SURVEY of golden-headed lion tamarins (*L. chrysomelas*) and an identification of high-priority habitats for a long-term conservation.

This survey determines the current geographical distribution and population numbers of the endangered golden-headed lion tamarins. In addition, a vegetation characterization will be conducted for realized and potential habitats to identify ecological factors limiting the distribution of lion tamarins. The results will enable AMAP to identify areas whose protection is of particular importance for the long-term survival of lion tamarins.

AMAP is a German-Brazilian environmental organization dedicated to the conservation of the Mata Atlântica, the Brazilian Atlantic Rain forest. Especially the long term survival of golden-headed lion tamarins is in the focus of AMAP's mission, as an flagship species of the region. AMAP promotes the conservation of the Mata Atlântica through land acquisition, reforestation, research projects and organic sustainable cacao cultivation. The base of our activities in the region is the association's own farm "Bom Pastor" not far from the Almada River. Based on the survey's results, AMAP will develop conservation concepts, to secure the long term survival of lion tamarins in the wild.

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Golden-headed lion tamarins (*Leontopithecus chrysomelas*) are endemic to southern Bahia, the Atlantic rain forest of Brazil, and are endangered. Due to ongoing habitat destruction and frag-mentation, their population continues to decline. This project will determine the current geographical distribution and population numbers. In addition, a vegetation characterization will be con-ducted for realized and potential habitats to identify ecological factors limiting the distribution of lion tamarins. The results will enable AMAP to identify areas whose protection is particularly important for the long-term survival of lion tamarins. Based on the results, protection concepts are developed and implemented.

I. Current situation

Golden-headed lion tamarins (*Leontopithecus chrysomelas*) are a small primate species that belongs to the marmoset family and has been classified as endangered (EN) by the IUCN. This species of marmoset is endemic to southern Bahia along Brazil's Cocoa Coast and originally lived in Brazil's Atlantic Forest, the Mata Atlântica (Kierulff, M.C.M. et al. 2008). The Mata Atlântica is one of the most threatened tropical forests and has been reduced to about 10% of its original extent, especially in the 20th century. Nevertheless, the Mata Atlântica is a hotspot of biodiversity (Myers et al. 2000; Shi et al. 2005).

The range of golden-headed lion tamarins is in southern Bahia and northern Minas Gerais between Rio Contas and Rio Jequitinhonha, with an estimated size of 19,043 km² in Bahia state and 418 km² in Minas Gerais state (Rylands, 1993; Pinto and Rylands 1997; Rylands et al., 2008b) and an estimated population between 6,000 and 15,000 individuals (Pinto and Rylands 1997).However, Raboy et al. 2010 indicated a decrease of its distribution, especially in the western part of the range, due to the decline of cocoa cultivation and intensification of livestock production in these areas. The remaining habitat is also highly fragmented and estimated at less than 1,000 km2 distributed in patches throughout the original range. Within this area, only 5% of the remaining forest fragments are larger than 36 ha (Zeigler et al. 2010). Lion tamarins, however, require habitat between 40 and 197 ha, depending on food availability (Rylands 1993), with an average of 53 ha (Dietz and Raboy, unpublished data). In addition, small, isolated subpopulations, especially in the western range, will become extinct in the near future because their population size is too small (Raboy et al. 2013). The total population is currently estimated to be less than 2500 individuals and may have deteriorated significantly (Raboy et al., 2010).

A lion tamarin of Fazenda Bom Pastor equipped with a radio collar.

In 2005, a population and habitat viability analysis was conducted for lion tamarins (Holst et al., 2006). The results indicate that only one population, in the Reserva Biológica de Una (Nature Reserve near Una, south of Ilheus), is viable and capable to maintain sufficient genetic variability for a period of 100 years (Zeigler et al. 2010). Cocoa agroforests, or cabrucas, play a critical role in ensuring the survival of lion tamarins (Holst et al. 2006). On the cacao coast of southern Bahia, cabrucas, due to traditional cacao cultivation as the dominant economic form, represent a matrix habitat in which other landscape forms, such as forest fragments, agricultural land, and infrastructure, are embedded.

