High altitude cloud forest: a suitable habitat for sloths

Wouter Meijboom

Cloudbridge Nature Reserve

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A field research to the suitability of Cloudbridge Nature Reserve, a high altitude cloud forest in Costa Rica as a habitat for sloths.

Student: Wouter Meijboom
Organisation: Cloudbridge Nature Reserve
External technical coach: Tom Gode
University of applied science: Van Hall Larenstein
Major coordinator and internal coach: Jaap de Vletter
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Abstract

Protected areas play an important role in the conservation of biodiversity worldwide (Bruner, Gullison, Rice and da Fonseca 2000). Sloths (*Bradypus* variegatus and *Choloepus hoffmanni*) play an important role in the ecosystem of a tropical forest. This research focuses on Cloudbridge Nature Reserve (Cloudbridge NR), a protected area of 250 hectare tropical forest in South Central Costa Rica. The management of Cloudbridge NR wants to get back to the original state of the forest. Sloths used to live in and around Cloudbridge NR but are not seen nowadays. That is why there is a wish to get sloths back in the area of Cloudbridge NR. This research is designed to investigate the possibilities for sloths to live again in Cloudbridge NR in the next ten years. The research question to investigate this is:

Can Cloudbridge NR sustain a healthy population of sloths within the next ten years?

The methodology of this research consists of in depth interviews, literature reviews and fieldwork in the form of an inventory. Interviews and the literature study are used to identify the preferences of sloths and the possible threats to sloths. Interviews are also used to investigate the situation in the past, regarding to sloths in and around Cloudbridge NR. Fieldwork is used to get a picture of the actual situation of the suitability of the habitat of Cloudbridge NR for sloths.

There are almost certainly no sloths present in and around Cloudbridge NR at the moment. The disappearing of the sloths cannot directly be linked to the deforestation which occurred in the area of Cloudbridge NR up to forty years ago. This is because the reforestation of Cloudbridge NR was already started before the sloths completely disappeared ten years ago. Factors which limit sloths to reach Cloudbridge are the Talamanca Range, Pan-American Highway and urban areas like San Isidro de El General. Predators which are threats to sloths and which are present in Cloudbridge NR are puma's and coyotes. Based on the size of Cloudbridge NR and the estimated food intake it is expected that there is enough food available for sloths. But it is not sure if the trees used by sloths are adequately available to meet the food demand of the sloths. Based on the information known so far primary forest is the most suitable habitat for sloths. For creating a more suitable area for sloths it is maybe good to stop the replanting of the areas, to get a good mix between primary and secondary species.

Some of the results are insufficient to answer all of the research questions adequately. Because of the missing information this research became more an exploratory study. Further research is necessary to get more complete information about the tree species used by sloths on higher altitudes and about the introduction of sloths to a new area. Additional research on the vegetation in Cloudbridge NR is necessary to get a higher sampling intensity.

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Wouter Meijboom

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Introduction

Protected areas play an important role in the protection of biodiversity worldwide (Bruner, Gullison, Rice and da Fonseca 2000). Globally, the number of protected areas has been increasing significantly over the last few decades, covering about 20,9 per cent of the world's land surface in 2010 (The World Bank, 2013). However, the loss of biological diversity continues unabated. Good management of these protected areas is an important tool for increasing the effectiveness of these protected areas in relation to biodiversity (Zedan, 2005).

Costa Rica is considered one of the twenty countries with the greatest biodiversity in the world. Its geographic position, its two coasts and its mountainous system - which provides numerous and varied (micro) climates - are some of the contributing factors for this rich biodiversity. The more than 500,000 species that are found in this country represent nearly four per cent of the total species estimated worldwide. This is a lot compared with the size of the country 51.100 km^2 (0,03 per cent of the planet's surface) (INBio, 2013). 21 per cent of this land is protected (The World Bank, 2013; Obando, 2000). The land in Costa Rica is protected by Sistema Nacional de Areas de Conservacion (SINAC). The protected areas in Costa Rica do not only increase the biological diversity, but they also reduce the poverty and forms the backbone of their ecotourism (Andam, et al., 2010; Buchsbaum, 2004).

Sloths are only found in South and Central America. There are two sloth species living in Cost Rica, namely *Bradypus variegatus* (three-toed sloths) and *Choloepus hoffmanni* (two-toed sloths). Sloths play an important role in the ecosystem of a tropical forest. They have an impact as leaf eater and in turn they are pray to other animals like puma's, ocelots and harpy eagles (Montgomery and Sunquist, 1978; World Animal Foundation, n.d.; Moreno, 2006; Hayssen, 2011). Other less obvious roles are their symbiotic relations with algae's in their fur. Sloths are also a host to a wide variety of arthropods like biting and bloodsucking flies, commensal beetles, mites and moths (Gilmore, Da Costa and Duarte, 2000).

This research focuses on the protected area Cloudbridge Nature Reserve (Cloudbridge NR) in South Central Costa Rica. The size of the Nature Reserve is approximately 250 hectares. In appendix 1 a map of the area is included. The area is partly reforested and partly regrown to restore the natural vegetation, the oak-dominated lower montane cloud forest. Before the start of Cloudbridge NR in 2002 the area was mainly used as pasture land (Cloudbridge Nature Reserve, 2013). Most animals which lived 40-50 years ago in Cloudbridge NR are back due to the reforestation. It is told that in former days sloths where found in Cloudbridge NR, but since the start of Cloudbridge NR until today they have not been seen (Gode, personal communication, 2013).

The management of Cloudbridge NR recognizes the preciousness of the tropical forest of Costa Rica is. Therefore the management want to protect and preserve this part of the tropical forest and the biodiversity in it (Cloudbridge Nature Reserve, 2013). They want to get close to the original state of the cloud forest. Therefore there is a wish to get sloths back in the area of Cloudbridge NR. In that way they can fulfil their role in the ecosystem and help to restore the rich biodiversity of the area. This also will give a possibility for sloths to live in an area without many threats of humans. Getting sloths back to Cloudbridge NR has also an aesthetical function for people visiting Cloudbridge NR.

This research is designed to investigate the possibilities for sloths to live again in Cloudbridge NR in the next ten years. Therefore research is done to the preferences of the sloths, the reasons that the are no sloths in Cloudbridge NR, the suitability of Cloudbridge NR as an habitat for the sloths and the possibilities of introducing the sloths in Cloudbridge NR. The research questions are as listed below.

Research question

Can Cloudbridge NR sustain a healthy population of sloths within the next ten years?

Sub questions

- What are the preferences of sloths regarding their diet, their habitat and threats to sloths in a natural area?
- What are the reasons that there are no sloth species in the Cloudbridge NR?
- Is the habitat of Cloudbridge suitable for sloths?
- Can sloths be introduced in Cloudbridge NR?

The following chapters give a report of the research undertaken to answer the research questions. The next chapter gives an insight into the current situation, regarding the socio-economic situation, the environmental situation and the national policy. Chapter three describes the methodology used to answer the research questions. In chapter four results of the research are described, after which a conclusion of the research is given in chapter five. The methodology and results are discussed in chapter six.

1. Situation analysis

Cloudbridge NR is a private nature reserve. It is located on the hillside of the Cordillera Talamanca range, Costa Rica's highest mountain chain, and it borders the Chirripo National Park. The area is divided in Cloudbridge North and Cloudbridge South and they both cover about fifty per cent of the area (appendix 1). This chapter gives a short analysis of the current situation in and around Cloudbridge NR. This analysis is divided in in the socio-economic situation, the environmental situation and the (inter)national policy.

1.1 Socio-economic situation

Cloudbridge NR is located in the Province of San Jose, the canton of Peréz Zeledón and the district Rivas. The district Rivas has an area of 307,85 km2 and a population of about 8700 inhabitants. The capital of the district is Rivas. The villages in the district are Alaska, Altamira, Ángeles, Boquete, Buenavista, Canaán, Chimirol, Chispa, Chuma, División (parte), Guadalupe, Herradura, Monterrey, Palmital, Piedra Alta, Playa Quesada, Playas, Pueblo Nuevo, Río Blanco, San Gerardo de Rivas, San José, San Juan Norte, Siberia (parte) and Tirrá (Costaricadatabase.com, 2013). San Gerardo is the closest town to Cloudbridge NR and is located two km southeast from the entrance of the reserve. An unpaved road leads to San Gerardo which continues all the way down to the town Rivas where it becomes a paved road. A map of the area indicating the different towns close to Cloudbridge NR is included in appendix 2.

The region around Cloudbridge NR is traditionally an agricultural economy. Nowadays tourism is getting more and more important. Farmers live mostly from the coffee, the sugar, the vegetables, the fruit and the dairy products. The mountain Chirripo attracts many hikers and nature lovers to the area of Cloudbridge NR and San Gerardo de Rivas (San Gerardo). In this way the community generates income also from guides, hotels, restaurants, bars and tourist activities (San Gerardo, 2009). In the Chirripo valley there live a number of indigenous people (Image 1). They are the Cabécar Indians, who live in reserves in remote areas. The members of these communities visit San Gerardo for work, to buy supplies, and to participate in social activities (Cabécar, n.d.).

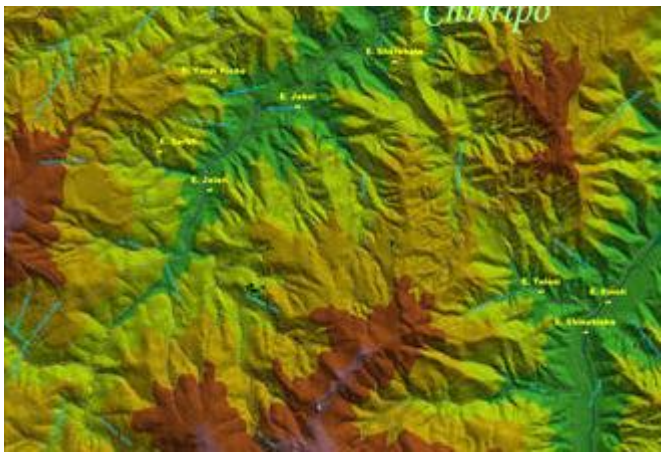

Image 1. Indigenous communities around Chirripo (Cabécar, n.d.).

