

Behavioural Studies and Rehabilitation of Sloths in *Parque Natural Metropolitano*

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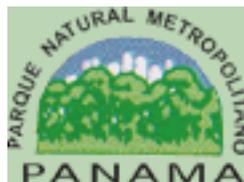


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Appendices:

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Number of days spent on this project in Panama

For the chronogram of all of the activities involved in completing this project, please see Appendix D.

The number of equivalent full days spent on the project in Panama: 55 days.

The number of days spent at the *Parque Natural Metropolitano*: 22 days.

The number of hours spent doing behaviour observations in the field: 33 hours.

McGill Thank-You note

McGill needs to send a thank you note to:

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EXECUTIVE SUMMARY

Parque natural Metropolitano, located within the city of Panama, is rich in mammal diversity and is home to both *Choloepus hoffmanni* and *Bradypus variegatus*.

The animal rescue and rehabilitation centre in the PNM is facing a major difficulty with rescued baby *Choloepus hoffmanni* sloths whose mothers have been killed mainly on the road that runs through the park. One of the main objectives of our study was to resolve the problems with baby sloth rehabilitation (diet inadequacy) in order to increase the survival rate of captive sloths in the park. This was done through behavioural studies and by conducting interviews with the PNM employees, zoos and animal rehabilitation centers. We obtained a list of complete sloth diets, a summary of all known food sources of *C.Hoffmanni* from captivity and the wild, and some suggestions of how to change the diet of the baby two toed sloths in the PNM, in order to increase survival.

The most useful suggestions from our results were that sloths should not be fed cows milk because it is very difficult to digest, and Gerbers baby food may be harmful to their health because it contains onion.

A behavioural study of sloths was conducted from February to April 2005. Observations were made in the morning, afternoon and night and all movements, behaviour, stratification in the canopy and habitat selection were recorded. Using data obtained from 9 sloths, 6 two-toed and 3 three-toed, an ethogram of generalized sloth behaviour was compiled.

A qualitative description of the habitat *Choloepus hoffmanni* was made using data obtained from interviews with the park rangers and from personal observations. The two toed sloth is found in large trees with many lianas, branches and usually dense leaves. *Pseudobombax septenatum*, *Cecropia* species, *Anacardium excelsum* and *Luehea* species are of particular importance to both species of sloths. Pioneer species, most abundant at the side of the road, are often inhabited by sloths which increases the probability of road collisions. During the day, *Choloepus hoffmanni* occupied the upper midlevel of the canopy (10-15 meter from the ground) and ascended to the top of the canopy at dusk possibly to increase their body temperature through movement and to feed.

In order to determine the feasibility of performing a census of sloths in the Parque Natural Metropolitano, one 25 meter by 100 meter pilot plot was examined. It took approximately two and a half hours to census one plot and no sloths were seen during the survey. This indicates that a census of sloths for the entire park would require a large number of plots to get an accurate estimate of abundance which would require considerable amounts of time and effort.

Using data from behavioural studies, the maximum density of sloths in the park was calculated to be roughly 0.06 sloths per kilometer squared. Interviews with park rangers indicated that *Bradypus variegatus* was seen more often than *Choloepus hoffmanni*. This may indicate a lower abundance of the two toed species in the park as well as lower observability.

Sloths are a potential flagship species in the park that can be used to promote eco-tourism. A sloth manual was therefore devised, containing pertinent facts, differences between the two species in the park and ways to find sloths for visitors. Furthermore, we painted a park for children near the entrance of the park in order to increase the attractiveness of the park and to provide a venue for the *Feria Ecologica* held at the park on the 24th of April, 2005.

RESUMEN EJECUTIVO

El Parque Natural Metropolitano, localizado dentro de la ciudad de Panamá, posee una gran diversidad de mamíferos y es hogar ambas especies de perezosos, *Choloepus hoffmanni* y *Bradypus variegatus*.

El centro del rescate y la rehabilitación de animales en el PNM está encarando una dificultad mayor con los bebés perezosos rescatados de *Choloepus hoffmanni* de los cuales sus madres han muerto principalmente en el carretera que corre por dentro del parque. Un objetivo principal de nuestro estudio fue resolver los problemas con la rehabilitación de perezosos juveniles (insuficiencia en la dieta) con el fin de aumentar la tasa de sobrevivencia de perezosos cautivos en el parque. Esto se hizo a través de estudios de compartimiento y realizando entrevistas con los empleados de PNM, los zoológicos y los centros de rehabilitación de animales. Obtuvimos una lista de dietas completas, un resumen de todas fuentes conocidas de alimento de *C. hoffmanni* en cautiverio y silvestres, y algunas sugerencias de cómo cambiar la dieta de los perezosos de dos dedos en el PNM, para aumentar su supervivencia.

Las sugerencias más útiles de nuestros resultados son que los perezosos no se deben alimentar con leche de vaca porque es muy difícil de digerir, y comida para bebés (de Gerbers) puede ser perjudicial a su salud porque contiene cebolla.

Un estudio del comportamiento de perezosos se realizó de febrero a abril 2005. Los registros se hicieron por la mañana, tarde y noche; observando los movimientos, el comportamiento, estratificación en el dosel y hábitat se registró. Utilizando los datos obtenidos de 9 perezosos, 6 de dos dedos y 3 de tres dedos, un ethograma del comportamiento generalizado del perezoso se compiló.

Una descripción cualitativa del hábitat del *Choloepus hoffmanni* se hizo con la información obtenida de entrevistas con los guardabosques del parque y de observaciones personales. El perezoso de dos dedos se encuentra en árboles grandes con muchas lianas, ramas grandes y hojas generalmente densas. *Pseudobombax septenatum*, especies de *Cecropia*, *Anacardium excelsum* y especies de *Luehea* son importantes para los dos especies de perezosos. Las especies pioneras son muy abundante al lado del carretera, son habitados por los perezosos que aumenta la probabilidad de que sean atropellados por los autos. Durante el día, *Choloepus hoffmanni* ocupó el nivel medio superior del dosel (10-15 metro del suelo) y subió a la cima del dosel para aumentar posiblemente su temperatura corporal por el movimiento y para alimentarse.

