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REFERÊNCIA

MARQUES, A. A. B.; SCHNEIDER, M.; ALHO, C. J. R. Translocation and radiotelemetry monitoring of black-tailed marmosets, *Callithrix (Mico) melanura*(É. Geoffroy in Humboldt), in a wildlife rescue operation in Brazil. **Braz. J. Biol.**, São Carlos, v. 71, n. 4, nov. 2011. Disponível em: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1519-69842011000500018&lng=en&nrm=iso>. Acesso em: 16 maio 2014. <http://dx.doi.org/10.1590/S1519-69842011000500018>.

Translocation and radiotelemetry monitoring of black-tailed marmosets, *Callithrix (Mico) melanura* (É. Geoffroy in Humboldt), in a wildlife rescue operation in Brazil

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Received September 24, 2010 – Accepted January 21, 2011 – Distributed November 30, 2011

(With 1 figure)

Abstract

Five black-tailed marmoset *Callithrix (Mico) melanura* (Primates - Callitrichidae) individuals were monitored by radiotelemetry as part of a project on translocated wildlife affected by flooding the Manso River reservoir in the state of Mato Grosso, western Brazil (14° 52' S and 55° 48' W). The animals were monitored for eight months from October 2000 through August 2001. Only one death was recorded among the translocated animals. Two pairs established their home ranges in the new area, after some exploratory behavior. The new home range sizes varied from 0.72 to 4.27 km². The home ranges of male and female overlapped in the case of both pairs by 0.59 to 2.30 km². Trips were always made in pairs and not individually. The results indicate the feasibility of a successful translocation program for this species, as long as the animals are translocated to a similar habitat nearby.

Keywords: hydroelectric plant, translocation, *Callithrix (Mico) melanura*, Cerrado, wildlife rescue, radiotelemetry.

Translocação e monitoramento por radiotelemetria de saguis-de-rabo-preto (*Callithrix (Mico) melanura*) em operação de resgate de fauna no Brasil

Resumo

Cinco saguis-de-rabo-preto, *Callithrix (Mico) melanura*, foram acompanhados por radiotelemetria como parte do projeto de monitoramento da fauna translocada pelo enchimento do reservatório do rio Manso, Estado de Mato Grosso, Brasil (14° 52' S e 55° 48' W). Os animais foram monitorados por até oito meses, entre outubro de 2000 e agosto de 2001. Registrou-se apenas um óbito entre os animais translocados. Os dois casais restantes estabeleceram áreas domiciliares estáveis após algum deslocamento que se poderia chamar exploratório. O tamanho das áreas domiciliares variou entre 0,72 e 4,27 km². A sobreposição das áreas domiciliares de macho e fêmea, em cada casal, foi de 0,59 a 2,30 km², e os deslocamentos dos indivíduos não eram aleatórios, mas sim na mesma direção, indicando que os animais andavam juntos, e não dispersos. Os resultados demonstram ser viável a translocação de *Callithrix (Mico) melanura* sem comprometer a sobrevivência da maioria dos animais translocados.

Palavras-chave: hidrelétrica, translocação, *Callithrix (Mico) melanura*, Cerrado, resgate de fauna, radiotelemetria.

1. Introduction

Translocation consists of humans moving wild animals from one part of their distribution area to another site within the species distribution range (IUCN, 1987). The translocation is usually in the interests of conservation, but it can also pose an additional risk to the affected populations, because it may result in local population densities increase and disease transmission (IUCN, 1987; Magnusson, 1995). However, studies relating to translocation of wild animals have been conducted in different situations, including conservation programs for threatened species, reintroduction when the animals have been rescued from different areas, management of metapopulations and, as in this case, rescue of wildlife when natural habitats are flooded by the formation of hydroelectric dam reservoirs (Griffith et al., 1989; Vié, 1999).

In the case of translocated animals from areas affected by hydroelectric plants, the possibility of pathogen transmission exists, but it constitutes a minor risk. The animals are released only a few kilometers from the capture location so they belong to the same population that inhabits the release sites, and are thus theoretically subject to the same diseases. However, the increase in the animal population (known as the extended effect of the dams, Willis and Oniki, 1988) because of animal displacement after flooding or caused by the translocation program, can have a significant local impact.