1.2 Environmental situation

In this chapter the following aspects are described regarding the situation in and around Cloudbridge NR: weather and climate, soil, water and geology and the vegetation types.

1.2.1 Weather and climate

In Costa Rica there is a tropical and subtropical rainforest climate. The subtropical climate is found in the higher mountains, like Chirripo. There is a dry season from December to April and a rainy season from May to November (Climatezone.com, 2004). In Cloudbridge NR there is a dryer period and a

wetter period, but it rains all year round. The average annual rainfall is about 4370 mm. The average minimum temperature is 13,4 degrees Celsius and the average high temperature is 23,1 degrees Celsius (Giddy, 2006).

1.2.2 Soil, water and geology

The two soil types found in Cloudbridge are Dystrudepts (Humic-Dystrudepts, and Sombric-Humic Dystrudepts) and Kandihumults. Soil texture of A and B-horizons are primarily Silty Loam, Loam, Sandy Loam, and Sandy Clay Loam. Soil texture of C-horizons is primarily Silty Loam, Sandy Loam, Loamy Sand and Sand with common rock fragments. Slopes range between ten per cent and 65 per cent. The landscape is commonly subject to landslides, both natural and human induced (Schembre, 2009). Two main rivers run through Cloudbridge: the Rio Chirripo Pacifico and the Rio Urán. Next to those rivers lots of smaller streams which are flowing true Cloudbridge NR into the two bigger rivers.

1.2.3 Vegetation types

There are four different types of vegetation found in Cloudbridge NR (appendix 3):

- Plantation forest;
- Natural regrowth;
- Secondary forest; and
- Primary forest.

About eight per cent of Cloudbridge NR is plantation forest. The planting started in 2002 and continues until today. Many different tree species are planted, like *Quercus* spp., *Ulmus mexicana* and *Persea caerulea* (Cloudbridge, 2004). Some areas had to be replanted - some several times -, because the initial plants did not survive. These are mainly the steeper parts of the plantation forest.

About 14 per cent of Cloudbridge NR is natural regrowth. This land is purchased between 1998 and 2002 and left for natural regeneration. The term natural regrowth is in this research only used for forest which was barren when Cloudbridge NR bought the land.

About 23 per cent of Cloudbridge NR is secondary forest. Forest is called secondary forest when the original vegetation was removed and/or disturbed and is regenerated with different canopy species as opposed to the original forest (Chokkalingam and de Jong 2001). The term secondary forest is in this research only used for land which was already forest when Cloudbridge NR bought the land.

About 56 per cent of Cloudbridge NR is primary forest. The term primary forest is in this research only used for the climax stage of the forest with related climax species in the canopy and which is relatively stable (Chokkalingam and de Jong 2001).

1.3 Policy

This paragraph describes the relevant national and international policies. Relevant policies are the Tropical forest action plan and the SINAC.

1.3.1 Tropical Forest Action Plan

For Latin America and the Caribbean the FAO in collaboration with the World Bank, the United Nations Development Programme and the World Resources Institute issued in 1985 a practical framework to preserve the tropical forest. This was the Tropical Forest Action Plan. This was designed for generating a much higher level of awareness and political commitment and for

intensifying the major actions to conserve the forest resources and to use their full potential for development. On part of the plan was to assist on a national level in the planning, management and development of individual protected areas. On the regional and subregional levels the goal is that the development of networks of protected areas meets the needs for the conservation of tropical forest ecosystems and of genetic resources of target species, covering complete their natural distribution range (Contreras, 1988).

1.3.2 SINAC

Cloudbridge NR is a protected area. Nature reserves differ from National Parks in the fact that community and conservationist groups manage their land. Visitor revenues are used to maintain the trail system, pay park staff, and purchase surrounding land for protected zone expansion. The protected areas or conservation areas and National Parks are regulated by SINAC. SINAC is a department of Costa Rica's Ministry of Environment and Energy. The definition they use for a conservation area is (translated from Spanish):

"A defined geographical space and an officially designated management category by virtue of their natural significance, cultural and/or socioeconomic status, to meet with specific conservation objectives and management targets (SINAC, 2013)."

2. Methods and project approach

This chapter describes the research methodology used to answer the research questions. It also indicates what approach and activities have been carried out to get to the answers on these questions. The project approach consists mainly of in depth interviews (further named interviews), literature reviews and fieldwork in the form of an inventory.

Interviews are used, because it provides knowledge about sloth and sloth behaviour and it places other derived knowledge, from literature and fieldwork, in a context. Next to that it provides the opportunity to obtain detailed information which is not available by other sources (Boyce and Neale 2013).

A literature review is firstly done to create a base for this research, secondly to derive general and specific knowledge about sloths and thirdly to make sure that no work is done twice (University of Western Sydney 2013; Unitec, 2013). With a literature review secondary sources are used, to save time. Fieldwork is carried out to collect specific data from the area of Cloudbridge NR. By using different research methods triangulation of the data is possible to check the different results.

2.1 Preferences of sloths and threats to sloths.

First of all it is important to determine what the preferences of sloths are in a natural area regarding their diet, their habitat and threats to sloths. Therefore it is examined what the desired diet and habitat is of sloths, what the major threats are to sloths and what the impact is of sloths on nature areas.

To get a clear picture of the preferences of sloths information is required from areas comparable with Cloudbridge NR. A comparable area is for example Monteverde Cloud Forest Preserve (MCFP). Interviews are done with the biologist of MCFP to get to know the preferences of sloths. Questions are asked about the presence of sloths in their area, the preferences of sloths in a cloud forest, the threats to sloths and the impact of sloths on a cloud forest. From other areas in and around Costa Rica where sloths are found data about the tree species where the sloths live in is derived. This data is analysed and compared with data about tree species in Cloudbridge NR to find out if the tree species and threats occur and can occur in Cloudbridge NR. This information is later used to determine if the habitat of Cloudbridge NR is suitable for sloths. Next to the interviews a literature review to the preferences of sloths and threats to sloths is done. Regarding the threats attention is paid to predators, human based threats and other threats.

The impact of sloths on an area is determined based on their food intake and home range. Other aspects that are taken into account are their place in the ecosystem and the effect this can have on the ecosystem of Cloudbridge NR, for example the predation of animals on sloths. Their food intake and home range will be based on researches on sloths. Their place in the ecosystem is based on the interviews mentioned before supported with literature.

2.2 Limitations for sloths to live in Cloudbridge NR

Sloths occurred in Cloudbridge NR until about ten years ago. To determine why sloths left Cloudbridge NR and did not come back the situation regarding sloths 40 to 50 years ago and what happened since that time is examined. The period since 50 years ago is interesting because it is long enough to distinguish different events like deforestation and the effects of these events and there are still people who clearly remember this period. After that it is investigated which threats to sloths

occur in Cloudbridge NR and which limitations there are for sloths to reach Cloudbridge NR. Five farmers between 60 and 80 years old are interviewed to get a picture of the situation 40 to 50 years ago. Questions will be asked about the occurrence and preferences of sloths in that time. The interview is included as appendix 4.They say that there are living about ten farmers older than 60 years around Cloudbridge NR. The farmers selected live the closest to Cloudbridge NR and who have lived all of their live in and around the area of Cloudbridge NR. This information is used to determine why the sloths left and if the factors causing the departure of sloths are still present in and around Cloudbridge NR.

The factors that threaten sloths in other areas will be compared with the actual situation in Cloudbridge NR. It will be examined what predators and other threats are present in Cloudbridge NR and estimated what the impact would be on sloths if they would remain in Cloudbridge NR.

Sometimes sloths are spotted in the neighbourhood (+- 10 km) of de Cloudbridge NR. To get to know the location of these sloths leaflets will be hanged in shops and hotels near Cloudbridge NR. The towns and hotels where the leaflets are hanged are (see appendix 2):

- San Gerardo de Rivas
- Canaan
- Guadalupe
- Chimirol
- Herradura
- Los Angeles
- Rivas, and
- The hotels Uran and El Pelicano

On these leaflets people will be asked to get in contact with Cloudbridge NR when they spot a sloth. The location of the sloth will be visited and the information about their location like vegetation type and tree species will be recorded. When the locations of the sloths are know they will be plotted on a map. This map is examined to see if there are any barriers or other factors that limit sloths to come to Cloudbridge NR (for example roads, towns and fragmentation of forest).

2.3 Suitability of the habitat of Cloudbridge NR for sloths

The suitability of the habitat of Cloudbridge NR for sloths is examined by determining the different vegetation types and there location, the tree species composition in the different vegetation types and the comparison available space and food supply with the needed home range and food intake.

The different vegetation types in Cloudbridge NR are needed to be known to determine if sloths can live in Cloudbridge NR. The expected vegetation types researched are:

- Primary forest
- Secondary forest
- Natural regrowth
- Plantation forest

In 2006 a research is done on the different vegetation types. The resulting vegetation map is included as appendix 3. This map and the division in vegetation types of 2006 are discussed with Tom Gode. Based on the changes occurred since 2006 the map is adjusted where needed.

The results of the desired habitat and desired tree species of sloths are compared with data about tree species which are present in Cloudbridge NR. A result of this is a list of tree species which are suitable for sloths and are present in Cloudbridge NR. This information is used later to estimate the suitability of Cloudbridge NR for sloths.

The tree species above ten cm diameter breast height (DBH) of the plantation forest and the natural regrowth forest is inventoried in 2011 (Spek). For the research done to plantation forest and the natural regrowth eight research sites were selected. Four of the selected sites were replanted and four were left for natural regrowth. In these selected sites plots with a length of 100m and 8m wide, 800m^2, were selected (see appendix 5). The total amount of area inventoried in 2011 is 6400m^2. Al trees were measured above ten cm. This was done to investigate the success of the regrowth and to compare the plantation forest with the natural regrowth (Spek, 2011).