Para determinar la viabilidad de realizar un censo de perezosos en el Parque Metropolitano Natural, diseñamos una parcela piloto de 25 por 100 metros. Nos tomó aproximadamente dos horas y media el censo de la parcela y ningún perezoso se observó durante la inspección. Esto indica que un censo de perezosos para el parque entero requeriría muchas parcelas para obtener una estimación exacta de la abundancia que requeriría cantidades considerables de tiempo y esfuerzo.

Utilizando la información de estudios de comportamiento, la densidad máxima de perezosos en el parque se calculó para ser aproximadamente 0,06 perezosos por kilómetro cuadrado. Las entrevistas con guardabosques de parque indicaron que *Bradypus variegatus* fue visto más a menudo que *Choloepus hoffmanni*. Esto puede indicar una abundancia más baja de la especie de dos dedos en el parque así como probabilidad para obsérvalo más baja.

Los perezosos son una potencial especie estandarte para el parque que se puede utilizar para promover el eco-turismo. Considerando esto, hicimos un guía de campo de los perezosos, conteniendo los hechos pertinentes, las diferencias entre la dos especies en el parque y maneras de encontrar los perezosos por los visitantes. Además, pintamos un parque para niños cerca de la entrada del parque para aumentar la atracción del parque y para proporcionar un lugar de actuación para la Feria Ecológica tuvo lugar en el parque el 24 de abril, 2005.

Introduction

1. Host Organization

Parque Natural Metropolitano (PNM), located about 1 km from the center of Panama City, is the only protected area within city limits in all of Latin America (St Louis, 2004, PNM 2005). About 75% of this 250-hectare Park is covered with Pacific dry tropical forests, an ecosystem that has almost disappeared in other regions of Panama (Plan 1999, PNM 2005). The protected area of PNM protects Curundu River's watershed that flows into the Pacific entrance of the Panama Canal and the flora and fauna in this area is extremely rich and diverse. The flora of this relatively small park consists of 284 species of plants, distributed in 80 families and contains trees that can be up to 40m tall (Plan de Manejo, 1999). *Parque Natural Metropolitano* also contains a rich variety of species of fauna and is home to 45 native mammal species, 227 species of birds 36 species of reptiles and 14 amphibian species (Plan de Manejo, 1999). Among these mammal species are the two-toed sloths (*Choleopus Hoffmanni*) and three-toed sloths (*Bradypus variegatus*). PNM was created on June 5th, 1988 and since then has offered three major programs: protection, environmental education and maintenance of the park (PNM 2005). A conservation activity that the park undertakes is the animal rescue and rehabilitation program, where sick or injured animals are cared for and then released back into the park.

2. The problem

The activities of the expanding human population of Panama City, including the recent construction of the four-lane Corredor Norte highway through the centre of *Parque Natural Metropolitano*, represent a significant threat to the animal populations within the Parque Metropolitano. Loss of habitat, highway accidents, aggression from domestic species and water contamination have injured or killed many animals (PNM 2005). To address this growing problem the park created a rescue and rehabilitation centre to receive and relocate injured animals. The park is presently facing a major difficulty with both the two-toed (*Choloepus hoffmanni*) and three-toed (*Bradypus variegatus*) sloths in the PNM. The park staff estimates that an average of 2-6 sloths die per year in the Parque Metropolitano and the majority of deaths are caused by highway accidents on the Corredor Norte, but also on the Ave Juan Pablo II. Ascanio Villalaz Ave. and the Amistad road. Other less frequent causes of death include electrical wires, water contamination, oil spills, falling branches and disease (Appendix C). The animal rehabilitation centre in the PNM have been rescuing the abandoned baby sloths whose mothers have been killed. However, out of the 15 baby sloths that the park has rescued over the past several years only 2 have survived, and no *Choloepus hoffmanni* survived (Rosas, 2005).

3. Objectives

With this problem in mind, one of the main objectives of our study was to resolve the difficulties with baby sloth rehabilitation (diet inadequacy) in order to increase the survival rate of captive sloths in the park. The second objective of our study was to conduct a behavioural study on *Choloepus hoffmanni* in the PNM in order to understand energy allocation and contribute to the general knowledge base. The third

objective of our study was to estimate the distribution and abundance of these animals in the PNM. According to the IUCN Red List, there is currently not enough information to determine this species conservation standing (IUCN, 2004). Our objective then was to determine for the first time an estimate of sloth abundance in PNM and to execute a comparable investigation to that of a pilot study presently underway in Brazil (Adriano Chiarello personal communication to Rafael Samudio). The final objective of our study was to promote eco-tourism by increasing the attractiveness of the park and providing information on sloths to visitors.

4. Study Species

Our study focused on the two-toed sloth (*Choloepus hoffmanni*) because there are presently 4 baby *C. Hoffmanni* in the rescue and rehabilitation at the PNM, and there was an urgent need to find out how their diets could be improved. Furthermore, previous studies have mostly focused on *Bradypus variagatus* and consequently much less is known about the diet and behaviour of *C.Hoffmanni* in the wild.

Hoffmann's two-toed sloth *Choloepus hoffmanni* is a eutherian (placental) mammal that belongs to the order of Edentates, suborder Xenarthra, Family Choloepidae (Emmons 1990) *C. Hoffmanni* has a range that extends from Northern Nicaragua to the Amazon region of Peru and Brazil and lives in lowland and upland tropical forests (Reid 1997). Two-toed sloths are mainly nocturnal, arboreal and solitary and their diet consists mainly of leaves and fruit (Montgomery, 1985). Two-toed sloths prefer trees covered with lianas that are exposed to the sun, and they are usually found high in the forest canopy and are often very difficult to see (Montgomery, 1985).

This species can be differentiated from the three-toed sloth by the two large curved claws on its forelegs and three claws on its hind legs (Reid 1997). Furthermore, *Choloepus hoffmanni* are usually brown in colour, ranging from light tan to dark brown, with lighter fur around the face and head, while the *Bradypus variegatus* is usually grey.