One indirect way to evaluate the consequences of increasing population size is by monitoring the translocated animal species to verify the mortality rates among individuals. This will in theory be higher than the normal mortality rate expected for the local resident population. Such monitoring also allows researchers to verify how long is needed for animals to establish a new home range. Monitoring translocated animals in hydroelectric projects by radiotelemetry has been seen to be efficient in various experiments (Neri et al., 1997; Ostro et al., 2000; Richard-Hansen et al., 2000; Rodrigues et al., 2001).

In Brazil, few studies have been conducted on monitoring fauna translocated due to hydroelectric dams. Primates in particular are strongly affected because they are present in most flooded habitats (riparian forests). Brazil has one of the most important primate diversities in the world, but most species have scarcely been studied using this approach. Studies that have been carried out on primate translocation have shown that primates may adapt to their new home sites, as has been the case with threatened species such as the golden tamarin *Leontopithecus rosalia* (Linnaeus) (Beck et al., 1986; Kleiman and Mallinson., 1998) and *Callithrix (Callithrix) geoffroyi* (É. Geoffroy in Humboldt) (Passamani et al., 1997). Both studies took advantage of radiotelemetry techniques to follow the animals' re-adaptation.

Black-tailed marmosets *Callithrix (Mico) melanura* occur in the Amazonian rainforest, the Cerrado savanna biome, the Pantanal wetland, the deciduous forest of eastern Bolivia and the dry forest of the Paraguayan Chaco (Stallings,

1985). The species of this genus present a diversified diet, which includes items from plant (exudates, fruits, flowers, nectar, seeds and fungi) and animal origin (invertebrates and small vertebrates, Peres, 1994).

Very scarce data are available on their ecology, especially relating to home range areas and movement. Data on other marmoset species living in savanna sites show great differences in home range size: 8.25 to 18.5 ha (*Callithrix penicillata* – Miranda and Faria, 2001) and 4.0 to 24.0 ha (*Callithrix argentata* – Albernaz and Magnusson, 1999). Marmoset groups usually defend home ranges of 10 to 40ha, depending on availability and distribution of foods and second-growth patches (Rylands et al., 2008).

This study is the first to deal with translocation of this species after individuals were rescued from the flood area of a hydroelectric dam in an area of Cerrado savanna biome. The objective of this work was to evaluate the survival success of the translocated animals following release in a new area after the rescue.

2. Material and Methods

2.1. Study area

This study was performed in the Manso River watershed (14° 52' S and 55° 48' W), state of Mato Grosso, within the Cerrado savanna biome, in western Brazil. The Manso River is a tributary of the Cuiabá River, which in turn is a tributary of the Paraguay River, forming the upper Paraguay basin. The hydroelectric dam created a reservoir of 427 km², flooding a mosaic of the savanna habitats, including dense gallery forests along the river and creeks. The most affected habitats were different types of gallery forests: the "buritizal" palm forest, dominated by the palm *Mauritia flexuosa* with a loss of 24.866 km²; the seasonally flooded gallery forest with a loss of 5.632 km²; and other kinds of gallery forest with a loss of 17.202 km².

The upper reaches of the Manso River are located at an elevation where the upper reaches of other watersheds are also located: the Teles Pires River (tributary of the Tapajós River) flows in a northerly direction; the Culuene River (tributary of the Xingu River) northeasterly, and the das Mortes River (tributary of the Araguaia River) southerly; all three belong to the Amazon basin. To the southeast begins the Cuiabá depression, near the Pantanal wetland. Thus, the area is under Cerrado savanna dominion but also has a strong influence from the Amazon as well as from the Pantanal biomes.

The region presents a savanna tropical rain climate (Aw type, according to the Köppen classification) with poor, erosion-prone soils and vegetation cover from different savanna habitats (gallery forests, dense woodland, open woodland, and different kinds of grasslands and fields (Eiten, 1972; Alho, 2000). The region presents a marked dry season from May to September, when the average monthly precipitation varies from 10.5 to 65.8 mm. June, July and August are the driest months (Alho, 2000). Monthly rainfall in the wet season (October to April) reaches 205.4 mm in

December, January and February, decreasing to 130 mm in the other rainy months).