The primary forest is inventoried using data derived from the 'Smithsonian Hectare' in Cloudbridge South and two plots in Cloudbridge North. The Smithsonian hectare is inventoried in 2007. The Smithsonian hectare is a one hectare plot in primary forest (see appendix 6). This plot is divided in 25 subplots of 20x20m. In these subplots all trees above ten cm are labelled and the height and the DBH are measured. From three subplots nearly all the names of the tree species are known, this is a total area of 1200m^2. The two plots in Cloudbridge North are inventoried using the methodology described in the next paragraphs. The data from the Smithsonian hectare combined with the data from the two plots in Cloudbridge North gives an indication of the different trees present and their growth development.

The secondary forest is researched using four plots, two in Cloudbridge North and two in Cloudbridge South. The plots are surveyed similar to the plots from the research of Spek (2011). The plots have a length of a 100 m and a width of 8 m. The total size of the four plots in the secondary forest is 3200m^2. The plots are plotted using ArcGIS. The location of the plots is based on the revised vegetation map (see appendix 7). The starting point of the plots is plotted, about ten meter from a trail to minimise disturbance and following contour lines to ensure accessibility

The total area inventoried in this research is 4800 m^2. The total area inventoried in earlier years and used for this research is 7600 m^2. An overview of the amount of plots and total size of the plots is shown in table 1. The total area covered in this research 12.400 m^2 or 1,24 hectare. This gives a sampling intensity of 0,5 per cent on a forest area of 250 hectare. This is too low to give absolute values about the area, but it will give an indication of the species composition and the suitability of the area for sloths in terms of crown development and liana development. There was not enough time to do a research that fully covered the area and there was no arborist available for such a long time to help determining the trees.

	2006-2007		**2013**	
Vegetation type	**Amount of plots**	**Total size (m^2)**	**Amount of plots**	**Total size (m^2)**
Primary	3	1200	2	1600
Secondary	-	-	4	3200
Natural regrowth	4	3200	-	-
Plantation	4	3200	-	-
Total	11	7600	6	4800

Table 1. Overview amount of plots and total size inventoried.

The plots are created using a machete to mark the middle line. The starting and end coordinates of the plot are determined using ArcGIS. From all the trees above 10cm the species name is determined, the DBH is measured using a measuring tape and height, crown development (1-4**,** meaning small till big in comparison with the DBH) and liana development in the crown (1-4, meaning not/hardly developed till very well developed in comparison to the crown) are estimated. The tree species will be determined with the help of an arborist. This data is filled in a field form (see appendix 8) and later entered into an excel sheet. In the excel sheet the calculation are done about the average height and diameter, and about stem number, basal area and volume per hectare.

2.4 Introducing sloths in Cloudbridge NR

When Cloudbridge NR has a suitable area for sloths, but sloths have other barriers to come to Cloudbridge NR it may be necessary to introduce sloths. With a literature review it is determined if that is possible for the different sloth species and what the challenges are. The expectation is that this question cannot be fully answered in this research, but will give an insight into the possibilities and an onset for further research.

3. Results

This chapter describes the results of the research. The results are discussed following the research questions.

3.1 Preferences of sloths and threats to sloths.

The results of research regarding the preferences of sloths and threats to sloths are described in this paragraph.

3.1.1 Preferred diet and habitat

Sloths feed almost entirely on (young) leaves (Montgomery and Sunquist, 1978). In addition they also eat flower buds, fruits, insects, lizards and carrion (Chinchilla-Romero, personal communication, 2013; World Animal Foundation, n.d.). The tree species most frequently mentioned as food source for the sloths is the *Cecropia* spp. (5 farmers; F. A. Chinchilla-Romero, personal communication, 2013). But is has to be taken into account that the sloths are easy to spot in *Cecropia* spp. Next to that they use many different other trees. According to a study on Barro Colorado Island *Bradypus* variegatus are using at least ninety-six other species of tree than *Cecropia* spp. (Montgomery and Sunquist, 1978). An overview of different tree species used by sloths is included in appendix 9. This overview is based on different researches on sloths, which are mentioned in the appendix.

Sloths are found in different areas from sea level to higher elevations (INBio, 2011). Neither of the two sloth species living in Costa Rica prefers cool temperature latitudes. Nevertheless they are both found in small numbers on altitudes above 2400 m in Costa Rica. The coat of *Choloepus* is thicker at higher altitudes. *Choloepus* has a dense woolly undercoat and therefore he can stand colder temperatures than *Bradypus* (Gilmore, Da Costa and Duarte 2000). At higher elevations they are present in pre-montane forest as well as cloud forest. They are present in small size forest fragments and also in continuous forest (Chinchilla-Romero, personal communication, 2013).

3.1.2 Tree selection

The tree selection of sloths is researched during the research mentioned before on Barro Colorado Island (Montgomery and Sunquist, 1978). *Bradypus* variegatus prefers trees from which the crown is more exposed to sunlight, while *Choloepus hoffmanni* prefers trees with masses of lianas in their crowns. The size of the crown is not of a significant influence on the choice of trees for *Choloepus hoffmanni*. A large crown tent to be more important for *Bradypus* variegatus. Sloths of both species tended to avoid using trees which lack lianas in their crowns, *Choloepus hoffmanni* selects trees with the most lianas, and *Bradypus* variegatus sloths tend to use trees with only moderate lianas. The tendency of *Bradypus* variegatus to use trees with crowns exposed to sunlight and which also contained masses of lianas, is related in part to vertical movements which the animals made into and out of direct sunlight as their body temperatures changed. *Choloepus hoffmanni* may choose trees with masses of lianas primarily to gain protection from predation. During the day they often sleep deep within mass of lianas. Small interlaced branches of the lianas are transmitting the motion caused by the presence of a predator which alarms the sloth. This gives the sloth the opportunity to flee or to attack. *Bradypus* variegatus on the other hand only attack when the predator touches the sloth (Montgomery and Sunquist, 1978).

3.1.3 Major threats to sloths

The main threats to sloths are the threats caused by predators and the threats due to human activity. The main predators of sloths are pumas, ocelots, coyotes, tayras and harpy eagles (World Animal Foundation, n.d.; Moreno, 2006; Hayssen, 2011; Chinchilla-Romero, personal communication, 2013). Their arboreal life, their limited moving and weak dispersal abilities make sloths more vulnerable to deforestation and fragmentation of their habitat (Peery, n.d.). Other main threats to sloths are electrical lines (electrocution) and poachers (World Animal Foundation, n.d.; Chinchilla-Romero, personal communication, 2013). Hunting on sloths is nowadays not allowed in Costa Rica (Agence France-Presse, 2012).

3.1.4 Impact of sloths on an area

The impact of sloths on a natural area is first determined by their place in the ecosystem. As mentioned before sloths eat leaves and flower buds, so they have a role as herbivores. They are also preys of some predators. The fur of the sloths is also a micro habitat for some species of insects (moths, beetles) as well as parasites (acari). The expectation is that there are some phoretic relations with pseudoscorpions in the fur of the sloths (Chinchilla-Romero, personal communication, 2013).

Estimations of food intake of sloths range between 5,1 g and 15 g of dry food per day (McNab's, 1978; Montgomery and Sunquist, 1975). This is about two per cent of the yearly leaf production of a wet tropical forest. This figure is supported by a study in Panama, where the cropping of the sloths is also about two per cent of the annual leaf production. About half of what might be expected of a mammal of this size (4-7 kg) (Montgomery and Sunquist, 1975).

Densities of *Bradypus variegatus* in nature areas may be about seven sloths per hectare but are usually about two to three per hectare. *Choloepus hoffmanni* occur at a lower density then *Bradypus variegatus*, about one animal per two to three hectares (Henderson, 2002). Each animal occupies a home range of less than 2 ha and may use fifty trees of up to thirty species. Sloths descend from the canopy about once a week to defecate (Janzen, et al., 1983).

3.2 Limitations for sloths to live in Cloudbridge NR

This paragraph shows the results of the research done to the limitations for sloths to live in Cloudbridge NR.

3.2.1 Situation 40-50 years ago

The elaboration of the interviews of five farmers can be found in appendix 10. Table 2 gives an overview of what happened regarding the sloths in the area of Cloudbridge in the past 50 years. This is based on the interviews and other information.

Time	Event	Source
1930-1950	Cut down of forest by farmers	(Gode, personal communication, 2013).
40 to 50 years ago	You could hear and see them a lot in and around the area of Cloudbridge.	Two farmers
1975	Establishment Chirripo National Park	(SINAC, n.d.)
30 years ago	It was possible to see sloths every day in the area of Cloudbridge NR.	One farmer
Before the reforestation started.	There were a lot of sloths. Even more than twenty individuals. There were a lot of sloths especially close to the river. Mostly more down than in the area of Cloudbridge. Also in the area of the Talamanca Reserve.	Three farmers
2002	Establishment of Cloudbridge Nature reserve	(Cloudbridge Nature Reserve 2013)
Ten years ago	Last ones seen close to the river and the Chirripo trail. Sloths disappeared.	Three farmers
6 or 7 years ago	Two sloths seen close to the road from San Gerardo to Cloudbridge.	One farmer
10 April 2013	One two-toed sloth seen close to Rivas 13 km from Cloudbridge.	(Store owner, personal communication, 2013)

Table 2. Time schedule regarding to the presence of sloths in and around Cloudbridge NR.

Two farmers do not think the sloths disappeared due to deforestation, but one other farmer thinks that it was because of the destruction of the habitat. All famers say that the sloths preferred secondary or open forest. Three farmers say that the sloths didn't disappeared because of hunting for food, because sloths are not nice to eat. One other farmer suggests that there is maybe some hunting done on sloths for fun. Another reason mentioned by one farmer is the increase in population in the area. According to four farmers the biggest threats to sloths are pumas (leonsillo de Breñon) and coyotes.