There has been some debate in the past over the time of day in which sloths are active. Three-toed sloths have been characterized as either crepuscular (Kreig, 1961) or nocturnal and have been seen feeding during the day and the night. Two-toed-sloths have also been observed feeding during the day (Goldman, 1920). Lundy (1952) considered sloths to be active only at night. Sunquist and Montgomery (1973), in a study on the activity patterns and movement of the two species of sloths at Barro Colorado Island in the Panama Canal Zone, found that two-toed sloths were nocturnally active. Most of the sloths demonstrated little activity until at least an hour after sunset and their activity decreased as the night progressed. Activity had ceased by dawn. There was apparent synchrony in bouts of activity among individual sloths (Sunquist and Montgomery, 1973). Three-toed sloths were active both during the day and the night. Their activity was on average equal at different times of the day except for a period of low activity around dawn. Furthermore, it was found that both species of sloths did move about in the forest although movement was slow (Sunquist and Montgomery, 1973). Two-toed sloths, unlike the three-toed, tended not to be in the same tree on successive days and moved from one tree to the next four times more often than the other species. More than half the two-toed sloths in the study moved more than 38 meters between daily locations.

Both two-toed and three-toed sloths have slow metabolism and can therefore survive on minimum food consumption. They must only descend from a tree approximately once every eight days to defecate and urinate (Goffart, 1971).

Choloepus hoffmanni are much more generalist in their eating habits than are the *Bradypus variegatus*. Sloths were found to be able to eat in any position, even hanging upside down, and are quite skilled at manipulation of branches. Choloepidae are classified as ruminants due to presence of four stomachs, however they do lack some important characteristics typical of ruminants such as a long intestine. Two-toed sloths have a high concentration of bacteria in their gastric content, which is capable of producing enzymes such as cellulase (Goffart 1971).

Each year the female *Choloepus hoffmanni* gives birth (upside down) to a single offspring after a gestation period of 11 1/2 months. Babies are born with claws and cling to their mother until they can feed themselves. The young will stay near the mother for two years (Goffart 1971).

Interview methodology

Semi-structured interviews with 5 members of the staff of *Parque Natural Metropolitano* and one student from the University of Panama were conducted on Thursday April 14th and Friday April 15th, 2005. Fourteen questions were devised before hand and used as a guideline during the interview. The purpose of the interview was to obtain a more complete picture of sloth life history and behaviour from the people in the park working most closely with these animals. Questions covered a number of topics including abundance, distribution, activity patterns, feeding habits, habitat selection and observability. Questions were added or deleted depending on the expertise of the interviewee (Refer to Appendix C).

Interviews were held in informal settings, mostly in the usual surrounding of the informant such as the forest, the main office and the park ranger station. The interviewees were questioned orally and were given the questions to read in Spanish if they desired. Many of the informants were eager to share their knowledge and we therefore allowed additional or unexpected subjects to be covered.

Information obtained during the interview was used to support the rehabilitation, behavioural and abundance and distribution sections of our study.

Rehabilitation

The park has been rescuing baby sloths for several years. However, in most cases the baby sloths started to have health problems and died after 8 or 9 months. In fact no *Choloepus hoffmanni* have survived in the rehabilitation center. The Park staff suspected that this was related to diet, however they were not sure what they should feed them in order that they receive adequate nutrition. Recently four abandoned infant sloths (*Choloepus hoffmanni*) have been rescued in the park. Therefore the first objective of our study was to resolve the problems with baby sloth rehabilitation (diet inadequacy) in order to increase the survival rate of captive sloths in the park.

1. Methods

1.1 Diet in the wild

We used various methods to achieve this objective. Firstly, we reviewed relevant literature to find out what *Choloepus hoffmanni* eats in the wild. The second method we used to determine the feeding behaviour of *Choloepus hoffmanni* in the *Parque Natural Metropolitano* was to attempt to locate sloths and make direct observations about their feeding habits. The third method we used to attempt to find out what the sloths eat in the PNM was interviews with six park employees about their direct observations of sloth feeding habits.

1.2 Diet in Captivity

Firstly, we began by interviewing Jessica Rosas about the present diet of the baby *Choloepus hoffmanni* in the rehabilitation centre. Secondly, we did a literature review about the diet of two toed sloths in captivity. Thirdly, we conducted telephone and personal interviews with various people who had knowledge about the diet of captive *Choloepus hoffmanni*. We contacted the nutritionists at the Oregon Zoo in Portland, U.S.A. and at the Toronto Zoo in Canada. We interviewed a sloth rescue and rehabilitation centre in Costa Rica, called *Aviarios del Caribe* and lastly, we visited an individual named Roger Crokin in Puerto Lindo, Panama, who is presently raising three *Choloepus hoffmanni*.

2. Results

2.1 Diet in the Wild

Samudio reports in a personal communication to have seen a *Choloepus hoffmanni* feeding on the immature fruits of *Gustavia superba* however no previous reports have documented what species *C. hoffmanni* prefers to eat in the wild (Sunquist and Montgomery, 1975; Montgomery and Sunquist, 1978). Sunquist and Montgomery carried out 17 months of field work on Barro Colorado Island on *Choloepus hoffmanni* and *Bradypus infuscatus*) however because these sloths are nocturnal, they were never observed feeding. Furthermore, the researchers were unable to collect the samples of stomach contents from *Choloepus hoffmanni* (Montgomery and Sunquist, 1975). When we attempted to observe what the sloths were eating in the wild we had the same difficulties as Sunquist and Montgomery. Sloths are nocturnal and climb to the top of

the canopy at night and therefore we were unsuccessful in discovering their diet in the wild. We then conducted six interviews with park employees and asked them to list the food that they had directly observed sloths eating in the park. Table 1. illustrates the results of these interviews.

