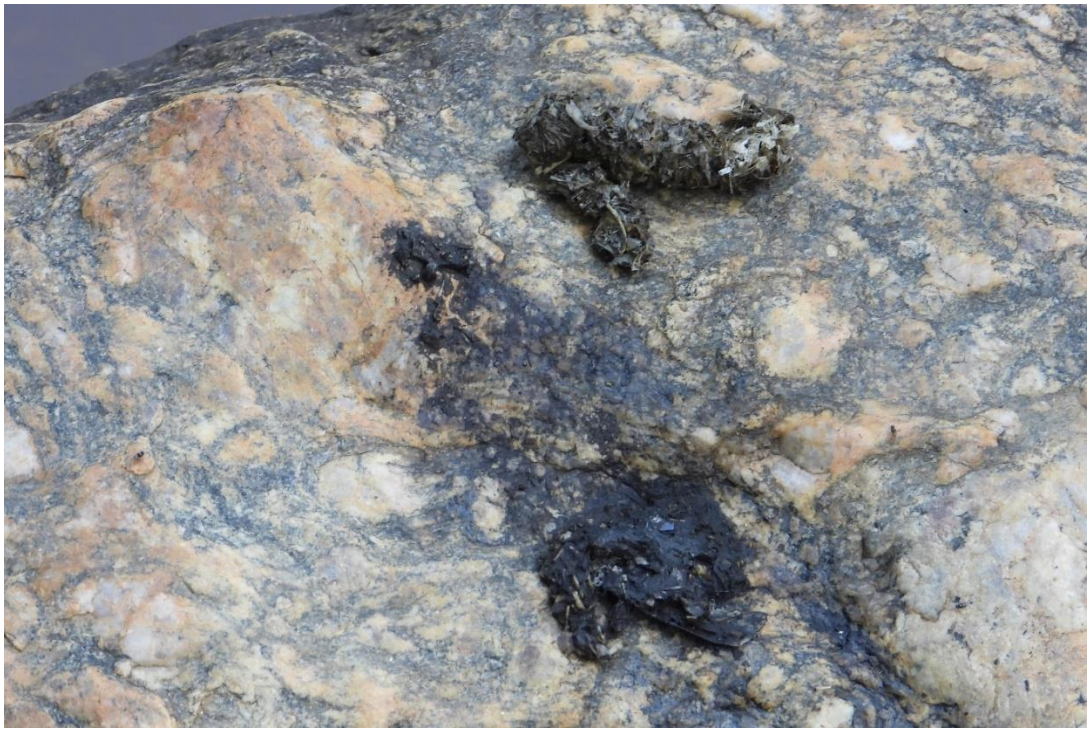

Figure 4. Fresh spraint of Asian small-clawed otters.

Figure 5. Rock cavities used as dens by Asian small-clawed otters.

Figure 6. Camera trap photo of Asian small-clawed otter at one of study sites.

It is vital to acknowledge the survey's limitations, since the study locations were dynamic systems and thus the species occurrence and detection were confined by seasonality and time of day due to variation in activity levels and behavior of the study species. Since otters are particularly sensitive to disturbance, including the presence of surveyors, they may have been under-recorded.

Table 1. New localities of Asian small-clawed otters reported during the study.

Sr. No.	Location	Coordinates	Evidence for otter presence	Remarks
1	Kanger Valley National Park (Kanger River)	18°49'55.5"N 82°00'04.8"E	Direct sighting of otters	2 otters were observed swimming in fresh water stream during pre-monsoon.
2	Koleng	18°48'51.6"N 82°03'02.0"E	Spraint and tracks	Camera trapping was done but no photographs were captured.
3	Pulcha (Bhainsadhara)	18°47'00.1"N 82°06'39.8"E	Otter spraint	Traps laid in the area to capture otters.
4	Tirathgarh waterfall	18°54'41.3"N 81°52'14.8"E	Spraint and tracks	Villagers attempted to capture otters using fishing nets.
5	Kasirrash	18°46'34.7"N 82°05'13.6"E	Spraint and tracks	-
6	Mundagarh	18°45'28.0"N 82°03'09.1"E	Photographed in camera trap and spraint and tracks found	Observed by the fishermen in night while fishing.
7	Darbha	18°52'42.5"N 81°52'42.2"E	Spraint and tracks	-
8	Midkulnar	18°53'57.6"N 81°13'45.1"E	Spraint and tracks	-
9	Jhodiyawadam	18°56'45.8"N 81°20'15.8"E	Spraint and tracks	-
10	Mirtur	18°52'31.3"N 81°10'28.8"E	Spraint and tracks	-