3.2.2 Threats to sloths in Cloudbridge

The threats to sloths are mentioned in subparagraph 3.1.3. This sub paragraph describes the treats which occur in Cloudbridge NR. Of the predators of sloths the pumas, ocelots, coyotes and tayras are present in Cloudbridge NR. As mentioned in the paragraph before the impact of pumas and coyotes could be big in Cloudbridge NR. Electrical lines are not present in Cloudbridge NR and there are no cases of hunting on any animals known in Cloudbridge NR. Deforestation or fragmentation doesn't occur anymore in and Cloudbridge NR.

3.2.3 Sloths in the neighbourhood of Cloudbridge

There was no response regarding sloths on the leaflets which were hanged in the villages. Only one store owner could tell that he spotted a two-toed sloth near Rivas on April 10th 2013. He showed a picture of the sloth to confirm this. This cannot be seen as evidence for sighting. This People living in the area and tourists confirmed that they had seen the leaflets but they did not see any sloths.

3.2.4 Factors limiting sloths to reach Cloudbridge

On a higher scale there are several barriers limiting sloths to reach Cloudbridge NR. This in the North and the east the Talamanca Range including peaks over 3200 meter like Chirripo. In the west and the south you find the Pan-American Highway. This is a busy and congested highway with many buses and truck traffic (ASIRT, 2005). In the South-West there is the town of San Isidro de El General, with a population of 45,000 inhabitants (Lonely planet, 2013). An aerial picture of these barriers is included as appendix 11.

3.3 Suitability of the habitat of Cloudbridge NR for sloths

This paragraph describes the results of the research about the suitability of Cloudbridge NR as a habitat for sloths.

3.3.1 Vegetation types in Cloudbridge NR

A map with the different vegetation types is included in appendix 12. The different vegetation types are discussed in paragraph 2.2.

3.3.2 Tree species in the different vegetation types.

About 73 different species are found in Cloudbridge NR. Al list of the different species is included in appendix 13. An overview of the differences between the vegetation types is shown in table 3.

	Natural regrowth	Plantation	Secondary forest	Primary forest
Area inventoried (m2)	3200	3200	3200	2800
Stem number per hectare	125	356	472	643
Average height (m)	8,9	8,8	10,7	32
Average diameter (cm)	19,3	17,2	25,6	30,8
Basal area (m2/hectare)	4,3	10	35,8	43,1
Volume (m3/hectare)	32,9	74,5	299,3	812,9

Table 3. Details of the different vegetation types

The most dominant tree species in the secondary forest are (in order of frequency): *Rubiaceae* spp., *Heliocarpus americanus* and *Perrottetia longistylis*. The most dominant tree species in the Primary forest are (in order of frequency): *Quercus bumelioides* and *Clusia* spp. The most dominant tree species in natural regeneration are (in order of frequency): *Heliocarpus americanus* and *Solanum* spp. The most dominant tree species in replanted areas are (in order of frequency): *Heliocarpus americanus, Mexican elm* and *psychotria sylvivaga.*

3.3.3 Suitability of Cloudbridge NR for Sloths.

There are seven different tree species occurring in Cloudbridge which are certainly used by sloths. This list of trees is not complete because there is not much research done on sloths in areas of higher altitudes. The seven species with their distribution is displayed in table 4.

Tree species	Amount in Cloudbridge (per hectare)			
	Natural regrowth	Plantation	Secondary	Primary
Cestrum racemosum	0	0	3	0
Dendropanax arborens	0	0	0	7
Hyeronima alchornioides	0	0	0	4
Posoquena latifolia	0	0	0	4
Cecropia polyphlebia	6	9	13	0
Symphonia globulifera	0	0	0	4
Inga sp.	0	0	9	14
Inga oerstediana	6	0	0	0
Total	13	9	25	32
Percentage of total amount of trees per hectare	10,4 %	2 %	5,3 %	5 %

Table 4. Distribution of trees used by sloths and present in Cloudbridge NR.

3.4 Introducing sloths in Cloudbridge NR

Not much is known about introducing sloths to an area. The dietary selectivity of sloths is responsible for the deaths of *Bradypus* variegatus in captivity, or of sloths introduced into areas lacking the preferred tree species (Sunquist, personal communication, 2013). When Cloudbridge NR decides to introduce sloths it is important to introduce them in a healthy ecosystem. The Sloths should be healthy animals and should be introduced slowly to the new environment (Martin, personal communication, 2013). When introducing sloths it essential that MINEA (Ministro de Ambiente y Energía) agrees with the introduction of the sloths. To get permission to introduce sloths you need to have a definite prove that sloths ones lived in Cloudbridge NR. Definite proof has to be with a photo or a video (MINEA, 2013; Rainsong Wildlife Sanctuary, 2007).

4. Conclusion

As mentioned before the research question is:

Can Cloudbridge NR sustain a healthy population of sloths within the next ten years?

The facts that sloths are present at higher elevations in pre-montane forests as well as cloud forests and the fact that they are present in small size forests and also in continuous forests suggests that they also can live in Cloudbridge NR. However there are almost certainly no sloths present in and around (10 km) Cloudbridge NR at the moment. Factors which limit sloths to reach Cloudbridge are the Talamanca Range, Pan-American Highway and urban areas like San Isidro de El General. The disappearing of the sloths cannot directly be linked to the deforestation which occurred in the area of Cloudbridge NR up to forty years ago. This is because the reforestation of Cloudbridge NR was already started before the sloths completely disappeared ten years ago. Farmers blamed the puma's and the coyotes for eating all the sloths in the area of Cloudbridge NR. Other threats like electrical lines and hunting do not occur in Cloudbridge NR. So the precise reason that sloths left and are not present at the moment is uncertain.

Based on the size of Cloudbridge NR and the estimated food intake it is expected that there is enough food available for sloths. But it is not sure if the trees used by sloths are adequately available to meet the food demand of the sloths. When Cloudbridge NR is completely a suitable and healthy area for sloths there could live up to 750 sloths of *Bradypus variegates* (two to three sloths per hectare) or up to 125 sloths of *Choloepus hoffmanni* (one sloth per two to three hectare).

Based on the information known so far primary forest is the most suitable habitat for sloths. This is mostly due to the high amount of *Inga* spp. Secondary forest is also interesting for sloths due to the high amount of *Cecropia polyphlebia. Inga* spp. and *Cecropia polyphlebia* are both secondary species. This means that disturbed areas are interesting for sloths. The replanted areas are the least interesting for sloths. For creating a more suitable area for sloths it is maybe good to stop the replanting of the areas, to get a good mix between primary and secondary species. This should be tested by the researches described in chapter five.

5. Discussion

In the literature it is stated that deforestation is a major threat to sloths. In the area of Cloudbridge NR it looks like it went the other way around: when the reforestation began the sloths disappeared. The farmers in the area mostly related this to the presence of predators in the area, but it could also be due to the population growth and the effects of this population growth on the area, like more traffic and wider roads.

Some of the results are not complete enough to answer all of the research questions adequately. There is no complete information about the tree species used by sloths on higher altitudes. As mentioned before the sampling intensity of this research is not high enough to conclude anything in absolute terms. Based on the interviews and the literature it is not possible to say why there are no sloths in Cloudbridge NR at the moment. As expected there is not enough information about the introduction of sloths. This is because introducing sloths in an area is not much done and there is not much documentation about the successful or not successful introduction of sloths.

Because of the missing information this research became more an exploratory study. This results in an advice for further research. This does not mean that the information provided by this research is not useful. The results give a good inside in the preferences of sloths and give adequate information about missing information and the research methods which should be used for further research.

To get the complete information about the tree species used on higher altitudes it is necessary to do a research in a high altitude area with sloths. This should be an inventory in an area like MCFP on trees where sloths are present. This must be done by plotting transect using ArcGIS in the area of MCFP. This transects should be walked, preferably with a person familiar with the presence of sloths in MCFP. The goal of this transects is to gather information about the presence of sloths and their preferences regarding to tree and habitat choice. Information should be gathered about tree species, tree size, crown development, liana development and sloths activity (sleeping, moving or eating). This information could be used to compare with the tree species in Cloudbridge NR to get a clear picture about which suitable tree species for sloths there are present in Cloudbridge. With this information it can be determined if sloths can live in Cloudbridge NR and maybe how many.

To get a more accurate research it is needed to increase the sampling intensity. Therefore additional plots should be plotted and inventoried in Cloudbridge NR. The same research methods as used in this research should be used. At least five times at much area should be inventoried to get a sampling intensity of 2,5%.

The questions why the sloths disappeared will probably never be answered. By conducting the previous proposed researches it is maybe possible to answer the question why the sloths disappeared, but this only when the reason is tree related. The more important question is not, why they are not here, but actually how you can get them back.

The question if sloths can be introduced in the future could be an important but difficult question to answer. It is an important question, because if Cloudbridge NR want to have them back shortly, say within ten years, it is not expected they come back by themselves in that time. It is also a difficult question, because to answer this question it is necessary to review an actual introduction of sloths. This is gone be another additional research.

