MONITORING

of golden-headed lion tamarins in cocoa-agroforest

This project monitors the endangered golden-headed lion tamarins (*Leontopithecus chrysomelas*) in cocoa-agroforestry systems (so called cabrucas) to determine ecological pressures and to understand baseline habitat suitability. This will allow us to identify which management practices will enable the long-term survival of golden-headed lion tamarins in the wild.

AMAP is an 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 *(Leontopithecus chrysomelas*) is in the focus of AMAP's mission, as a flagship species of the region. AMAP promotes the conservation of the Mata Atlântica through species conservation projects like reforestations and the support of research projects. The base of our activities in the region is the cocoa farm Fazenda Bom Pastor not far from the Almada River.

Project coordinator

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The golden-headed lion tamarin is an endangered primate, endemic to a small part of Southern Bahia within the Brazilian Atlantic Forest. Caused by anthropogenic habitat reduction and fragmentation, the long-term survival of the species depends on its ability to persist in cocoa agroforests (cabrucas). In the municipality of Ilhéus, our project area, predominant cabrucas forms as matrix a connected forest landscape. Since 2008, several groups of lion tamarins are monitored. The monitoring generates a biological, ecological and behavioral dataset, which gives us the knowledge to understand the basic habitat suitability of cabrucas and to develop biodiversity friendly cocoa harvesting and maintenance strategies for local farmers. This strategy will secure the long-time survival of golden-headed lion tamarins in a human dominated agricultural landscape.

I. Current situation

The golden-headed lion tamarin (*Leontopithecus chrysomelas*) is an endangered small primate endemic to southern Bahia in the Brazilian Atlantic Forest, the Mata Atlântica. The Mata Atlântica is one of the most threatened tropical forests and was especially during the 20th century reduced to 10% of its original extent. Nevertheless, it is one of the most diverse regions in the world (Myers et al. 2000; Shi et al. 2005). The remaining forest is strongly fragmented, within the lion tamarin range only 5% of the forest patches are larger than 36 ha (Zeigler et al. 2010). The home range size varies from 40 to 197 ha (Dietz et al. 1996; Rylands 1993) with an average of 83 ha (Oliveira et al. 2011). Thus, the remaining habitat is also extremely reduced. Estimates of the total wild population size ranges from 6,000 to 15,000 individuals in an area of ca. 19,000km2 (Pinto & Rylands 1997), however, many small populations, mainly in the western part of the distribution, disappeared in the past years reducing the geographic distribution of lion tamarins (Raboy et al. 2010). Results from a Population and Habitat Viability Analysis suggested that only one population, situated in the protected Una Biological and Wildlife Refuge, is viable and capable of preserving sufficient genetic variability for a period of 100 years (Zeigler et al. 2010). However, assuming a metapopulation scenario in which forested areas are connected by a matrix habitat, in this case cocoa agroforest (so called cabruca), suitable for dispersal of lion tamarins, their conservation in the wild is relatively secure (Holst et al. 2006).

Cabruca of Fazenda Bom Pastor, habitat of lion tamarins.

Agroforest can be defined as a complex multistrata agroforestry systems based on shade-tolerant understorey crops such as cocoa (*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 forest-agriculture-system can thus provide habitat and resources for forest-dependent species that would not survive in a purely agricultural landscape, or may permit species dispersal in a fragmented landscape (Schroth et al., 2007). The cabruca has been considered as an important habitat for the Mata Atlântica biodiversity for plants (Sambuichi 2002, 2006; Sambuichi and Haridasan 2007) and animals (Pardini 2004; Delabie et al., 2007; Faria et al., 2006 and 2007).

In contrast to many other forest dwelling animals, lion tamarins and other marmosets (Callitrichidae), uses disturbed and regenerating forests for foraging, for instance fruits, flowers, nectar, gum and animal prey (Oliveira et al., 2010). Especially fruits are available in large

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quantities in secondary forests and cabrucas, caused by a better light availability as in primary forests. Cabrucas (Oliveira pers.comm.) provide more than 60% of the habitable areas for lion tamarins in the eastern part of it's distribution. Cabrucas can provide suitable conditions, moreover lion tamarins are in many areas the last remaining frugivorous mammals, putting them in an key role as seed vector for forest regeneration (Oliveira & Estrada 2017).