Table 1. Direct observations of sloth food choices in PNM

<i>C. hoffmanni</i>	<i>B. variagatus</i>
Bobacaceae flowers	<i>Cecropia</i> sp. leaves (new ones preferred)
Flowers of Barrigon (<i>Pseudobombax septenatum</i>)	Domesticated maracuja (passion fruit) (<i>Passiflora</i> sp.)
Buds of Barrigon leaves (<i>Pseudobombax septenatum</i>)	Flowers of Barrigon (<i>Pseudobombax septenatum</i>)
Liana leaf buds	
New leaves on lianas,	
Espave (<i>Anacardium excelsum</i>)	
Poro poro (<i>cochlospermum vitifolium</i>).	
Jobo (<i>Spondias</i> species)	

2.2 Diet in Captivity

We began by interviewing Jessica Rosas about the present diet of the baby sloths in the rehabilitation centre. Their diet consists of Mango leaves, Barrigon flowers and Poro Poro flowers. When they are very young they are fed evaporated milk with water, baby food (Gerbers) and fruit such as mango or apple. In order to determine what was missing from this diet or what was causing the deficiency in the captive baby sloths in the PNM, we began by reviewing previous studies which discussed the diets of *Choloepus hoffmanni* in captivity. There have been several reports written about the diet of sloths in captivity. Meritt outlines the diet of captive *Choloepus hoffmanni* in the Lincoln Park zoological gardens in Chicago (Meritt 1973, Meritt 1976 (2), Meritt 1985). Sloths are fed diced apple, banana, lettuce or escarole, celery, cooked sweat potato, orange, green beans and meat mixture daily (Meritt 1973). Sloths also accepted carrots, spinach, grapes, cooked white potato, bread, peas, fruit cocktail and several types of meat or meat products such as fresh ground horsemeat, canned dog food, moistened kibbled dogfood, canned salmon and fresh ground smelt (Meritt 1985). Furthermore, a vitamin mineral powder with an added source of vitamin K is sprinkled over the food to insure adequate intake of vitamins and minerals. When available, ground hard boiled eggs with shells are sprinkled over the vitamin powder (Meritt 1985). Experiments were conducted in previous studies and it was determined that the animals consume more food if the fruits and vegetables are offered in diced form (Meritt 1973). The sloths were fed daily and the daily food consumption by individual adult sloth was between 250 and 340g per day. Water was available at all times and sloths drank frequently and regularly. Average daily water consumption was 170cc (6 ounces) per animal per day (Meritt 1985).

The second study that had useful information about the diet of *Choloepus hoffmanni* was conducted in laboratory conditions on Barro Colorado Island, Panama Canal Zone (Goffart, 1971). In this study, *C. hoffmanni* was observed to eat bananas,

oranges, figs, lettuce, hibiscus, *Cecropia* leaves, spinach, kale, escarole, apples, and bread moistened in water (Montgomery and Sunquist, 1975). In both of these studies, the captive sloths lived for several years, which illustrates the adequacy of their diets (Meritt 1985, Montgomery and Sunquist, 1975).

We then interviewed nutritionists at the Oregon Zoo and Toronto Zoo to find more information about the diets of *Choloepus hoffmanni* in captivity. Neither of these zoos had any experience raising baby sloths, however they gave us lists of what the adult sloths (*Choloepus hoffmanni*) are fed in captivity. The diet at the Oregon zoo is:

- 7 pieces of leaf eater chow (monkey chow, Marian Zoological brand)
- 100g of primate diet
- 75g of greens (lettuce, Kale Spinach)
- 37g cooked yams
- 60g apple
- 20g carrot, green pepper or broccoli
- 13g of bananas or grapes

The diet at the Toronto zoo consists of:

- 200g apple
- 40g pear
- 40g avocado
- 60g banana
- 30g spinach
- 15g romaine lettuce
- 15g cantaloupe
- 10g broccoli
- 10g yam
- 15g hard boiled egg
- 25g soft gel (like zooprime primate diet)
- 15g fruit gel

We then contacted Aviarrios del Caribe, a sloth rescue and rehabilitation centre in Costa Rica. Judy and Luis Arroyo have been running the sloth rescue and rehabilitation centre for 10 years and have been successful in raising *Choloepus hoffmanni* babies so that they live past one year and are healthy. The diet they feed the sloths is as follows:

- Carrots (in slices)
- Green beans
- Sweet potato
- Cayote
- Platanos
- Green mangos
- High fibre bread (7-grain etc.) cut in cubes and mixed with water.
- Apples, pears and grapes
- Greens (spinach, lettuce etc.)
- Pedigree dogfood for puppies. (Dry pellets) They soaked the food in water to feed the sloths. Very good source of Protein.

Mango leaves
Cecropia leaves
 New pink leaves of Chocolate bush (the newer the leaves are the better).

An interview was conducted in person with Roger Crokin, an individual in Puerto Lindo, Panama, who successfully rescued and raised 3 sloths (*Choloepus hoffmanni*) whose mothers had been killed. The sloth's diet is as follows:

Long green beans (rinsed)
 Avocados
 Pops: Red hibiscus flowers
 Fresh white cheese (1.5 pds/week)
 Mangos (ripe) and young mango leaves
 Flowering vines (blue, white, yellow and pink flowers)
 Almond leaves and almond nut (not mature): rinsed in water so they are wet
 Hobo leaves (wild plum tree): compound leaves and small round fruit, eat leaves and fruit (must still be green and immature so that the pit is soft and chewable/digestible. They will not eat it if the center is hard and the fruit is sweet and ripe)

He prepares the almond leaves by chopping them and soaking them in a bowl of water so they are wet when the sloths eat them. The avocados are thinly sliced and the long green beans are also rinsed. The cheese is diced. he tried feeding them goats milk and powdered milk, but they did not like it and would not drink it.

Table 2 and 3 compile all the results for the diet of *Choloepus hoffmanni* from the literature, the observations of park staff and the interviews with zoos and rehabilitation centers for both store bought food in captivity and food from the forest. This provides a list of possible additional food that the PNM can now feed the baby sloths.