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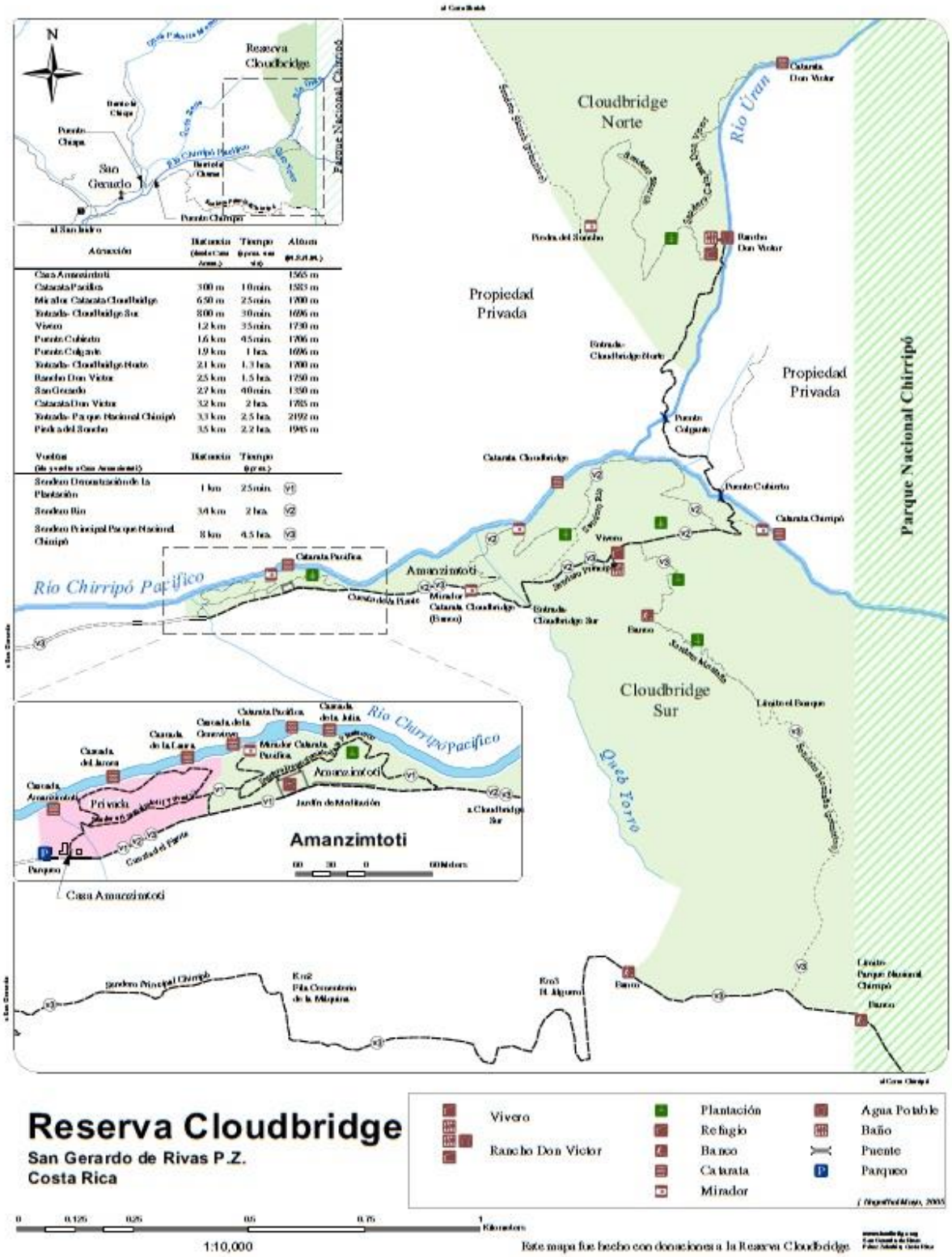
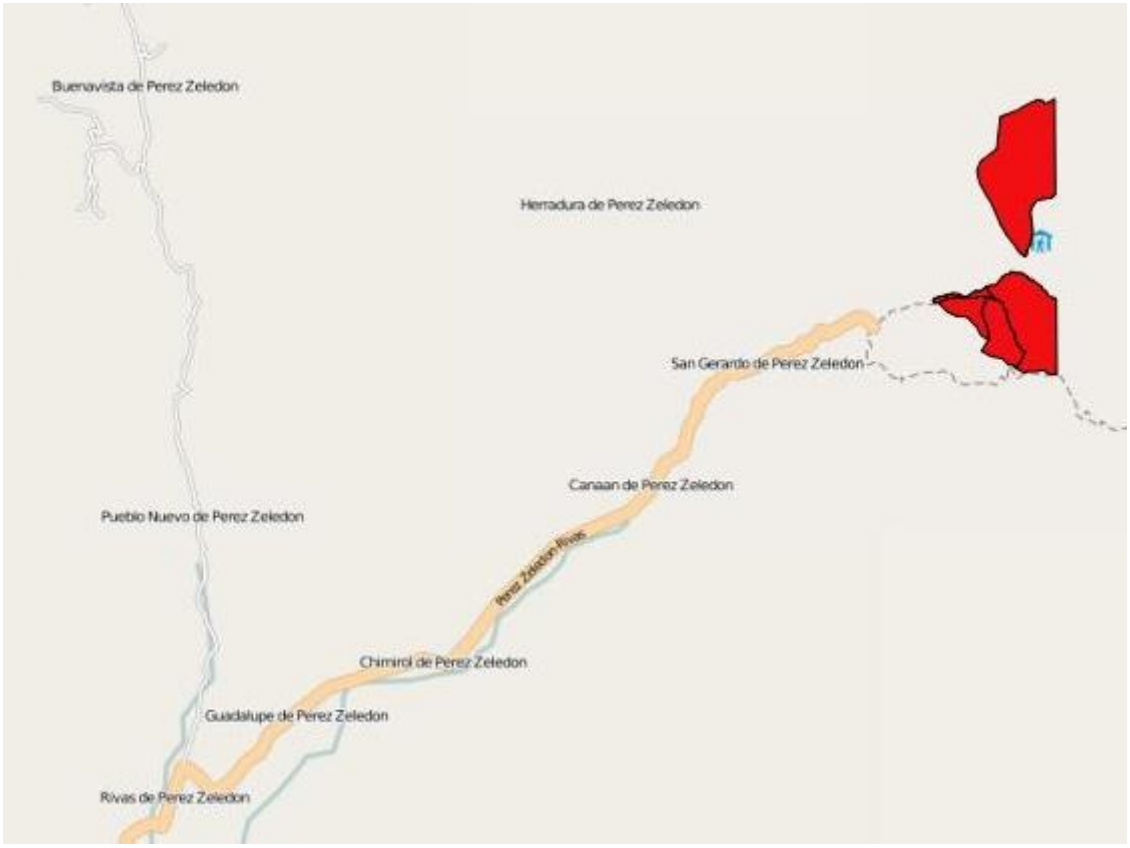
Martin, M. P., vet Kids Saving the Rainforest, Personal communication on April 29th, 2013