11	Cherli	18°50'36.8"N 81°09'55.3"E	Spraint and tracks	-
12	Benchram	19°01'08.7"N 80°52'11.3"E	Spraint and tracks	-
13	Usur	18°30'42.5"N 80°53'02.7"E	Spraint and tracks	Villagers have seen it yearlong during fish hunting at night.
14	Nambi Waterfall	18°24'02.4"N 80°45'14.3"E	Photographed in camera trap and spraint and tracks found	-
15	Indravati National Park	19°13'32.0"N 81°05'00.6"E	Spraint and tracks	Camera trapping was done but no photographs were captured.
16	Bedma	19°32'26.5"N 81°14'00.3"E	Spraint and tracks	Camera trapping was done but no photographs were captured.
17	Makarbhaja Waterfall (Manoharpur)	23°13'26.5"N 83°38'04.7"E	Spraint and tracks	While fish hunting some villagers have seen this otter hunting side by side with then as if he has adapted humans and their activities.
18	Dangari	23°09'13.6"N 83°34'37.4"E	Photographed in camera trap and spraint and tracks found	Due to loss and damage of fishing net, 2 otters were killed by the villagers.
19	Gullu	22°54'33.7"N 83°56'59.5"E	Spraint and tracks	Villagers have been sighting it for past 5 years, also their den locations.
20	Hatkalata	22°48'21.7"N 84°11'15.2"E	Spraint and tracks	Villagers have seen it yearlong during fish hunting at night.

DISCUSSION

The Asian small-clawed otter was the only species of otter directly identified in the study area. This study did not find any evidence for the presence the Eurasian or the Smooth-coated otters. However, the absence of otter indicators in one place does not necessarily imply that there are no otters in that area (Hussain & Choudhury, 1997). This study indicates that the northern and southern region have higher otter populations than the central region of Chhattisgarh because of the available hilly terrain and forest habitat in the region. Our observations suggest that Chhattisgarh is a stronghold for Asian Small-clawed Otter. However, there is a growing body of evidence that human-otter conflict is increasing. Other potential threats such as habitat destruction, sand mining, poaching, extensive fishing, etc. need to be addressed by the policymakers. Being one of the top predators in the Chhattisgarh aquatic ecosystem, otters can be a crucial keystone species for monitoring ecosystem health. Therefore, robust population assessment of otters is strongly recommended for guiding their future conservation effort and for monitoring the ecosystem health of the Chhattisgarh. Furthermore, regular monitoring of existing otter habitats must be ensured by developing the capacities of local community members to assist in the compilation of a database of otter population status. The availability of this vital information to decision-makers in prominent entities at the national and international levels would aid in the implementation of an otter conservation efforts for Chhattisgarh and other similar places. Efforts shall be made to develop a proper conservation strategy to save this elusive and important animal species.

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RESUMÉ: DISTRIBUTION DE LA LOUTRE CENDREE D'ASIE (*Aonyx cinereus*) AU CHHATTISGARH, EN INDE

La loutre cendrée (*Aonyx cinereus*) est la plus petite des 13 espèces de loutres. Très peu d'informations sont disponibles sur le statut et la distribution des loutres cendrées dans le Chhattisgarh. La présente étude rapporte la présence de loutres sur 20 sites différents dans 5 districts du Chhattisgarh. Pour confirmer la présence des loutres dans cette région, nous avons utilisé des pièges photographiques, des indices de présence et des observations directes. Des menaces telles que la destruction de l'habitat, l'extraction de sable et la pêche intensive ont été identifiées. Des relevés systématiques de loutres sont nécessaires dans cette région pour effectuer une évaluation précise de la population et concevoir un plan de conservation spécifique pour la loutre.