2.2. Rescue, translocation and monitoring

Animal rescue during reservoir formation was done between January 2000 and December 2001. The rescue program at the Manso River reservoir captured a total of 1,436 mammals, including the 17 marmosets mentioned above, 467 howler monkeys (*Alouatta caraya*), 335 capuchin monkeys (*Cebus apella*) and one single spider monkey (*Ateles chamek*) (Alho, 2003).

A total of 17 individuals of *C. melanura* were captured in the flood area. Seven animals were sent to zoological parks and 10 were released in similar habitats near the reservoir. The monitoring procedure took place from October 2000 to August 2002, with a 10-day field routine per month. The individuals chosen to receive the radio transmitters for monitoring were selected one week in advance to ensure the animals' familiarity with the equipment and their good health before release.

For each monitored animal we recorded sex, individual identification (radio frequency), hour and date that the radio was turned on and that the animal was released, and release site (UTM coordinates).

The radio transmitters used (model 073 Telonics) were assembled in ball chain collars and given two pulse bands. The first one (35 pulses per minute) indicated that the animal was active. The other (75 pulses per minute) was programmed to be activated after 18 hours of immobility, indicating death of the animal or a missing collar. For each monitoring day, the observer recorded the radio frequency, date and hour, UTM coordinates (from the observer's location) and azimuth with a hand-held compass and proper magnetic declination setting. Using a Telonics TR-5 receiver with headphones to reduce bearing error, the observers estimated at least two consecutive bearings of the target individual in a space of few minutes. Thus, the location of the animal was detected by triangulation for each record.

Three methodological aspects also interfere with evaluation of the home range area: 1) the minimum convex polygon, which tends to overestimate the area effectively used, by considering outlier points; 2) GPS error (in reference to the observation point), variable by 15 m in more than 100 m at the time field work was carried out, depending on the U.S. DOD-imposed selective program; and 3) the azimuth error, due to several interferences in signal reception.

Due to the number of animals included in the monitoring program (five marmosets, plus eleven *C. apella*, three *A. caraya*, five *Coendou prehensilis*, six *Myrmecophaga trydactyla* and four *Tamandua tetradactyla*), the size of the monitoring area (301 km²) and limited roads available on a steep topography, no more than one location per individual was obtained in each field work day. All observations are independent, as required for home range estimation (White and Garrot, 1990). Azimuth error ranged from 4° to 14°,

with an average of 8.8°, based on known locations in the study area.

The data for triangulation of the monitored animals was entered using CartaLinx 1.2 software (Hagan et al., 1998). The points containing information on locations of each focal animal (date and hour) could be exported in vector format and overlapped, with the help of Idrisi 32.11 software (Eastman, 1999).

The home ranges were mapped accordingly to triangulation points, using the minimum convex polygon trimmed at 95% fixes (White and Garrot, 1990). We considered the triangulation points only from the moment that the animals established movements in a given area, i.e. when no dispersal trips were observed. Since all individuals were released south of the Manso river, and the river is too large for marmosets to cross, minimum convex polygons were adjusted to fit river contour.

The forest area available within the savanna release locality was 19.82 km². However, the areas of gallery forest extended into nearby ranches. The other available habitats present in the region are: savanna Cerrado (22.39 km²); grassland (7.74 km²); old fields formerly used for agriculture and cattle ranching now in ecological succession (18.18 km²) and bare soil (0.22 km²) (Schneider, 2001).

3. Results

Three releases of animals were conducted in habitats similar to the animals' original capture sites (Conceição, 2000). In the first two releases, a pair of adult animals (male and female) received radio transmitters and, in the third release, only one adult female received the transmitter (Table 1). For most of the monitoring period, the observations registered the same two groups. Male M1 and female F1 were monitored for eight months (239 days). Male M2 and female F2 were monitored for seven months (202 days). Female F3 was followed for 37 days, when a sign of mortality was detected. The body was found with no evidence of predation.