Gode, T., Director Cloudbridge NR, Personal communication on April 24th, 2013

Appendix 1 Map of Cloudbridge NR

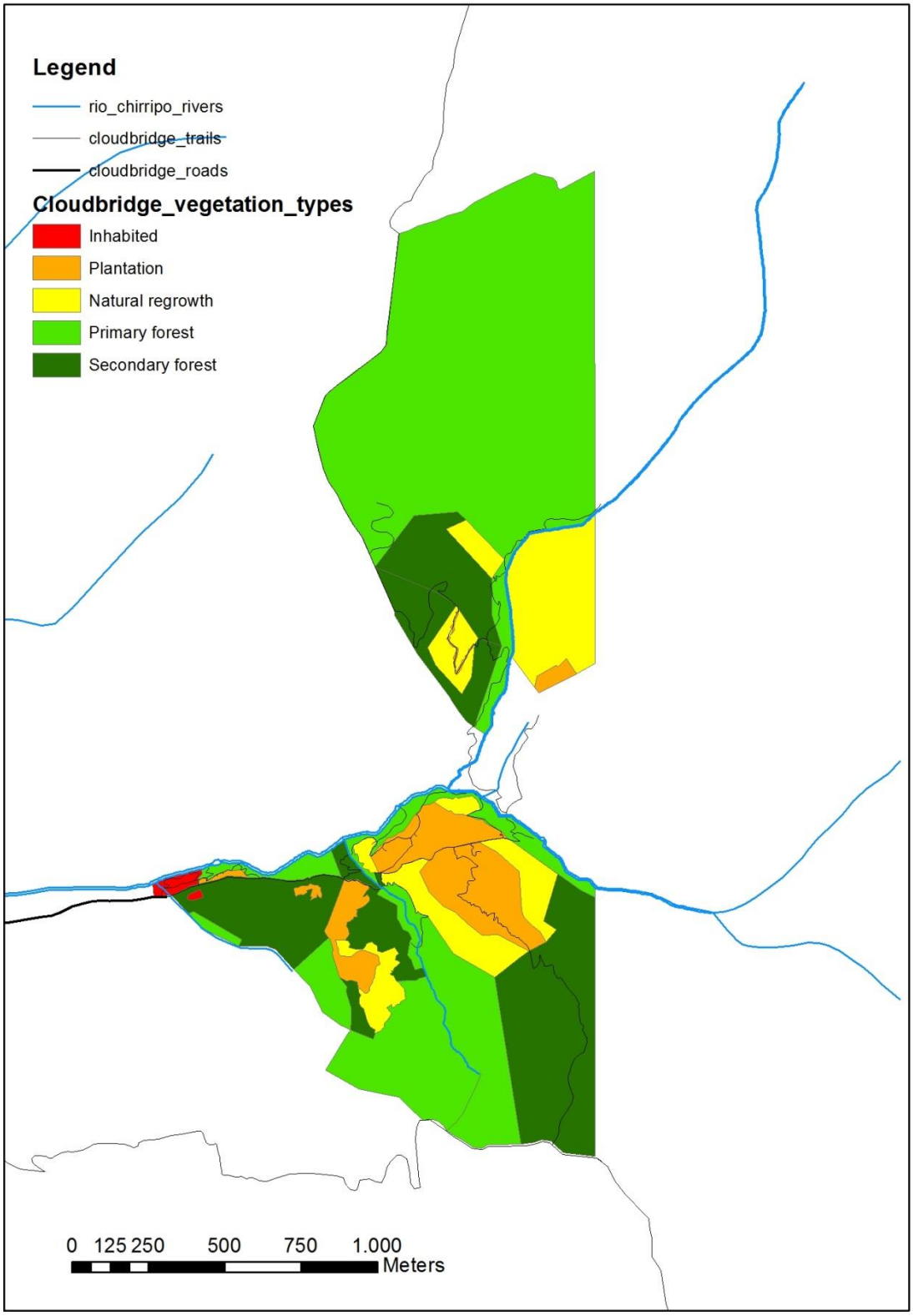


Appendix 2 Map of the towns near Cloudbridge NR



Source: maps.google.nl

Appendix 3 Vegetation map 2006

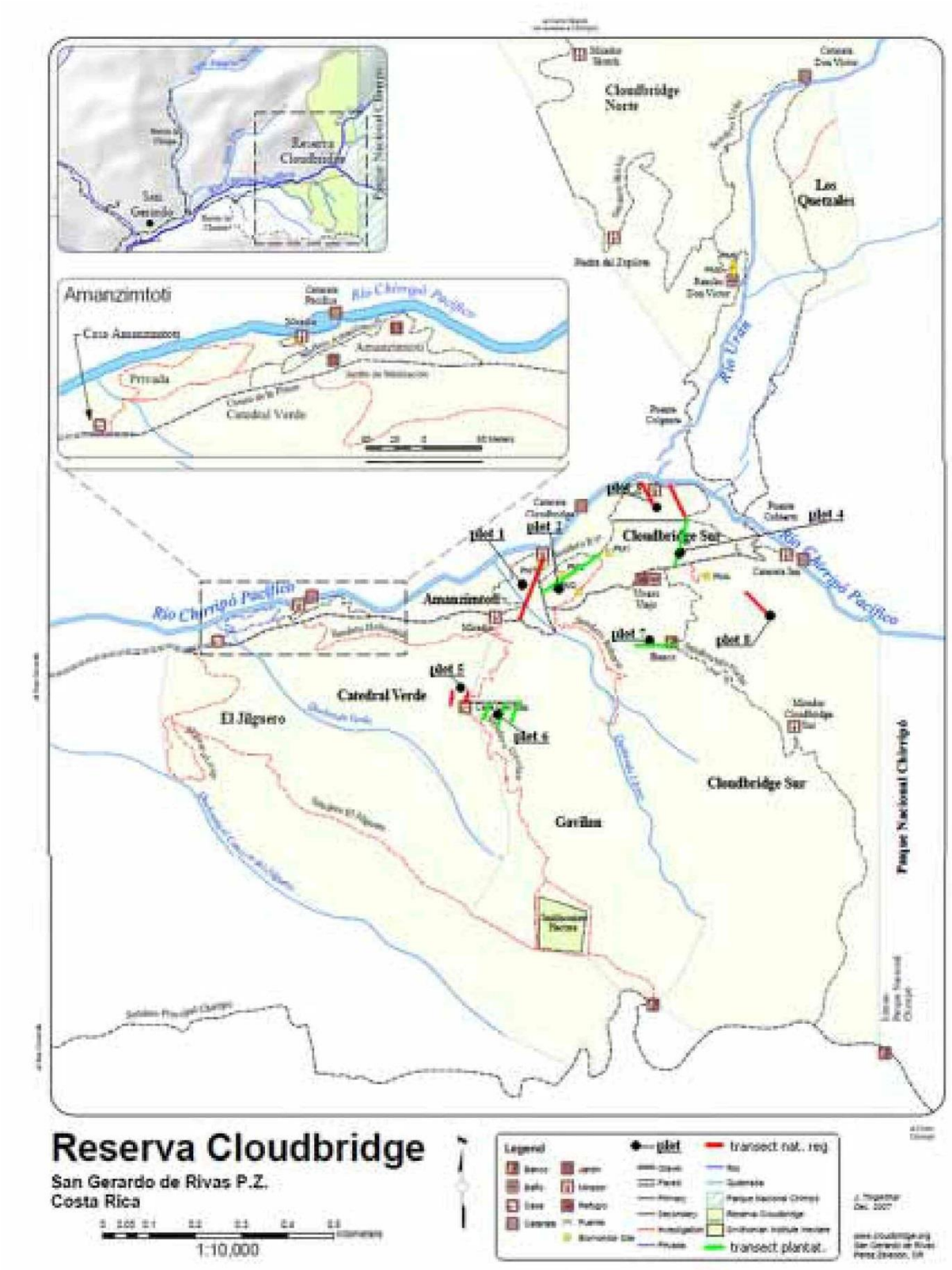


Appendix 4 Interview farmers

Name	
Date	
Place	
Subject	Sloths in and around Cloudbridge in earlier days
Question 1: What is your age and what is your profession?	
Question 2: How long have you lived in the San Gerardo area?	
Question 3: Have you ever seen a sloth in and around Cloudbridge NR?	
Question 4: If yes, when was this and where?	
Question 5: Which sloth species was present in and around Cloudbridge NR (two-toed or three-toed)?	
Question 6: What is the difference in the amount of sloths present now and 40-50 years ago?	
Question 7: Why do you think did the sloths disappear?	

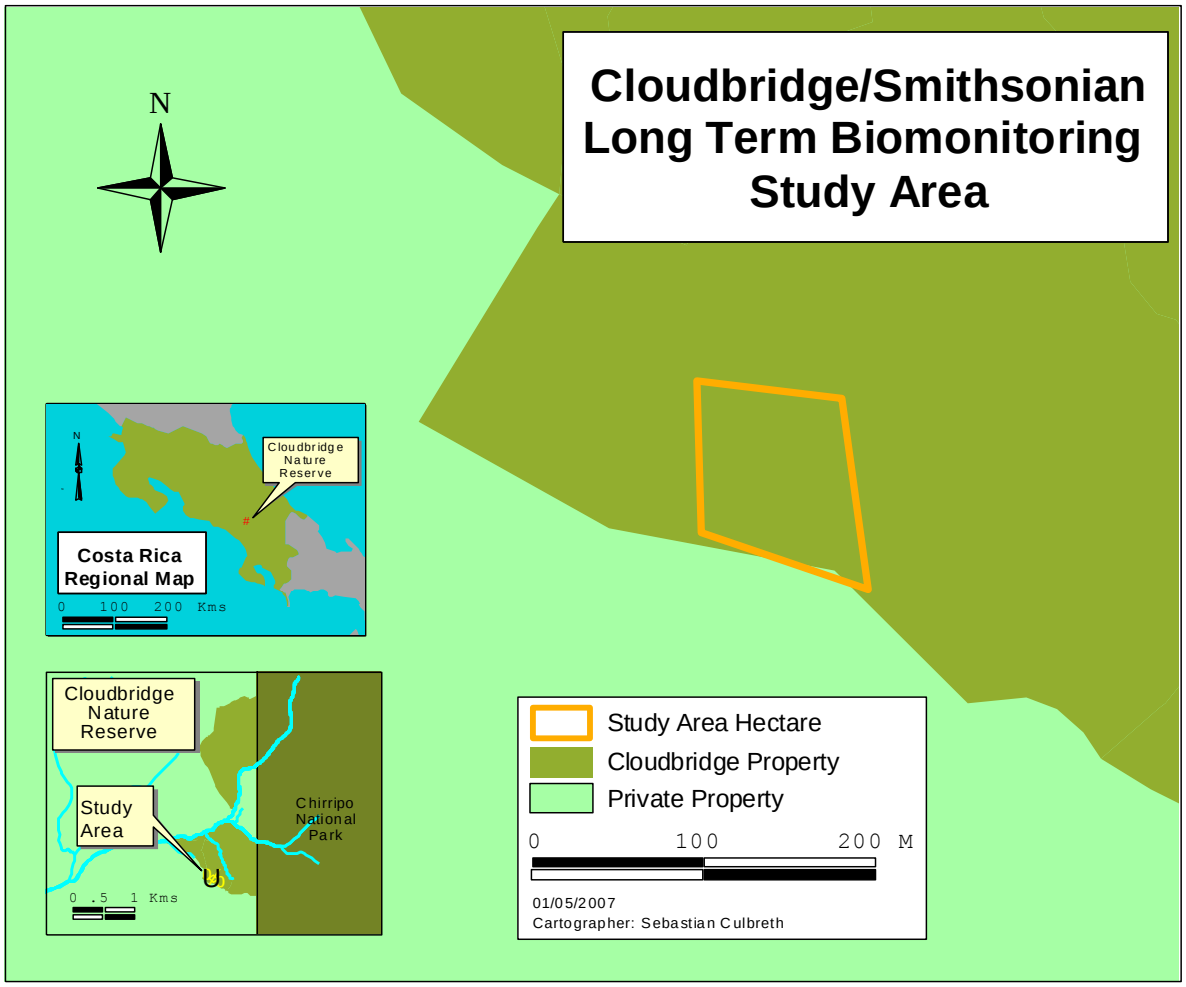
Question 8: What habitat and tree species did sloths prefer in and around Cloudbridge NR?
Question 9: What where the major threats to sloths in and around Cloudbridge NR?
Question 10: Do you have any other comments regarding this interview or my research?

Appendix 5 Map plots 2011



Source: Spek (2011). *Cloud Forest recovery* – evaluation at Cloudbridge Nature Reserve, Costa Rica. Retrieved May 24th, 2013 from http://www.cloudbridge.org/wp-content/uploads/2011/11/Cloud-Forest-Recovery-sm.pdf

Appendix 6 Map Smithsonian hectare



Source: Sebastian Culbreth, S. (2007) *Smithsonian Hectare Map Layout*

Appendix 8 – Field form

Name		**GPS coordinate begin**	N		W	
Date		**GPS coordinate end**	N		W	
Transect number		**Soil**				
Vegetation type		**Weather**				
Undergrowth		**Comments**				

Name species	**DBH**	**Height**	**Crown development 1-4**	**Liana development (1-4)**	**Comments**