A cabruca can be defined as a complex multistrata agroforestry system based on shade-tolerant understory crops such as cacao

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(*Theobroma cacao*) or coffee (*Coffea* spp.) grown under a complex and often species-rich canopy of native and/or planted trees (Schroth et al., 2014). This agroforestry system can thus provide habitat and resources for forest-dwelling species that would not survive in a purely agricultural landscape or plantation, or allow species to disperse across a fragmented landscape (Schroth et al., 2007).Thus, the cacao coast of southern Bahia has been able to remain a hotspot of biodiversity. In Bahia, the cabruca thus represents a vital habitat for the survival of the native flora (Sambuichi 2002, 2006; Sambuichi and Haridasan 2007) and fauna (Pardini 2004; Delabie et al., 2007; Faria et al., 2006 and 2007) of the Mata Atlântica.

Cabruca of Fazenda Bom Pastor, habitat of lion tamarins.

Unlike many other forest-dwelling animals, lion tamarins and other marmosets use secondary forests and cabrucas for oraging, e.g., for fruits, nectar, and animal prey (Oliveira et al., 2010). Fruits, in particular, are abundant in secondary forests and cabrucas due to better light availability than in primary forests. In addition, lion tamarins are the last remaining frugivorous mammals in many areas, making them key seed dispersers for tree species (Oliveira & Estrada 2017).

The last inventory was more than 25 years ago and in some regions there is a lack of sufficient assessment. Potential habitats, which were not taking into account during the last census, despite the absence of geographical barriers (Pinto and Rylands 1997; Raboy et al., 2010), are to be found nearby the estuarine of Rio de Contas on the coast of Bahia and between the lower river Pardo and the Jequitinhonha river. Additionally, the presence of lion tamarins in the area of Salto da Divisa, a municipality in the state of Minas Gerais, must be evaluated. It holds the only suitable habitat in Minas Gerais, which is currently considered as extinct in the state (Olveira pers.comm.). These areas will be included in the survey. In addition, a vegetation characterization of realized and potential habitats will be carried out in order to decipher the ecological factors that limit the distribution of lion tamarins. This is the basis for identifying and prioritizing areas that are particularly important for the preservation of lion tamarins. This will enable AMAP to develop protection concepts to ensure the long-term survival of the golden-headed lion tamarins in the wild.

The objective of the inventory is to:

- estimate the current geographic range and population numbers,
- to conduct a vegetation characterization of realized and potential habitat in order to
- identify ecological factors limiting the distribution of lion tamarins and
- identify current threats.

A golden-headed lion tamarin of the Fazenda Bom Pastor

The project is a collaboration between AMAP Brazil and the Universidade Estadual de Santa Cruz (UESC). Dr. Teixeira coordinates this project as project coordinator of AMAP Brazil and Post Doc at the UESC. The project is carried out by research assistants, employed by AMAP Brazil. Prof. Oliveira (UESC), collaborator and initiator of the project, hold all necessary permits to conduct the project. He is a member of the

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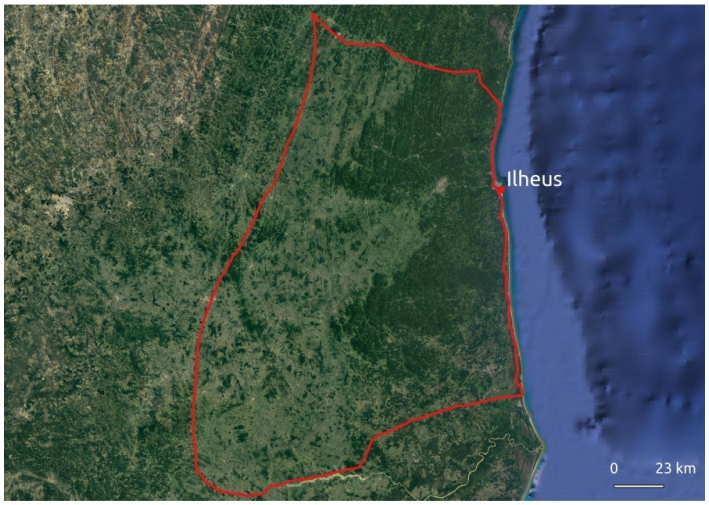
Primate Specialist Group of IUCN. The results will be published and incorporated into the IUCN assessment of the conservation status of *L. chrysomelas* and in the Ministry of Environment's National Action Plans for Mammal and Primate Conservation. The results of the project will be used by AMAP to develop appropriate conservation projects and ensure the long-term survival of lion tamarins in the wild.