RESUMEN : DISTRIBUCIÓN DE LA NUTRIA DE UÑAS PEQUEÑAS ASIÁTICA (*Aonyx cinereus*) EN CHHATTISGARH, INDIA

La nutria de uñas pequeñas asiática (*Aonyx cinereus*) es la más pequeña de las 13 especies de nutria. Se cuenta con muy poca información sobre el status y distribución de la nutria de uñas pequeñas asiática en Chhattisgarh. Este estudio reporta la presencia de nutrias en 20 sitios diferentes en 5 distritos de Chhattisgarh. Para confirmar la presencia de las nutrias en ésta región, usamos cámaras-trampa, relevamientos de signos, y avistajes directos. Identificamos amenazas como destrucción de hábitats, minería de arena, y pesca extensiva. Se necesitan relevamientos sistemáticos en ésta región para realizar una evaluación poblacional confiable y crear un plan de conservación específico para las nutrias.

REPORT

ON THE CURRENT OCCURRENCE OF THE NEOTROPICAL OTTER (*Lontra longicaudis* OLFERS, 1818) IN A DEGRADED RIVER AFTER A DAM COLLAPSE, SOUTHEAST BRAZIL

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Abstract: The Neotropical otter (*Lontra longicaudis*) is a semi-aquatic predator that occurs in a wide geographic distribution in the Neotropical region, and can be used as indicator of ecosystem health. In January 2019, the Paraopeba River, which has historically been affected by anthropic activities, was impacted by the B1 iron ore tailings' dam collapse. This might have caused severe negative impacts to the entire fauna of the region. We carried out an inventory along the Paraopeba River to assess the current occurrence of the Neotropical otter in such asystem. The results obtained indicate the occurrence of this species in the study region eight months after the damage, with records upstream and downstream of B1 dam.
Keywords: Brumadinho, dam disaster, environmental monitoring, iron ore tailings

INTRODUCTION

Otters (subfamily Lutrinae) are semiaquatic predators, with diets based on fishes, crustaceans, molluscs, small mammals, birds, amphibians, and invertebrates (Pardini, 1998; Quadros and Monteiro-Filh,o 2001; Duplaix and Savage, 2018; Rheingantz et al., 2017). Some of the thirteen otters species that occur worldwide have been considered as a model for toxicological studies due to their position as an apex predator in aquatic systems, and to their sensitivity to environmental disturbances (Ben-David et al., 2001, Crowley et al., 2018). Thus, otters can be useful for indexing levels of ecosystem health (Ben-David et al., 2001; Bowyer et al., 2003; Crowley et al., 2018), making it an ideal species for measuring environmental change, such as contamination of trace elements.

The Neotropical otter (*Lontra longicaudis* Olfers, 1818) occurs in a wide geographic range in the Neotropical region, including all of Brazil's biomes: Amazon, Atlantic Forest, Pantanal, Cerrado, Pampa, and Caatinga (Rheingantz et al., 2017; Rosas-Ribeiro et al., 2017). This species occurs in rivers with some degree of

degradation, but its presence has been associated with rivers that have a riparian vegetation structure and clean water (Rheingantz et al., 2014; Almeida and Ramos Pereira, 2018). However, the threshold of contamination and pollution tolerance for the persistence of Neotropical otter is unknown (Rheingantz et al., 2017).

The Paraopeba River is a large river with 504 km of extension in the Minas Gerais State, Brazil, and it is a tributary of the São Francisco River. Historically, it has been impacted by several anthropic activities, particularly mining and agriculture (FEAM, 2013). Human occupation focused on mining activities in the Paraopeba basin has been intense since the beginning of the 18th century during the gold cycle in Brazil colonial period (FEAM, 2013). Therefore, the Paraopeba River is historically affected by anthropic activities that tend to compromise the quality of water bodies and on the ecology of several species that occur in this environment (e.g. Savassi et al., 2016). Despite the long and intense occupation of the Paraopeba basin, water monitoring began only in 1997, and initial monitoring reports that some indicators, such as *Escherichia coli*, copper and nitrate, are above the values allowed in the Brazilian standards (IGAM, 2019). This was likely related to mining, discharge of sanitary sewage, agricultural, industries, as well as erosion and silting processes (IGAM, 2019).