A golden-headed lion tamarin of the Fazenda Bom Pastor

Thus, conservation approaches are concentrated on two areas with viable lion tamarin populations, the Una Biological and Wildlife Refuge as a larger protected forest area and the cocoa region of Ilhéus. The latter one, our project area, represents a patchwork of different vegetation types embedded in a cabruca landscape matrix. Primary and secondary forest fragments are present, as well as pastures. Cocoa is the most important crop of the Ilhéus region and plays a major role in local economics and is the only income generating agricultural system, which allows the implementation of biodiversity conservation approaches.
The evaluation of the use of cabruca by lion tamarins was recognized as a conservation priority for the species (Holst et al. 2006). Our long-term research project wants to understand how different management types of cabrucas shape the suitability as habitat. Therefore an analysis of biological, ecological and behavioral datasets are necessary.
Radio collared lion tamarin groups are monitored since 2008 by Dr. Leonardo Oliveira (Universidade Estadual de Santa Cruz). During the monitoring in our project area it was possible to document that lion tamarins exclusively survive and reproduce in cabrucas (Oliveira et al. 2011). Moreover, in cases where cabruca contains concentrated resources, such as jackfruit and bromeliads lion tamarins are heavier and bigger than expected for the species, with a higher reproduction (Oliveira et al., 2011). In one monitored groups (the Santa Rita group) the first report of triplets in wild populations could be made, additionally this group shows the smallest home range (22-28 ha) and highest density reported (0,17 Ind./ha) for lion tamarins (Oliveira et al., 2011). A categorized list of key tree species crucial for the survival of lion tamarins in the cabrucas was created by Oliveira et al. 2010.

The long-term monitoring project aims to understand:

- How lion tamarins use the cabrucas in space and time
- Which types of cabruca supports a viable population.
- Which parameter of the maintenance is crucial for the suitability as habitat.

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

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. Prof. Oliveira (UESC), collaborator and initiator of the project, hold all necessary permits to conduct the project. He is a member of the Primate

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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 will allow AMAP to create a guideline for local cocoa farmers to practice biodiversity-friendly cocoa harvesting and maintenance.

Jiomario "Bila" dos Santos Souza with TR-4K receiver and handheld antenna.

Target groups
The project is directed at the following audiences:

Local level:
Local stakeholders, mainly cocoa farmers and landowners whose land is or could be a habitat of golden-headed lion tamarins.
National level:
Administrative actors, such as ICMBio (Institute for Biodiversity Conservation), which develops the national conservation plans.
International level:
The research community working on the conservation of Brazil's primates, the IUCN - to assess the conservation status of golden-headed lion tamarins.

II. Project Design

2.1 Study area
The study area in the municipality Ilhéus is dominated by cabruca as landscape matrix, with patches of secondary forest, pastures, and is situated on Fazenda Bom Pastor and the neighboring cocoa-farms Santa Rita and Bom Fin/Almada. These farms are actively managed cocoa farms with varying proportions of cabruca, secondary forest and pasture. Several habituated lion tamarin groups are monitored, named after the Fazendas where they are most frequently found.

Fazenda Bom Pastor, monitoring project area in the original distribution area of golden-headed lion tamarins in Bahia, Brazil

2.2 Methods
Radio Telemetry is used to facilitate location and monitoring. On one or two individuals of each lion tamarin groups, have attached RI-2D radio transmitter collars (Holohil Inc.), optimized for small mammals with a body weight of 550-590gr. The capture for the collar attachment is carried out by using Tomahawk live traps (48.3 x 15.2 x 15.2 cm), designed for small mammals, baited with bananas and placed on wooden platforms 1,5m above the ground. The capture takes place once or twice a year and is carried out only by trained personal under the supervision of a veterinarian (see paragraph III). Transmitter collared lion tamaris are detected in its habitat by using an biomedical receiver TR-4K (Telonics Inc.) and a handheld antenna.