II. Project Design

2.1 Study area

The study area includes the entire original range according to Coimbra-Filho 1973; Rylands et al., 2009 and Raboy et al., 2010 in the southern part of Bahia, including a small part of northern Minas Gerais, with a total area of approximately 37,000 km2. In addition, adjacent areas where the species potentially occurs are also included in the study.



Original distribution area of golden-headed lion tamarins in Bahia, Bazil

The distribution of lion tamarin is bounded to the south by the Rio Jequitinhonha and to the north by the Rio de Contas, and to the west by the change in vegetation from semi-seasonal rain forest to the "mata de cipó," a forest in transition to the caatinga associated with an increase in elevation in the Vitória da Conquista plateau (Pinto and Rylands, 1997; Rylands et al., 2008b). The range includes two forest types (Rylands et al., 2002), ombrophilous rain forest with no defined dry season and semi-shade mesophilous rain forest (Gouvea et al., 1976). The former occurs in a strip about 70 km wide parallel to the coastline (Vinha et al., 1976), the latter in the westernmost region of the range. The largest inhabited fragments are in the region of ombrophilous rain forests, defined by the predominant cabruca agroforestry that provides connectivity among the remaining rain forest fragments (Pinto and Rylands, 1997).

2.2 Methods

Interviews with local people and the playback technique are used for the inventory.

2.2.1 Interviews

Interviews will be open-ended and semi-structured, supplemented by conversations with local people who have some contact with the studied habitats and its fauna, e.g., hunters and cacao farmers (Huntington, 2000). Interviewees are selected on the basis of "local experts," following Hays 1976 and Bailley 1994. Photographs of lion tamarins and other primates of the region are shown for species identification. In addition, calls of primates will be replayed for species identification. Interviewees will be asked about the locations where they have been sighted, as well as general aspects of biology and ecology, such as group size, foraging, and habitat preferences. Traditional knowledge about lion tamarins will also be surveyed. This information will be combined with a previously structured questionnaire on local wildlife and primates present in the region, including the exact location and characterization of areas where primates occur. Additionally anthropogenic influences are recorded. Own observations are added to the above questions in each interview. The consent of the interviewee to use the interview for the purpose of analysis will be obtained through a free consent form (Termo de Consentimento Livre e Esclarecido) and an authorization period for the use of the interview in accordance with Resolution No. 196 (10/1996) of the National Committee and Ethics Committee for Research on Human Subjects (CEP) of the Santa Cruz State University.

2.2.2 Playback-Technique

The playback of recorded calls is a proven technique for locating unknown groups in the wild. The "long call" is used to stimulate a response from an unknown group. The long call is the third most common vocalization of lion tamarins, emitted during conflicts to warn of the presence of unfamiliar individuals or groups in their territory or to increase the bonding strength of the reproducing pair (Kleiman et al., 1988). A group emits a long call in response to another roup entering its territory, with the frequency of the call increasing. The recordings include calls from both males and females, as Peres observed long calls for both sexes in 1986. The study area is covered by parallel transects throughout. A playback point will be established every 200 m, according to Kierulff et al. 1993 for *L. rosalia.* At each playback point, five playback sessions will be performed within 10 minutes. In each run, playback is performed in four directions (north, south, east, west). Each playback consists of alternating calls from males and females.

The study areas are selected according to the following criteria:

- Original distribution areas according to Coimbra-Filho and Mittermeier, 1973; Pinto and Rylands 1997; Raboy et al., 2010; Rylands et al., 2009.
- Areas defined as potential distribution areas.
- Areas mentioned as distribution areas by locals in the interviews.