In addition to this historic anthropic use, in January 2019 one of the greatest mining-related disasters took place in the region. The B1 iron ore tailings' dam, maintained by the company Vale and located about 9 km east of Brumadinho, collapse caused a mud wave of 12,106m^3 of tailing, which potentially affected the Paraopeba River (Ramos et al., 2020, Parente et al., 2021). Recent water quality monitoring in the Paraopeba River revealed high levels of dissolved metals and turbity (Ramos et al., 2020), elements that can be harmful to the fauna (Jadoon and Malik, 2017). Here we present data on the occurrence of *L. longicaudis* following the collapse of Vale's B1 dam.

MATERIAL AND METHODS

We performed an inventory along the Paraopeba River and nearby forest remnants (Fig. 1) aiming to investigate the occurrence of medium and large sized mammalian after the event of dam collapse and report the possible current occurrence of Neotropical otter in the Paraopeba River. We carried the inventory through non-invasive techniques (camera traps and active search) between August 2019 and January 2020. We investigated the Paraopeba basin between the stretch comprised between 30 km upstream the confluence of Córrego do Feijão (Feijão stream), near B1 iron ore tailings' dam, and Três Marias Reservoir around 450 km downstream.

We established nine sampling points in nine regions along the area potentially affected by the collapse of the Córrego do Feijão Mine B1 tailings dam on the Paraopeba River. Three sampling points were established in control areas upstream of the confluence. Four camera traps were installed at each sampling point. Camera traps remained active for five consecutive days in both dry (Aug. 2019) and wet season (Dec. 2019/Jan. 2020).The total effort applied in the study were 480 camera trap days. We installed camera traps preferably in native vegetation physiognomies and near to the Paraopeba River.

We also used the active search methodology (sensu Wilson et al., 1996) during 36 days based on visualizations of alive individuals, encounter of carcass, and identification of characteristics vestiges of the *L. longicaudis* occurrence (footprints, feces, scratches, and prey remains). We performed data collection in a random sampling along the entire area potentially affected by the collapse of the B1 tailings dam at the Córrego do Feijão.