The two pairs were followed until their radio transmitters ran out of batteries. Movements after translocation are represented in Table 2 and Figure 1. Triangulations for F1 and M1 at the southeast of the map represent locations prior to their new home ranges establishment. Significant differences in home range sizes were detected. The home range size of male M1 was estimated at 1.03 km² and that of female F1 at 0.40 km². Male M2 showed a range twice as large as that of male M1 (2.24 km²), and female F2's range was almost nine times that of female F1 (3.48 km²). The overlap in the home range areas for both couples represented at least 36% of the individual polygonal site (Figure 2). Male M1 showed a home range 157% larger than female F1. The size of the home ranges of male M1 and female F1 were quite stable after 10 and 15 observations, respectively. Female F2 showed a home range 55% larger than that of male M2. Female F3 zigzagged mostly to the north of the release point. Since this animal died short

Table 1. Number of *Callithrix (Mico) melanura* released, sex/age ratio of the released and monitored animals, period of monitoring, and number of triangulations.

Released animals	Sex/age ratio	Animals with radio transmitters	Monitoring period (start and finish)	Number of triangulations
7	3 adult males	M1	26/10/00-22/06/01	45
	3 adult females	F1	26/10/00-22/06/01	45
	1 young male			
2	1 adult male	M2	29/01/01-19/08/01	12
	1 adult female	F2	29/01/01-19/08/01	16
1	1 adult female	F3	12/02/01-21/03/01*	12

*Mortality.

Table 2. Individual data on the home range size (km²), overlap of the home areas between each released pair, greatest distance between extreme points of the home range (km), and greatest distance in relation to the release point (km) of the four monitored *Callithrix (Mico) melanura* individuals.

Sex	Home range (km ²)	Overlapping of the pair's home range (km ²)	Greatest distance between extreme points of the home range (km)	Greater distance in relation to the release point (km)
M1	1.03	0.37	1.372	7.108
F1	0.40		1.749	7.086
M2	2.24	1.76	3.706	3.093
F2	3.48		2.678	1.985