2.3 Data Collection
During the capture for each individual following data are recorded:
Weight, knee to heel and wrist to elbow length, reproductive condition and group size and composition (age and sex). The group size and composition is adjusted by including not captured individuals in the surrounding of the traps. As cooperative breeders that lives in

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family groups, it is assumed, that not captured individuals of the group remain in the vicinity of captured individuals. Tooth wear is used to estimate the age of adult animals and tooth wear, body weight and dental composition to estimate ages of younger members of group. The monitoring takes place once a week for each group. A group is monitored the whole day, starting when they left a sleeping site in the morning until they enter a sleeping site in the evening, or on partial days either from the morning until noon or from noon until evening.

Preparing a platform for catching the golden-headed lion tamarins

Following data are documented:

Demographic data:
- Number of Individuals (male, female, offspring, infants)
- Reproduction (time of breeding, number and time of offspring)

Ecological data:
- Diets
- Sleeping site use
- Home range

Behavioral data:
- Amount of time spend with foraging in bromeliads, fruit trees and others
- Amount of time spend with resting
- Moving distance
- Moving speed
- Changing of sleeping sites

III. The project team

The project is coordinated by Dr. Joanison Vicente dos Santos Teixeira and carried out by two research assistants. Students are integrated into the team as part of master's or doctoral theses.

Dr. Joanison Vicente dos Santos Teixeira
Dr. Teixeira holds an unpaid post doc position at LECAP (Laboratório de Etnoconservação e Áreas Protegidas) of the UESC. He is responsible for coordinating the project and evaluating and publishing the results. AMAP already supported the realization of his doctoral thesis. Since the beginning of 2022, Dr. Teixeira has been the Project Coordinator for golden-headed lion tamarin related projects for AMAP Brazil.

Prof. Leonardo de Carvalho Oliveira
Professor at the Universidade Estadual de Santa Cruz (UESC). He is member of the Primate Specialist Group of the IUCN. Prof. Oliveira began his work with golden-headed lion tamarins in 2008, and since then this primates have been the focus of his university work. Prof. Oliveira supervised also the PhD thesis of the project coordinator.

Prof. Danilo Simonini Teixeira
Institute of Veterinary Medicine at the UESC. Prof. Simonini Teixeira is a veterinarian and primatologist. His research group is responsible for the capture and local anaesthesia of the golden-headed lion tamarins for changing the collar transmitters. The state of health is also documented.

Students

Maria Alejandra, a student of the UESC will carry out her **master thesis** within the monitoring project. She will collect data on the ecology and behavior of the lion tamarins and will especially investigate the use of sleeping sites by lion tamarins. The data collection will begin in April 2024. The master thesis will take place as part of the regular monitoring at the fazendas Bom Pastor and Santa Rita. The study will use existing monitoring data, expand the data and analyses the dataset.

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Research Assistants

Jiomario „Bila“ dos Santos Souza
Bila was hired by AMAP for this project in 2018. For over 20 years, Bila has been carrying out monitoring and guided tours on request of various scientists, including for the research work of Becky Raboy and Kristel de Vleeschouver. Since 2008, Bila has been working on behalf of Dr. Oliveira and is responsible for the realization of the monitoring in the field.

Rodrigo Souza dos Santos
was hired by AMAP as an assistant for Bila at the beginning of 2022 and was trained over the course of the year. He has already been working for AMAP in the reforestations since 2018, but showed a strong interest in working with golden-headed lion tamarins.

Their scope of work includes:

1. Conducting the basic monitoring
2. Catching the 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.

VI. Animal handling methods

The lion tamarin groups will be captured and collared once or twice a year. Prof. Oliveira, has passed the ethics committee requirements to conduct safe captures and ensure the well-being of all individuals. Prof. Oliveira holds all necessary permits to conduct the monitoring with lion tamarins. Additionally, qualified veterinarians will accompany the capture process for all groups. All captures will be performed as described in Kleiman et al. 1986 and Dietz & Baker 1993, using non-injurious techniques which we are using since 2008.

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Our Partners

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V Publications generated with the projects monitoring data

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