Appendix 9 Tree species used by sloths

Above 1000 meter

Tree species	Use (% of the tree species/ f=feeding, R=Resting/ 2/3= level of significance)		Habitat
	Tree-toed	Two-toed	
Apeiba tibourbou	x	x	Wet to seasonally dry forest, Pacific slope, 0-1100m.[7]
Bamboo sp.	0,05%		*0-1600m.*[2]
Billia rosea		x	1750-2000m.[14]
Cecropia eximia (Cecropia insignis)	7,6%		*Wet forest, below 1500m.*[7]
Cecropia obtusifolia	0,7%		*Wet areas below 1450m.*[1]
Cedrela odorata	x	x	Both slopes 0-1200m.[6]
Cestrum racemosum		R	0-2650m.[2]
Cordia alliodora	0,5%	0,3%	*Both slopes, 0-1100m. In secondary and older forest, wet and dry climates.*[1]
Dendropanax arboreus	0,05%		*0-1400m.*[2]
Didymopanax morototoni	0,05%		*Slopes 45 per cent or more. 0-1700m,*[9]
Erythrina poeppigiana	R	F,R	500-1100m.[7]
Ficus costaricana	0,05%		*Wet to seasonally dry forest, second growth, 0-1600m.*[7]
Ficus insipida	0,6%	1,1%	*Wet to seasonally dry lowlands. 0-1100m.*[7]
Ficus obtusifolia	1,1%	0,1%	*0-1050m.*[2]
Ficus werckleana (ficus insipida)	F,R	R	50-1100m.[2]
Ficus yoponensis	1%	0,3%	*10-1500m.*[2]
Genipa americana		2,6%	*Wet to seasonally dry forests, second growth, 0-1100m.*[7]
Hirtella triandra			*Both slopes, mainly at low and medium elevations with (very) wet climates, 0-1100m.*[12]
Inga marginata	0,05%		*Secondary, wet to very wet, 0-1500m.*[2]
Inga oerstediana	F,R	F,R	0-2050m. Mostly above 600m.[2]
Leucaena leucocephala	R	R	0-1000m.[18]
Licania hypoleuca	0,2%		*Both slopes, 0-1150m.*[12]
Macrocnenum glabrescens (Macrocnenum roseum)	0,3%	1,3%	*Moist to seasonally dry forest, second growth and edges, 0-1600m.*[7]
Mangifera indica	2, 0,1%	0,3%	*Planted in Costa Rica, doing best in warm areas with a distinct dry period.0-1500m.*[1,2]
Ochroma pyramidale	0,1%		*Moist and wet lowlands, both slopes, 0-1200m.*[1]
Posoqueria latifolia	0,1%		*Understories of moist to wet forest, 0-1700m.*[7]
Pterocarpus hayesii (Pterocarpus rohrii)	3	0,3%	100-1400m.[2]
Samanea saman	R		Mostly in seasonally dry forest, 0-1200m, mostly below 500m.[7]

Sapium caudatum (Sapium glandulosum)	0,3%	3, 1,1%	0-1800, more frequent above 1000m.[2]
Sloanea terniflora	0,1%	0,3%	*80-1100m.*[12]
Solanum umbellatum		F,R	Wet forest, 1300-1500m.[17]
Spondias nigrescens (Spondias mombin)	1,3%	3, 4,5%	*0-1200m.*[2]
Symphonia globulifera	0,4%		*Wet to very wet rainforest, both slopes, 0-1700m.*[12]
Tabebuia rosea	1%		*0-1200m. wet to dry forest. Common in dry forest.*[1]
Zanthoxylum procerum (Zanthoxylum acuminatum)		0,3%	Moist and wet forest, both slopes, 200-2000m.[2]

Below or equal to 1000 meter

Tree species	Use (% of the tree species/ f=feeding, R=Resting/ 2/3= level of significance)		Habitat
	Tree-toed	Two-toed	
Acalypha diversifolia	0,05%		*Below 1000m.*[5]
Alchornea costaricensis	1,7%	0,5%	*In moist and wet forest, both slopes, 0-900m.*[12]
Anacardium excelsum	2/3, 4,8%	3, 30,9%	From north to south, on both slopes but more common on Pacific, from lowlands to 900 m.[1]
Andira inermis	0,1%		0-900m.[2]
Apeiba membranacea	x	x	Wet forest, 0-900m.[7]
Artocarpus communis (Artocarpus altilis)	0,05%		*Lowland.*[1]
Astrocaryum standleyanum	3, 0,5%		*Very wet lowland forest, 0-500m, Pacific slope.*[7]
Astronium graveolens		1,3%	*0-1000m. Dry to moist forest.*[1]
Beilschmiedia pendula	0,5%	0,3%	*350-900m.*[14]
Bombacopsis quinata (Pachira quinata)	0,6%		*0-900m.Dry to moist forest.*[1]
Bombacopsis sessilis (Pachira sessilis)	0,7%	4%	*Mostly along pacific coast, including dry forest, but also found in wet and lower montane forest.*[10]
Brosium bernadetteae (Brosimum alicastrum subsp. Bolivarense)		0,8%	Wet to seasonal dry, 0-700m.[7]
Calophyllum longifolium	1,3%	0,3%	*Wet to very wet forest, pacific slope, 0-400m.*[12]
Cassipourea elliptica	0,1%		*Below 1000m.*[5]
Cavanillesia platanifolia		0,5%	A widely distributed species, occurring in lowland rainforest and in areas which have been disturbed or cleared of forest.[11]
Ceiba pentandra	1,5%	1,3%	*0-1000m. dry to wet regions. Secondary and primary forest.* [1]
Couratari panamensis (Couratari guianensis)	0,05%		*Pacific lowlands.*[2]
Coussapoa panamensis (Coussapoa villosa)	0,1%		*Both slopes 0-800m.*[2]
Croton billbergianus	0,05%		*0-900m.*[2]
Dipteryx panamensis	3, 3,8%	3, 4%	Atlantic lowlands in the north-east section of CR. 0-100m.[1]
Eriobotrya japonica	x		Below 1100m.[2]
Ficus popenoei	0,1%		*50-1000m.*[2]
Ficus tonduzii	0,1%		*0-800m.*[2]
Goethalsia meiantha	F,R		Moist to very wet lowlands, 0-600m.[7]
Guarea guidonia	0,1%		*150-600m.*[16]
Gustavia superba	3, 2%	0,8%	Up to 600m, very wet forest.[4]
Heisteria concinna	0,1%	1,4%	*Lowland.*[7]
Hirtella americana	0,1%		*50-700m.*[12]
Hura crepitans	2, 0,2%		*Moist and wet forest, both slopes,*

			20-900m.[12]
Hyeronima laxiflora (Hyeronima alchorneoides)	3, 2,0%	2,1%	Both slopes, lowland humid and very humid mixed tropical forests. 0-900m.[3,6]
Inga goldmanii	3, 2,4%	0,5%	0-650m.[2]
Jacaranda copaia	1%		*Wet lowlands.*[2]
Lacmellea panamensis	3, 6,8%	0,3%	*0-700m.*[2]
Leucaena leucocephala	R	R	0-1000m.[18]
Licania platypus	1,3%	2, 1,8%	*10-950m.*[2]
Lonchocarpus sp.	0,2%		At low or moderate elevations. [7,15]
Luehea seemannii	2		10-900m.[2]
Platymiscium polystachyum (Platymiscium pinnatum var. polystachyum)	0,4%	0,8%	*Wet forest, 0-600m.*[2]
Platypodium elegans	0,5%	0,3%	*In CR only on Barro Colorado Is.*[10]
Poulsenia armata	3, 5,9%	2,6%	Below 1000m.[5]
Pourounia aspera (Pourouma bicolor)	0,1%		*Both slopes, 0-900m.*[2]
Prioria copaifera	0,1%	1,6%	*Wet lowland forest, 0-300m.*[7]
Protium costarricense	0,7%		*Lowlands, in forest interior only.*[10]
Protium panamense	x		Below 1000m.[5]
Protium tenuifolium	1,3%	1,1%	*Lowlands.* [10]
Pseudobombax septenatum	1,5%		*Pacific lowlands, 0-600m.* [1,2]
Pterocarpus officinalis	F,R	F,R	Wet lowlands, 0-200m.[7]
Quararibea asterolepis	0,2%	0,3%	*0-700m.*[2]
*Rheedia madruno (*Garcinia madruno)	0,5%		*Wet forest, both slopes, 25-400m.*[2]
Rollinia pittieri	F,R		0-700m.[2]
Sterculia apetala	2		Wet to seasonally dry, lowland forests. Altitude Pacific slope 0-400m.[7]
Terminalia amazonica	0,05%	3, 1,3%	30-1000m.[2]
Theobroma cacao	F,R	F,R	0-600m.[7]
Trichilia cipo (trichilia tuberculata)	2, 4,1%	0,3%	*0-150m.*[2]
Trophis racemosa	0,3%		*Dry, wet and lower montane sites.*[10]
Virola sebifera	1,4%	1,1%	*Below 1000m.*[5]
Zanthoxylum panamense	0,3%	0,3%	*Both slopes, 50-600m.*[2]
Zuelania guidonia	3		Below 1000m.[5]

Unknown

Tree species	Use (% of the tree species/ f=feeding, R=Resting/ 2/3= level of significance)		Habitat
	Tree-toed	Two-toed	
Alseis blackiana	3, 1,4%	1,8%	Only in the drier half of the Panama-isthmus.[8]
casearia arborea	0,1%		*Moist to wet and montane forest, species of natural clearings.*[10]
Chrysophyllum panamensis	3	3	?
Eucalyptus globulus		R	Not native to Costa Rica.
Eugenia nesiotica	0,05%	0,3%	?
Eugenia sp.	0,1%		?
Ficus sp.	1%		*Sea level to high elevations, wet and dry regions.*[1]
Ficus trigonata (Ficus crassinervia)	3, 3,2%		?
Guapira standleyanum	0,1%		?
Guatteria dometorum	0,4%		?
Guettarda foliacea	0,05%		?
Hirtella sp.	0,1%		?
Inga guaternata	0,05%		?
Inga sp.	1,9%		?
Maguira costaricana	0,5%		?
Nectandra salicifolia	F,R		?
Nectandra sp.	0,2%		?
Ocotea sinuate	F,R	F,R	?
Protium sp.	0,9%	0,3%	?
Scheelia zonesis	0,05%		?
Tetragastris panamensis	4,1%	0,3%	*Only sporadic records in Costa Rica.*[10]
Tetrahylacium johansenii	0,1%		*Uncommon.*[7]
Trattinickia aspera		3, 2,9%	?
Trichanthera gigantea	0,8%		*Streams and swampy areas and wet forests*
Virola nobilis (Virola Surinamensis)	3, 2,5%	3,4%	*Only at a few sites.*[10]
Zuelania guidonia	0,6%		*Mostly Pacific slope, in dry zone, in secondary forest and edges.*[10]

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Appendix 10 Elaboration interviews farmers

Question 1: What is your age and what is your profession?