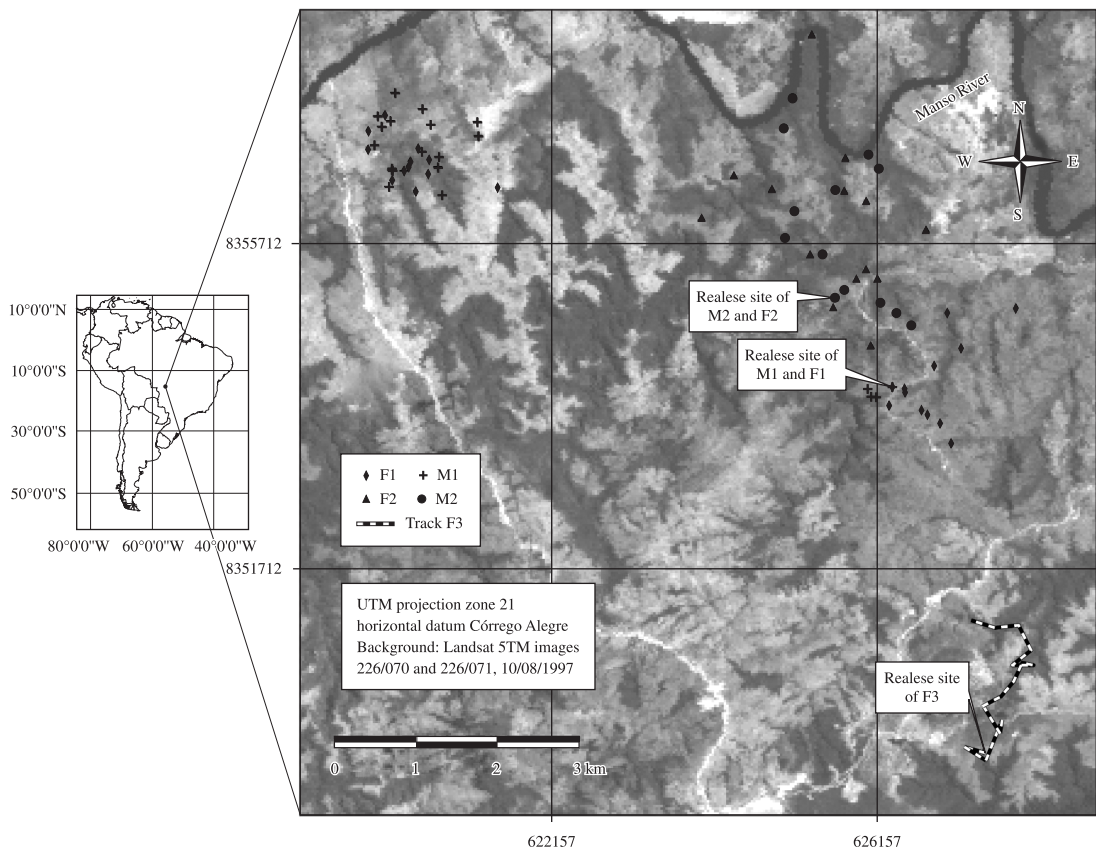


Figure 1. Track logs of translocated black-tailed marmosets in Manso, Mato Grosso, Brazil.

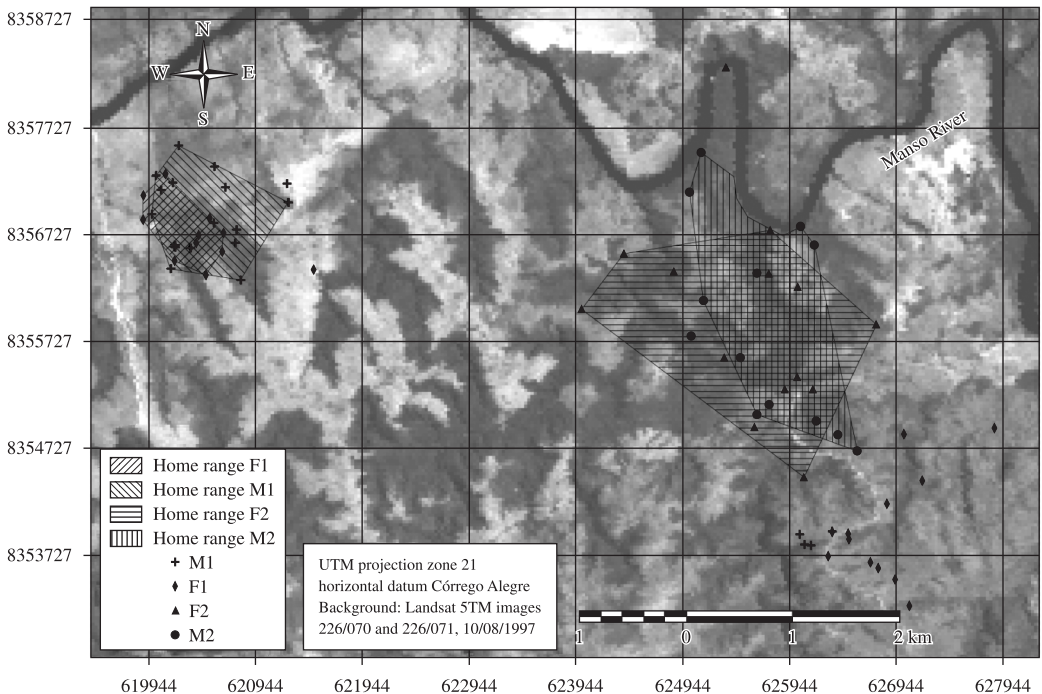


Figure 2. Home ranges of translocated black-tailed marmosets in Manso, Mato Grosso, Brazil.

after release, it would be meaningless to trace a home range polygon.

The first pair moved farther from the release point than the second did. In October (first month of the monitoring period), all the animals stayed near the release point. In November, they were not found in the area. Between December and January, M1 and F1 were located at about 7 km from the release point, in a gallery forest on the Manso River, where they settled, establishing a new home area. The animals stayed together during the monitoring period.

The second pair stayed near the release point throughout the monitoring period. Male M2 moved further away than female F2 (Table 2) and both of them fixed their new home area sooner than the first pair. Movements also indicated that the animals stayed together after release. Vegetation in both areas was quite similar, including a range of Cerrado phytophysiognomies (fields, open savannah, thick savannah, deciduous forest) as well as pastures.