2.3 Data Collection

2.3.1 Playback

The playback data sheet contains the following information:

- Location of the fragment (coordinates, height).
- Name of the person responsible for the object
- Name of the owner
- Date and number of the visit
- Number of transects performed

For each lion tamarin group found, the following information is recorded:

- Group size
- Presence of young animals
- Structure of the group (number of adults, juveniles)
- Vegetation type of the fragment
- Type of response to playback
- Presence of other marmosets (e.g. *Callithrix kuhlii*)
- observation of other animals in the fragment (mammals, reptiles, birds)
- Other observations such as presence of traps, hunters, etc.

Callithrix kuhlii can often be seen together with lion tamarins. They warn each other of predators.

2.3.2 Vegetation characterization

The vegetation of the distribution area is characterized according to the Projeto Bio Brasil and the Projeto Mico-Leão-da-Cara-Dourada of the Bicho do Mato Instituto de Pesquisa.

Primary forest
Forest with little or no sign of anthropogenic disturbance, a closed canopy, a height of at least 20 m and large trunk diameters, few thin trees, many bromeliads of different sizes, and a dense layer of lianas. The soil has a thick layer of dried leaves and fine roots.

Secondary forest
Forest with visible signs of previous anthropogenic disturbance that is recovering from either complete logging or selective logging (cutting of selected tree species). It has a relatively closed canopy, but with more light

penetration than primary forest. Trees are usually between 15 and 20 m tall and relatively thick, but have a smaller diameter than in the primary forest. Bromeliads are small and not very numerous.

Capoeira
Forest with an open canopy, flooded with light, the trees are generally smaller than 15 m and have a small diameter. Capoeira is generally dense, bromeliads and lianas are not present. The soil has few dry leaves and no root layer.

Cabruca
Agroforestry where the understory has been removed and replaced by cacao trees, often with a high proportion of interplanted crops such as rubber (*Hevea brasiliensis*), jackfruit (*Artocarpus heterophyllus*), and bananas as shade trees.

Secondary forest of Fazenda Bom Pastor

Seringal / Jaqueiral
Areas planted with rubber trees (*Hevea brasiliensis*) and/or jackfruit (*Artocarpus heterophyllus*).

Pastures
Areas that have been subjected to anthropogenic disturbance that has resulted in the absence of forest at all stages of succession. These areas are generally used for livestock grazing. "Dirty pastures" are areas that have been abandoned and are in an early successional stage with shrubs and bushes. "Open pastures" are areas that are still used for livestock grazing or have been recently abandoned and have no shrubs or bushes.

2.3.2 Inventory with the playback method.

To estimate the inventory of a study area, the transmission distance of sound from each playback point was estimated to be 200 m. This results in a circular area with a radius of 200 m (S (circle) = π * r2) . The area value is multiplied by the number of playback points to obtain the total area sampled per site. Then, the number of sightings is divided by the area sampled in km2 to obtain the density. To estimate the total number of individuals in the area, a range of the maximum and minimum number of individuals sighted and/or heard during the survey is determined. To calculate the possible number of lion tamarin groups per area, the data obtained from density are multiplied by the total size of each site.

2.3.3 GIS

All coordinates are transferred to ESRI ArcGIS 9.3 to combine the derived population information with additional datasets such as precipitation, relief and vegetation types. The official classification of Brazil is used. The resulting maps are used to examine the influence of environmental variables on the occurrence of lion tamarins and to define distribution limits.

III. Human resources

The basic monitoring is carried out by Jiomario dos Santos Souza and Rodrigo Souza dos Santos, employed by AMAP Brazil with a full-time position. He is assisted by Rodrigo Souza dos Santos, employed by AMAP Brazil with a full-time position.

Their scope of work includes:

1. Conducting the basic monitoring
2. Catching the GHLT groups for the purpose of radio collar attachment and/or changing
3. Handling and maintaining of all equipment
4.Guidance of students under supervision of Prof. Oliveira and/or Dr. Teixeira.

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