Table 2. Compiled results for store bought food fed to *C. hoffmanni* in captivity

Store Bought Food		
vegetables	fruit	protein/other
lettuce	apple	leaf eater chow (monkey chow)
kale	banana	primate diet
spinach	grapes	hard boiled egg with shells
Yam (sweet potatoes)	pear	high fibre bread
carrot	avocado	pedigree dogfood for puppies
green pepper	cantelope	fresh white cheese
Broccoli	platanos	meat mixture
green beans	green mangos	ground horsemeat
cayote	orange	canned dog food
escarole	fruit cocktail	moistened kibbled dog food
celery	fig	canned salmon
cooked white potato	fruit gel	fresh ground smelt
peas	melon	vitamin mineral powder

Table 3. Compiled results for *C. hoffmanni* food sources in the forest

Food from the Forest		
leaves	flowers	fruit
Almond (<i>Prunus dulcis</i>)	popos: red hibiscus flowers	Almond nut (<i>Prunus dulcis</i>)
mango (<i>mangifera indica</i>)	flowering vines (blue, white, yellow, pink)	fresh mangos (<i>mangifera indica</i>)
Chocolate bush	bombacaceae flowers	immature fruits of <i>Gustavia superba</i>
buds of Barrigon leaves	Poro Poro (<i>cochlospermum vitifolium</i>).	immature fruits of wild plum (Jobo) (<i>Spondias</i> species)
Liana leaf buds	Barrigon (<i>Pseudobombax septenatum</i>)	
liana		
Jobo (<i>Spondias</i> species)		
Espave (<i>Anacardium excelsum</i>)		
<i>cecropia</i>		

Discussion

Our results from the interviews with zoos and rehabilitation centres provided us with examples of complete and adequate diets for sloths in captivity. All of the diets contain a variety of fruits and vegetables (listed in Table 2), and these can be added to the diet of the *C. hoffmanni* in the PNM. Furthermore, all of the diets included a source of protein and fibre, which seems to be lacking in the diet of the captive sloths in the PNM. We therefore recommend that a source of protein such as hard-boiled egg, dog food for puppies, bread soaked in water, fresh white cheese or some kind of meat be fed to the captive *Choloepus hoffmanni* in the PNM.

Secondly, another problem may be that the sloths are not getting enough liquid and are dehydrated. In most of the interviews it was found that sloths were not only given water to drink but their food was also soaked in water before feeding, and this allowed them to intake water while they were eating. R.Crokin claimed that his sloths were not interested in drinking water and absorbed the water through the food. There is some debate in the literature about the need for sloths to drink (Goffart, 1971). According to Sixto Mequizana, a park employee, water intake through feeding is very important for the sloths. He explained that sloths eat Barrigon flowers when they are closed because they contain lots of water. He claims that during the dry season sloths eat between 2 and 6 AM because that is the time when there is dew on the leaves, which is a good source of water for the sloths. He claims that during the wet season the sloths start eating earlier, possibly as early as 6 or 7pm, because the leaves are wet when it rains and they do not have to wait for the dew. Therefore, it is important that the captive sloths at the PNM have enough water directly or through their food (Appendix C).

Thirdly, all of the interviews emphasized the fact that sloths need fresh greens and young tender leaves. The young leaves are much easier to digest, because cellulose is not yet well established in the leaf structure. This leads to another possible health problem with the baby sloths in PNM. Sloths are ruminants, having four stomachs, and the gastric content of *C. hoffmanni* is extremely rich in bacteria that can hydrolyse

cellulose (Goffart 1971). These enzymes break up cellulose into reducing sugars which are then transformed into volatile fatty acids (Goffart 1971). The enzymes that break down the cellulose in leaves is thought to be passed down to the young sloth from the mother (Montgomery and Sunquist 1978). It has been hypothesized that *Bradypus cuculliger* regurgitates food to feed its young at the weaning period (Goffart 1971). The problem with the baby sloths in the park may be that they did not receive the enzymes necessary to breakdown their food, and are consequently dying of starvation at 8 or 9 months, when the enzymes would normally be passed on to them. Jessica Rosas suggested feeding them a small portion of the feces of an adult sloth in order that they gain the proper enzymes, however sloth feces are very difficult to locate in the forest, as they only defecate every 8 days.

The sloth rehabilitation centre in Costa Rica, with ten years of experience raising baby sloths gave us some valuable suggestions about possible problems with the present diet of the baby *C. hoffmanni* in the park. Firstly, Judy Arroyo explained that the Gerbers baby food that is presently being fed to sloths may contain onion, which is poisonous to sloths. She recommended making baby food by mashing carrots or green beans, and after a month the sloths can eat solid food. Secondly, although the Chicago zoo recommended feeding the baby sloths evaporated milk, Judy found that cows' milk was not good for the baby sloths and when they were raised on evaporated milk they would usually die at an early age. Her solution to this problem was to switch to goats milk, which is much easier for the sloths to digest. They now feed their baby sloths only fresh goats milk or powdered goats milk, and never cows milk. The sloths should be fed goats milk up to 10 months and they fed some of their sloths goats' milk until they were 18 months old.

Behavioural Studies

There is a limited amount of information available on the behaviour of sloths, particularly *Choloepus hoffmanni*. Knowledge of behaviour, however, is an important first step for understanding the factors influencing these mammals and is therefore essential for the conservation of the species.

Ethograms are a useful tool in behavioural studies and are most often used in many studies similar to ours to provide a detailed description of every movement observed. The first step in constructing an ethogram is to go out in the field and make a daily checklist of all behaviours and their frequency. This has the main purpose of determining the actual frequency of rare or unusual behaviours since recording all behaviours avoids overestimating the unusual behaviours (Weatherhead, 1986). For example, when observing animals with slow movement patterns, such as the sloth, it often occurs that only ‘interesting’ behaviours such as eating or climbing are recorded and small movements such as stretching or moving heads and limbs are neglected. The study can thus become erroneous as small movements such as stretching consume energy much needed by sloths. Making a checklist can allow the researcher to construct a graph of the cumulative number of observed behaviors versus time, which according to the *Handbook of ethological methods* will asymptote after many hours of observation (Lehner, 1996). In our study, due to limited time and field equipment, we were not able to record all possible behaviours of the *C. hoffmanni* and *B. variagatus*. However we did complete a preliminary ethogram of the behaviours observed and more time and research is needed to complete an exhaustive list of all possible behaviours.