- 80 years, farmer
- 62 years, farmer 2x
- 68 years, farmer
- 60 years, farmer

Question 2: How long have you lived in the San Gerardo area?

- His whole live 5x

Question 3: Have you ever seen a sloth in and around Cloudbridge NR?

- Yes, in earlier days there were a lot.
- Yes 2x
- Only long ago.
- Yes, I saw a lot of them a long time ago. I used to live in Cloudbridge when I was a child and I saw them usually around there.

Question 4: If yes, when was this and where?

- 10 years ago the last ones. In his farm and on the Chirripo trail between kilometre 2 and 3.
- 2 behind his house 6 or 7 years ago. In his whole life he saw a lot of them.
- Last was 10 years ago close by his house.
- More than ten years ago down at the river.
- About 30 years ago and I used to live close to the vivero (close to the mountain trail).

Question 5: Which sloth species was present in and around Cloudbridge NR (two-toed or three-toed)?

- Only three-toed sloths. 3X
- ?
- Only two-toed sloth.

Question 6: What is the difference in the amount of sloths present now and 40-50 years ago?

- A long time ago at night in the summer he could hear them.
- When there was more pasture there were a lot of them. Now there is more protection of forest and they disappeared.
- Early a lot more than 20 individuals.
- There were a lot especially close to the river. Mostly more down than in the area of Cloudbridge. Also in the area of the Talamanca Reserve.
- I don’t know exactly, but before it was possible to see them every day (around 30 years ago).

Question 7: Why do you think did the sloths disappear?

- First the lions came and after that the coyotes. There is no hunting done on sloths they preferred other animals.

- Due to Pumas and coyotes. Not due to deforestation or hunting (prefer tapir, pecari and deer).
- (1) Destruction of the habitat. (2) Puma eat a lot of sloths (sloth is slow so easy to catch). Not hunting because it is not nice to eat.
- Doesn't know exactly. Maybe hunting for fun. Not because of deforestation, because when he was a child there was a lot of pasture but more sloths. There live much more people now than before
- I think the leonsillo (Puma) ate all of them and the coyotes too.

Question 8: What habitat and tree species did sloths prefer in and around Cloudbridge NR?

- Cecropia and Joco. Open places and close to pasture land in forest.
- Both species of guarumo (cecropia). They prefer more open spaces not on the mountains.
- Cecropia trees, but also other trees. Mostly young leaves. Secondary forest with open places, not in dense forest.
- Secondary forest. Different trees but especially cecropia trees.
- They used to be in open places, and they ate guarumo (cecropia).

Question 9: What where the major threats to sloths in and around Cloudbridge NR?

- No other threats then mentioned before. 3x
- Mostly coyotes and also puma (leonsillo de Breñon). Now there are still a lot of pumas.
- Doesn't know exactly. Difficult for a predator to catch because it is high in the tree. Maybe it moved to another place.

Question 10: Do you have any other comments regarding this interview or my research?

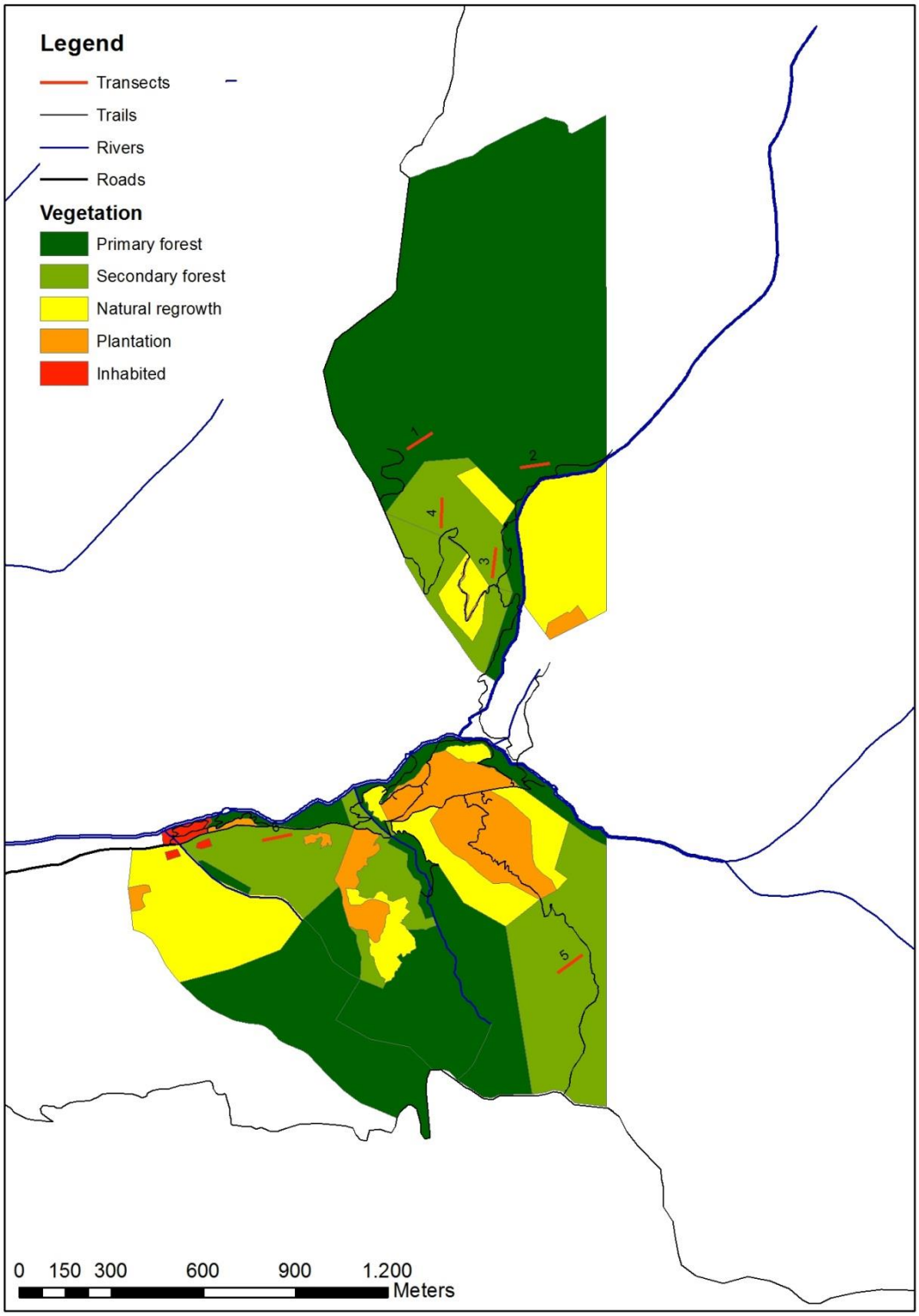
- He really likes to help with the research.
- Really interested in nature and why the animals disappeared. Preferred the protection of the forest.
- It is a good idea to bring some of the animals to this area.
- Really interesting research.
- I would like to see sloths again around here.

Appendix 11 Aerial picture Cloudbridge NR

Cloudbridge NR is indicated as a red area.

Source: maps.google.nl

Appendix 12 Map of the vegetation types 2013



Appendix 13 Tree species found in Cloudbridge NR

1. *'Ira'*
2. *Aioueae costaricensis*
3. *Alnas acuminata*
4. *Alnus sp.*
5. *Ardisia sp.*
6. *Biala hippocastanum*
7. *Bocconia frutescens*
8. *Brosimum costaricense*
9. *Brosimum sp.*
10. *Cecropia polyphlebia*
11. *Cedrela tonduzii*
12. *Cedro dulce*
13. *Cestrum racemosum*
14. *Chione sylvicota*
15. *Cichona pubescens*
16. *Cinnamomum triplinerve*
17. *Citharexylum donnell-smithii*
18. *Clusia sp.*
19. *Cyathea sp.*
20. *Dendropanax arborens*
21. *Elaeagia auriculata*
22. *Erythrina costaricensus*
23. *Erythrina sp.*
24. *Ficus tuerckheimii*
25. *Ginchona pubescens*
26. *Gliricidia sepium*
27. *Gonzalagunia rosea*
28. *Guarea glabra*
29. *Heliocarpus americanus*
30. *Hyeronima alchornioides*
31. *Inga oerstediana*
32. *Inga sp.*
33. *Macrohasseltia macroterantha*
34. *Meliosma vernicosa*
35. *Miconia sp.*
36. *Moilinedia sp.*
37. *Mortoniodendrum anisophylum*
38. *Myrcianthes fragrans*
39. *Myrsine coriacea*
40. *Myrsine coriacea*
41. *Myrsine sp.*
42. *Nectandra sp.*
43. *Oreopanax sp.*
44. *Oreopanax standleyi*
45. *Oreopanax xalapensis*
46. *Panopsis suaveolens*
47. *Perrottetia longistylis*
48. *Persea americana*
49. *piipisdoclamys sp.*
50. *Piper nigrum*
51. *Posoquena latifolia*
52. *Posoquena sp.*
53. *Prunus annulans*
54. *Pseudolmedia sp*
55. *Psychiotra sylvivaga*
56. *Quercus*
57. *Quercus bumelioides*
58. *Quercus costaricensis*
59. *Quercus sp.*
60. *Quiebra hacha*
61. *Randia sp.*
62. *Rondeletia amoena*
63. *Rubiaceae*
64. *Sabia melliosma*
65. *Salanum sp.*
66. *Sapium sp.*
67. *Saurauia montana*
68. *Saurauia pittierii*
69. *Saurauia rubiformis*
70. *Saurauia sp.*
71. *Cecropia polyphlebia*
72. *Solanum sp.*
73. *Sphaeropteris brunei*
74. *Symphonia globulifera*
75. *Tree fern*
76. *Ulmus mexicana*