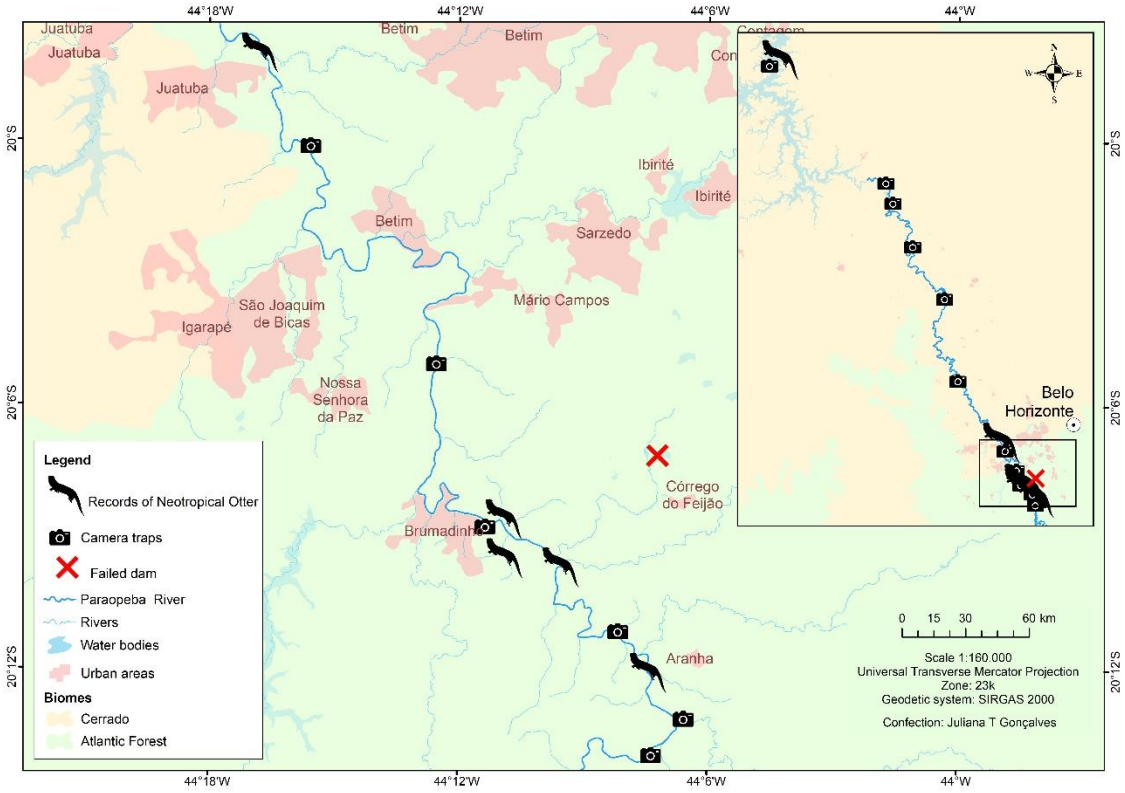

Figure 1. Geographical location of Neotropical otter (*Lontra longicaudis*) records along the area potentially affected by the collapse of the B1 tailings dam at the Córrego do Feijão Mine in the Paraopeba river basin, Minas Gerais State, Brazil.

RESULTS AND DISCUSSION

We obtained five records of *L. longicaudis* in the Paraopeba River sub-basin. Three records were obtained downstream of the Córrego do Feijão, which is a critical zone as it was the first place where mud has spread in the Paraopeba River after the B1 dam´s collapse. Further, two records were obtained upstream (Fig.1). Three records comprised feces identification, one record was made by camera trap photograph, and one record comprised the encounter of a prey (Loricariidae fish) remain. (Fig. 2).

Our results show that the Neotropical otters have persisted after the B1 iron ore tailings' dam collapse, even with high levels of dissolved metals and turbidity (Ramos et al., 2020).

The occurrence of Neotropical otters in the Paraopeba River even after the B1 iron ore tailings' dam collapse presents an opportunity to monitoring the exposure of the species to contaminants in a long-term study. Variables such as population estimation and if otters are affected by chemical contamination, including the current contamination of fishes in the Paraopeba River, should be evaluated (Parente et al., 2021). There is a cumulative effect of these chemicals, such as methyl mercury and persistent organic pollutants (e.g., organochlorine insecticides), in animals in the top of the trophic chain (Crowley et al., 2018; Huang et al., 2018). Therefore, it is essential that sentinel species such as the Neotropical otter be evaluated to assess the magnitude of contamination (Rheingantz et al., 2017; Parente et al., 2021).