The second step in the construction of an ethogram is to provide an exemplary description of all observed behaviours in the list, which can be complemented by drawings.

1. Methods

1.1 Field work

A descriptive study of both species of sloths was carried out over the months of March and April in *Parque Natural Metropolitano*. All sloths studied were located either along or in close proximity of the trails.

The two sloth species being studied were located in the park with the aid of park rangers and by walking transects along the park trails. Park rangers were regularly asked for information on previous sloth spotting by tourists or themselves. Trees pointed out by these informants were scanned for sloths using binoculars. All paths in PNM were walked, with the exception of *Los Caobos*, which was still under construction at the start of our study. *La Cieneguita* and *El Roble* trails were walked more often than the others because sloth sighting were more frequent in this area.

Once a sloth had been located, the tree in which the sloth was found was noted for future reference and in order to allow us to return to the same site the following day. Behaviour was monitored from the ground. Sloths were monitored by one to three people at a time during different hours of the day in order to compare levels of activity and vertical location in the canopy. The individual sloths were monitored in the

morning, the afternoon and during the evening. This was usually done for a number of hours at time unless we lost sight of the sloth or intended on returning at a time when a higher rate of activity was expected.

We attempted to record behaviour at as many different hours of the day as possible. If sloths were repeatedly observed to be inactive at a given time, the next observations were made at different times. Night observations were initially conducted using flashlights and headlamps. A thousand candlepower spotlight was purchased in April in order to enable observations once night had fallen.

Using binoculars, identification of sloth species was initially based on the colour of the fur, *Choloepus hoffmanni* having a blonder coat with a dark brown face, and *Bradypus variegatus* having a grey coat. When possible, the two species were also differentiated using the number of claws on the paws of the front limbs.

Nicknames were allocated to each sloth found in order to assist with data collection and tabulation. Date, observers, sloth species, tree species, description of the tree, location of the tree in the park, location of sloth in the tree, hours of observation, number of sloths observed and descriptions of all movements, small or large, as well as the time at which each movement occurred were recorded.

Data was entered using a number of conventions. In terms of height, the canopy was divided into: lower canopy (< 10 meters), mid-canopy (10 to 20 meters) and upper canopy (> 20 meters) (Table 3 and 4). The time intervals in these two tables correspond to when sloths changed position along the vertical column. If they remained within the same canopy range the category title did not change.

1.2 Ethogram

The main behavioural categories chosen in our study were sleeping and resting, locomotion, care of the body surface and comfort movements, movements and a miscellaneous category. In order to describe each movement a general description of each of the subgroups of the above mentioned categories was given, and then a further description was given regarding each individual body part involved in the action. For example, in the case of scratching, we first provided a general description of the motion of scratching, then for each depending on what was being scratch, such as the shoulder, head, side or back, angles were provided to describe the movements of limbs to the desired area. Angles themselves were established with reference to the sloth main body (all vital organs) as the zero angle and any displacement from the body was an angle. The horizon was not chosen as a base or standard angle since sloths were most often not leveled with the horizon. We believed this constant readjustment would create confusion for the reader, whom would have no concept of actual position of sloth arm movements of 50, 60, or 70 degrees from the horizon. Drawings of the most frequently observed positions and movements were also provided in order to aid the reader visualize the actions described.

Angles were approximated after the fact, when compiling the ethogram. All movements were generalized and categorized. The data used was obtained from the behavioural observations recorded in our fields. Certain details were added from our recollections when constructing the ethogram.

2. Results

2.1 General Results

In this study we directly studied the behaviour of 6 sloths; 4 two-toed sloths and 2 three-toed sloths. All sloth height categories have been represented in tables below.

Most *Choloepus hoffmanni* were located at mid-canopy height during the morning observations (times in the charts below referred to as AM correspond to morning observations). The exceptions being one occurrence in which a sloth typically found at mid-canopy height was located in the upper canopy and another occurrence in which a disturbed pregnant sloth moved up to the upper canopy and remained there for two consecutive days. Thus 8 out of the 10 morning observations recorded sloths at mid-canopy height. Two-toed sloths observed in the afternoon were at mid-canopy height for 80% of the afternoon times. Five out of six evening observations of the two-toed sloths were characterized by movements to the upper canopy at sunset (Table 3).

In the case of *Bradypus variegatus*, the vertical displacement was much less consistent among the two sloths observed and there was no apparent relationship between height and time of day between the three individuals. Furthermore, only one of the three-toed sloths was detected at or after dusk (Table 4).

Sloths were located almost exclusively in Espave trees, particularly those that were large and with many lianas. On many occasions, two sloths of the same species as well as sloth of different species co-inhabited the same tree.

From data compiled from field observations (see Appendix A), we have determined that the most commonly observed behaviours were sleeping, occupying 25 out of a total of 32 hours of observation time or approximately 78%, followed by lifting and lowering limbs, moving of head, climbing and scratching. The frequency of each behaviour is defined here as the number of times each behaviour was noted in the ethogram. The percentage for *sleeping* rather than the number of times the behaviour was repeated was presented because the number of occurrence is a severe misrepresentation since sleeping/resting consumed much more time than a measure of frequency would suggest (Table 5).