4. Discussion

The success of the studies involving translocated animals is due to previous knowledge of their biology, especially foraging habits and the type of habitat where they were released. Some evidence suggests that primates select food for its digestible characteristics, its nutritional or caloric value, or its toxicological degree (Freeland and Janzen, 1974; Clutton-Brock and Harvey, 1977). Despite the fact that chemical defenses are found in greater quantities in the leaves than in the reproductive parts of the plants, they

also represent a determining factor for plant palatability (Milton, 1978).

The release points in Manso showed poor soils in terms of nutrients and water retention. It is known that in a poor environment plants produce tissues with more secondary compounds, and the carrying capacity for herbivores becomes lower (Janzen, 1974; Coley et al., 1985). In other kinds of habitat, this relationship has already been pointed out. Emmons (1984) stated that the quality of habitat in different sites of the Amazon forest seems to explain mammal density variation.

Two primate species, *C. melanura* and *A. chamek*, were rare at the study site and poorly known by the locals. Despite having no initial estimation of the species' local density, the small number of rescued animals shows its low abundance. Besides, in observations conducted on the same site, before the release activity, no other marmosets had been seen or heard.

Despite the low density, the presence of *C. melanura* in the region was registered (specimens in the University of São Paulo, Museum of Zoology, Mato Grosso, 1977) by the authors' personal observation and from local residents' reports. These low densities would justify, at least in part, the extensive home ranges of the translocated individuals.

The released groups showed differences in the distance covered from the release point and in the size of their home ranges. Male M1 and female F1 moved to a denser forest, on the banks of the Manso river. This area showed a more diverse flora and fewer deciduous leaves on the ground during the dry season. All of these factors, plus

the proximity of the river, help with water collection and intake of food, such as fruits and insects. The other group, formed by male M2 and female F2, stayed closer to the release point, which was a rocky soil in a markedly deciduous forest during the dry season, far away from perennial water sources. The size of their home ranges was larger, presumably due to lower food availability.

The only registered death was of the female F3, an animal that was captured and released alone. Her movement in a straight line indicated that the animal was not exploring the areas surrounding the release site. Social groups that keep close together explore the area where they are released more easily, while solitary animals are more exposed to predation and also may find it more difficult to gather food.

5. Conclusion and Recommendations

The construction of hydroelectric plants represents an impact on primate populations, by destroying their habitats. Translocation is carried out in order to reduce losses. Rescue-release and monitoring programs for wild species help to increase our knowledge of scarcely studied species, but they are generally limited because of high operational costs and the need for trained professionals to carry out the programs. In this study, the most relevant conclusions to arise from monitoring rescued and translocated black-tailed marmosets for two years were:

- Translocation and monitoring of rescued *C. melanura* individuals was feasible.
- Translocation of primates may play an important role in conservation programs for populations affected by human disturbances in the environment.
- Translocated animals belonging to social groups have a better chance of survival than solitary individuals.
- Exploratory behavior is more frequently observed right after release. Once familiar with the new environment, the animals tend to disperse or establish territory.

In any conservation program that involves primate translocation, several aspects need to be considered for the success of the program. Among basic procedures that should be adopted, the following are recommended:

- Sites chosen for release should present basis conditions for survival of the released animals. Studies of habitat selection should be previously carried out.
- The release site must have vegetation structurally able to support dispersion of individuals.
- Species density in the release area should be estimated in order to avoid stress caused by competition for resources such as water, food, reproductive partners and sleeping sites.
- The translocation must involve structured social groups. Individuals captured from a group should be kept together in captivity before release.

- Captivity period should be as short as possible. It is advisable to avoid contact with other species and exchange among social groups.
- Release sites should have similar vegetation structure and flora composition to the home area of the species, and should also be located as near of capture sites as possible.

Acknowledgements – The authors would like to thank FURNAS Centrais Elétricas S.A. for providing financial support to make the research possible; Luis Augusto da Silva Vasconcellos (Head of the Fauna Rescue Program in *Operação Tapiti*); and Raimundo Lima Reis (field logistics operator).

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