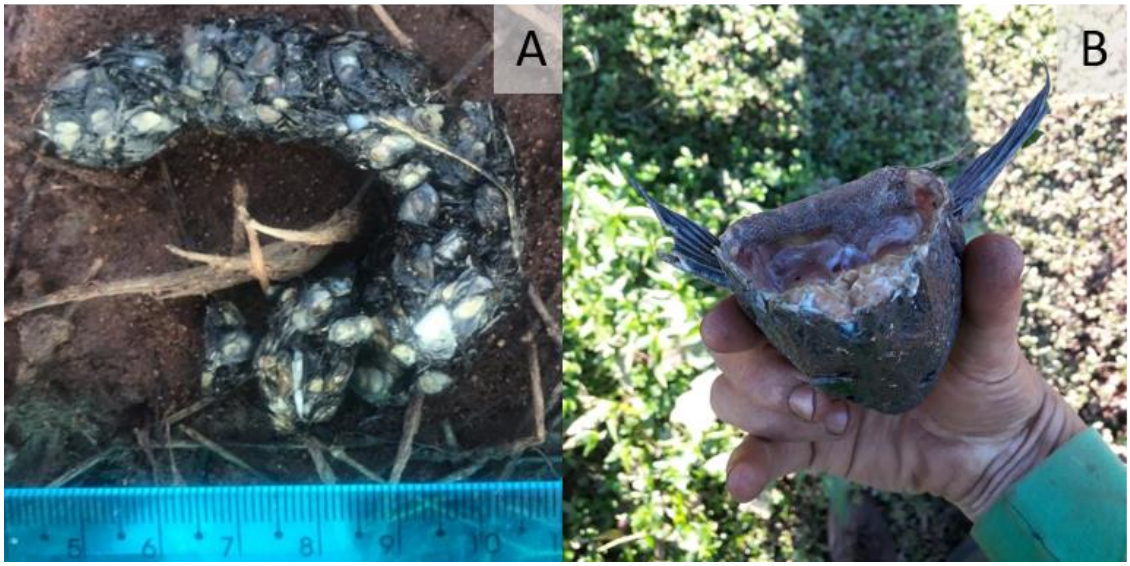

Figure 2. Evidence of the Neotropical otters (*Lontra longicaudis*) occurrence in the Paraopeba River: feces (A) and prey remains (B). Photo A by João Bianchini; photo B by Matheus Freitas).

Furthermore, in the last years, monitoring the *L. longicaudis* population through non-invasive methods such as otter feces have demonstrated to be an opportunity, as it is possible to evaluate the individual's exposure to contamination, the diet of animals through DNA metabarcoding and demographic parameters through population genetics techniques (Latorre-Cardenas et al., 2020). Finally, a long-term study would be necessary to assess the physiological (stress markers), reproductive (hormonal levels) and population status (genetic markers) of the species in reference to the changes that have occurred in the region after the disruption of B1. Once we confirmed the persistence of *L. longicaudis* in Paraopepeba river, we have now an opportunity to study in depth some biological parameters useful for the assessment on conservation of such population.

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RESUME

SUR L'OCCURRENCE ACTUELLE DE LA LOUTRE NÉOTROPIQUE (*Lontra longicaudis* OLFERS, 1818) DANS UNE RIVIÈRE DÉGRAVÉE APRÈS L'EFFONDREMENT D'UN BARRAGE, SUD-EST DU BRÉSIL

La loutre néotropicale (*Lontra longicaudis*) est un prédateur semi-aquatique présent dans une large distribution géographique dans la région néotropicale, et peut être utilisée comme indicateur de la santé des écosystèmes. En janvier 2019, la rivière Paraopeba, qui a historiquement été affectée par des activités anthropiques, a été touchée par l'effondrement des résidus de minerai de fer B1. Cela pourrait avoir causé de graves impacts négatifs sur l'ensemble de la faune de la région. Nous avons réalisé un inventaire le long de la rivière Paraopeba pour évaluer la présence actuelle de la loutre néotropicale dans ce système. Les résultats obtenus indiquent la présence de cette espèce dans la région étudiée huit mois après les dégâts, avec des enregistrements en amont et en aval du barrage B1.

RESUMEN

SOBRE LA PRESENCIA ACTUAL DE LA NUTRIA NEOTROPICAL (*Lontra longicaudis* OLFERS, 1818) EN UN RÍO DEGRADADO DESPUÉS DEL COLAPSO DE UNA PRESA, SURESTE DE BRASIL

La nutria neotropical (*Lontra longicaudis*) es un depredador semiacuático que ocurre en una amplia distribución geográfica en la región neotropical, y puede ser utilizada como indicador de la salud del ecosistema. En enero de 2019, el río Paraopeba, históricamente afectado por actividades antrópicas, sufrió el impacto del derrumbe de los relaves de hierro B1. Esto puede haber causado graves impactos negativos a toda la fauna de la región. Realizamos un inventario a lo largo del río Paraopeba para evaluar la ocurrencia actual de la nutria neotropical en dicho sistema. Los resultados obtenidos indican la presencia de esta especie en la región de estudio ocho meses después del daño, con registros aguas arriba y aguas abajo de la presa B1.

OSG MEMBER NEWS

The Otter Specialist Group contains 383 members at 12 October 2022.

Since the last issue, we have welcomed 9 new members to the OSG: you can read more about them on the Members-Only pages.

Laura Bonesi, United Kingdom: I have been working on the Eurasian otter for many years, studying it in the UK and supporting its conservation in Italy. I have led for many years a monitoring system for otter road casualties in Italy and contributed to the drafting of the Italian Otter Action Plan. I have now shifted my focus to a broader subject as I now work mostly on ecosystem restoration.