Table 3: *Choloepus hoffmanni*

Nickname: George		
	Time (in hours)	Sloth height in Canopy (meters)
Date: March 12th	10:00am-12:00pm 2:00-4:00pm	mid-canopy mid-canopy
Date: March 14th	10:00am-1:00pm 7:00-9:00pm	mid-canopy undetected
Date: March 15th	6:30-8:00am 6:00-6:30pm 6:30-6:40pm 6:40-6:47pm 6:47-8:00pm	mid-canopy mid-canopy mid-canopy upper-canopy upper-canopy
Date: March 16th	6:10-8:10am 5:30-6:28pm 6:28-7:00pm	undetected mid-canopy upper-canopy
Date: March 17th	6:30-6:37pm	mid-canopy

	6:37-6:40pm	upper-canopy
Date: March 24th	1:30-1:35pm	mid-canopy
Date: March 25th	3:27pm	undetected

Nickname: Lance		
	Time (in hours)	Sloth height in Canopy (meters)
Date: March 18th	11:30am-12:10pm	mid-canopy
	12:10-12:30pm	mid-canopy
	5:00- 5:25pm	upper canopy
	5:25-7:00pm	upper canopy
Date: March 19th	11:30am-3:00pm	mid- canopy
Date: March 24th	11:30am-7:00pm	mid-canopy
Date: March 25th	3:13pm	undetected

Nickname: Gwen		
	Time (in hours)	Sloth height in Canopy (meters)
Date: March 18th	11:30am-12:30pm	undetected
	5:00-7:00pm	mid-canopy
Date: March 19th	11:30am-3:00pm	mid-canopy
Date: March 24th	11:30am-6:03pm	upper canopy
	6:03-7:00pm	upper canopy
Date: March 25th	3:13pm	undetected

Nickname: Margarita		
Date: April 11th	10:35-10:45am	mid-canopy
	10:45-10:50am	upper canopy
Date: April 13th	12:45-12:50pm	upper canopy

Table 4 : *Bradypus variegatus*

Nickname: Herald		
	Time (in hours)	Sloth height in Canopy (meters)
Date: March 16th	6:10-8:10am	upper-canopy
	5:30-7:00pm	undetected
Date: March 24th	1:36-1:40pm	mid-canopy
Date: March 25th	3:27pm	undetected

Nickname: Cosmo		
	Time (in hours)	Sloth height in Canopy (meters)
Date: March 24th	3:00-3:05pm	lower canopy
Date: March 25th	3:07pm	undetected

Table 5 : The number of occurrences of the most commonly recorded behaviours

Behaviour	Number of occurrences
Sleeping/resting	35
Limb movements	30
Head movements	29
Climbing	18
Scratching	15

Table 6. Species of trees mentioned in the interview and the number of interviewees that mentioned each one according to species.

Tree Species	C. hoffmanni	B. variegatus
<i>Cecropia</i> species (Guarumo)	4	4
<i>Anacardium excelsum</i> (Espave)	3	3
<i>Pseudobombax septenatum</i> (Barrigon)	3	3
<i>Luehea</i> species (Guacimo)	2	--
<i>Luehea seemannii</i> (Guacimo colorado)	2	1
<i>Cederla odorata</i> (Cedro cebollo)	1	1
<i>Apeiba</i> species (Cortezo)	1	1
<i>Ochroma pyramidale</i> (Balso)	1	1
<i>Spondias</i> species (Jobo)	1	--
<i>Interlobium cyclocarpum</i> (Corotu)	2	--
<i>Tabebuia rosea</i> (Roble)	--	1

Indirect Observations

The ethogram that we constructed included all the movements that we observed *Choloepus hoffmanni* making in the PNM. However, due to limited time and equipment, we were unable to observe all possible behaviours of the *Choloepus hoffmanni*. Our interviews with the park employees and the zoos and rehabilitation centres provided us with descriptions of more unusual behaviours of *Choloepus hoffmanni*. For example, Roger Crokin described the *Choloepus hoffmanni*'s response to predators. He said that when the sloth was threatened by predator, the sloth puffed up his fur like a cat and made barking noises. The unusual behaviours described in the interviews include swimming, defecating, eating, mating, urinating, crawling across the ground and predator response behaviour, and these descriptions are provided in Appendix B and C.

2.2 The Ethogram

Sleeping and resting:

- **Curled:** Sleeping/resting with body curled in a tight ball. The arms, legs and head tucked in, with the back resting on a surface.

- **Upside down:** Curled in a ball (see above) with the entire body rotated such that the head and neck area are facing the ground below. Arms and legs are tucked in the ventrum, and the back is facing up to the sky with little if any contact with tree or liana surfaces.

Upright: Curled in a ball with head, neck and back erect and rump resting on a tree branch.

- **Stretched:** Sleeping/resting with body stretched out horizontally.
 - On ventrum:** Stretched out with ventrum on branch or surface.
 - **Limbs gripping:** Lying on ventral surface with limbs gripping the branch below.
 - **Limbs hanging:** Lying on ventral surface with limbs dangling from the branch below.
 - On back:** Stretched out dorsally on surface.
 - **Limbs gripping:** Limbs gripping the branch above while resting. Depending on the position of the sloth relative to the above branch, the angle of grip will vary.
 - **Limbs hanging:** Limbs hanging freely while lying on back.
 - Sideways:** Lying stretched out on either side of the body with arms gripping over head and legs gripping the branch posteriorly.
- **Upright:** Sleeping/resting vertically with limbs wrapped around a vertical branch (or liana hanging from above), head at the top, no other surfaces of contact. The upper arm is elevated approximately 90° from the side of the body, while the forearm is tilted 30° away from the dorsal ventral axis.
- **Upside down:** Sleeping/resting vertically, with limbs wrapped around a vertical branch (or liana hanging from above), with body upside down (head at the bottom).
- **Sitting position:** Sleeping/resting in a seated position (with rump on the branch, but not in a tight ball). Arms and legs are not wrapped around any branches, twigs or lianas as in the *upright* position above. Instead the upper arms are leaning against the side of the body, while the forearms are bent approximately 50° from the upper arms. The forearms are thus leaning on the animal's lap.

Locomotion:

- **Climbing:** Ascending/descending the tree branch or liana.
 - Diagonal coordination:** Right arm moves at the same time as the right leg and left arm moves with left leg, alternating one side to the next.
 - Fore and hind limb alteration:** Pulling with arms; branch is gripped above the head with both arms and body is pulled upwards onto the branch with the arms.
 - Each limb individually:** A four-step process in which each limb move sequentially one by one.
- **Crawling:** Advance horizontally along the branch, alternating with back and front limbs. The move is initiated first by one arm then followed by the other, and then the alternating leg follows, and the stride is complete when the second leg advances.
- **Hanging:** Suspended from the branch or Liana using limbs (the mass of the body is in the air)
 - Upside down:** Hanging with head towards the bottom, the sloth's head is then the body part closest to the ground.