Nicole Delgado, Chile : I currently have a degree in Marine Biology from the Pontificia Universidad Católica de Chile. In my academic career, I have researched biological, social and geographical issues in the Chilean otters *Lontra felina* and *Lontra provocax*. I know that these areas are transversal to all otters in the world. Therefore, I would also like to contribute with my knowledge to other otter species, especially endangered species.

Tamara Huerta, Chile: I am doing research on the endangered sea otter species *Lontra felina*, also known by the local name Chungungo, particularly the characterization of their burrows and the description of the subtidal habitat. I am founder and CEO of Fundación Chungungo: Our mission is to protect areas of high ecological and cultural value along the Chilean coasts, starting in our local territory of Biobío, in the hope of expanding our impact at a regional and national scale in the future. Our activities include research, knowledge dissemination, and education, with a focus on sustainable development.

Vinni Jain, India: I am a Research Fellow with the Centre for Wildlife Studies, Bangalore and have done a very interesting project on otters in the Central India river ecosystem; much of the riparian habitat wasn't surveyed for otters earlier or in the recent past and my project established the presence of Eurasian Otters there (with a number of camera trap images) and likely incidences of hunting and conflict with fishermen. Preliminary results indicate that Eurasian otters are widespread in the Kanha-Pench area of Central India, an important finding which would expand the current assumed range of the species in India.

Giridhar Malla, India: I am founder member of the "Godavari Fishing Cat Project", a partner of the Fishing Cat Conservation Alliance. I work on the long term conservation of Fishing Cats and Smooth Coated Otters in the Godavari riverine habitats of Andhra Pradesh, regularly interacting with local fishing communities to raise awareness and influence perceptions of these animals.

Salami Olalekan, Nigeria: I am almost through with my MSc in Wildlife Ecology and Rangeland Management with research interest in the "Occurrence Pattern, Threat and Conflict with Humans of Otter and African Manatee", along the longest coastline in

Nigeria (Ondo State), which I am doing in collaboration with the African Otter Network. I am currently working on community-based otter conservation in this area, including school otter clubs.

Filipa Paiva, Germany: I am a Post-doctoral researcher at the Institute for Terrestrial and Aquatic Wildlife Research (University of Veterinary Medicine Hannover) in Büsum, Germany. I am working on the dietary analyses of the European otter, identifying fish remains in the stomachs of dead animals found on the side of the road or by analysing otter spraints. In the next years I will be involved in several projects investigating ecology, potential conflicts with fisheries and conservation measures related to the return of the Eurasian otter to Schleswig-Holstein.

Carla Pozzo, Argentina: Since 2009, I have been actively working in research applied to conservation, in management of the conservation problems, and tasks of environmental education with the population of freshwater huillines (Southern River Otters, *Lontra provocax*) in Argentina. I am the Coordinator of a conservation project for Southern River Otters in the Nahuel Huapi National Park .

Jo Rockingham, United Kingdom: I am an Associate Director at Tetra Tech Europe, with 22 years' experience of Eurasian otter survey and mitigation for projects including utilities, housing and commercial, mining and quarrying. As a former countryside ranger I organised otter guided walks, mammal tracking activities and wildlife crime events with the Lothian & Borders Police Force as part of PAW Scotland. My areas of interest include otter resting places, including seasonal timing and duration of use, type of use, and better definition of resting places and natal holts; and shared otter and mink habitat use.

NEW JOURNAL

Dear Friends and Colleagues,

Yes, the North American Otter Chronicles has been launched. Access is open and the link is: https://otterchronicles.org/
Please pay particular attention to the section on How to Submit an Articles to the Chronicles and Request for Otter Scientist Participation/How you can help. Enjoy!

So, sharpen your pencils and contribute an article or provide some information about your North American otter research and conservation initiatives. You can always contact me about your ideas for articles at victorcamp.otters@gmail.com.

Please feel free to share this link with your colleagues and the students you may be mentoring.

Best regards,

Victor L. Camp, Editor
North American Otter Chronicles