- **One leg:** Hanging upside down from one back leg.
- **Two legs:** Hanging upside down gripping the branch above with both legs.

Upright: Hanging from the branch or Liana in an upright position, head at the top.

- **One arm:** Hanging from only one of the arms.
- **Two arms:** Hanging from both arms.

Care of the body surface and comfort movements:

- **Licking:** Runs tongue back and forth along the fur.

Licking shoulder: During the course of this motion the head was rotated left or right and moved down, the tongue was extruded and run up along the fur as the head moved back up.

Licking left leg: The head was pulled in towards the abdomen, and turned towards the leg. Licking the fur along the leg was done in a back and forth motion as described above.

- **Stretching:** Extending limb, then bringing them back to a resting position.

Left arm: A full extension of the left arm along the horizon. The arm is initially straight along the side of the body, and then the entire arm is lifted up and passed over and past the head, making a 180° rotation. It is then held out and extended for a few seconds.

Right arm: A full extension of the right arm along the horizon, and the following follows from the above left arm description.

Left leg: An almost complete leg extension, in which the leg is at first curled into the ventral area, then pushed outwards posteriorly and extended into a stretch.

Right leg: Same as left leg, but with right leg instead.

Back and head: Lying on back and head is leaned back, as if the sloth is attempting to look around upside down. The frontal part of the neck is completely stretched out.

- **Scratching:** Abrading or scraping the surface of the fur in a back and forth motion making use of claws. In the case of *Bradypus variegatus* scratching is done with three claws, whereas for *Choloepus hoffmanni* it is done with only two claws.

Neck: Scratching of the neck area is done mostly with the arms (either right or left) and at times with the back legs. When scratching with arms, the forearm is bent 90°. The entire arm is then lifted approximately 50°, and the hand is placed on the neck. At this point scratching (see above) begins.

Shoulder: Use of arm and hand of opposing side of body (e.g. if the left shoulder is being scratched, the right arm is involved in the motion). The forearm is first flexed 90° and rotated towards the ventrum approximately, while moving the entire arm up and across the body. This final motion involves approximately a 45° angle arm rise to the shoulder.

Side: The upper arm (from the shoulder to the elbow) remains fixed along the body. Only the forearm is moving, and is displaced approximately 30° outward

(from the side) and the hand and claws are twisted downward. As the hand is lowered, the claws contact the lower side and scratching begins.

Stomach: Scratching along the ventral area is similar to scratching along the side (see above) except the forearm is lifted upward (along the side) approximately 45°, then the hand is bent in towards the abdomen.

- **Yawning:** The upper and lower jaws are moved in opposite direction, opening the mouth wide.

Movements:

- **Open eyes:** Upper eyelids lift completely.
- **Close eyes:** Upper eyelids are lowered until contact is made with lower eyelids.
- **Squinting eyes:** Upper eyelids are lifted only halfway, leaving a slight opening that exposes part of the sloth's eyes.
- **Lifting/ Lowering:** The action of moving different body parts against gravity when lifting and with gravity when lowering.
 - Left arm:** The sloth moves its left arm from a position along the side of its body to an approximate 90° angle (parallel to its head). In most cases the arm is twisted slightly inward (towards the body). The angle could vary either reaching more than 90° for example when grabbing something overhead, or less than 90° in other cases. The forearm is usually slightly bent.
 - Right arm:** Same as above, only the right arm is doing the movement as opposed to the left.
 - Left leg:** The sloth first extends its left leg out from his body, in the posterior direction. This leg extension results in the leg going from a completely bent position, where the back calves are contacting the quads, to one where the angle between the two is almost 180°. Once this angle is reached the sloth will either lower or raise the entire leg.
 - Right leg:** Same as description of left leg above.
- **Body shift:** The sloth has been observed to complete a full body rotation of 180°, such that the head and butt reverse position.
- **Grabbing branch or liana:** Contact of foot or hand with the corresponding tree part and complete surrounding of it with the animal's two claws if referring to the hand or three claws if referring to the foot. The claws are curved and on average of about seven and a half centimetres.
 - With arms:** The arm is lifted (see above) to an angle that depends on the position of the liana or branch, then upon contact the sloth places its hand on the branch or liana and then squeezes it by wrapping its fingers/claws slowly around. Its hand or paw is soft in appearance (similar to human skin).
 - With legs:** Same as grabbing with arms.
- **Sitting up:** This movement is carried out either from pulling on a branch/liana with the arms or from pushing on the main branch with arms. The head is placed in

completely vertical position, erected, and the back is moderately straight, and often times leaning on a large branch or liana.

- **Head movement:** Displacement of the entire area above and beyond the shoulder, using neck to help.

 - Lift:** Movement up along the vertical column

 - Lower:** Movement up along the vertical column.

 - Turn:** Twisting of the head either right or left along the horizontal.

- **Gripping:**

 - Back leg:** Similar to grabbing; however the motion involves a lift or pull towards the branch or liana. There is thus tension created and not solely contact.

 - Foreleg:** Same as directly above except with the legs.

 - **With whole arm:** Wrapping of entire arm around a branch or liana.

 - **With hand only:**

- **Curling up:** Lowering in all limbs towards the body, and tucking them in together.

Miscellaneous:

- **Sniffing:** The sloth's nostrils flare up and down, which causes the top part of the nose to crumple up slightly forming a small bump as it flares up. This motion is repeated numerous times and mucus is sometimes be excreted.

- **Breaking small branch:** Grabbing the branch (see above) and pressing harder with outer claw, pulling in towards the body the arm or leg at the same time, thereby creating a force strong enough to snap the branch.

- **Watching:** Eyes are opened (see above) and the sloth's head moves left and right (see above) following the motion of the observer as she or he moves, clearly demonstrating that the observer is perceived.

- **Reaching towards other sloth:** Lifting arm (see above) and moving it in the direction of another sloth demonstrating a response or stimulation from the presence of the other sloth.

Figure 1. Sleeping/resting on back – limbs gripping



Figure 2. Sleeping on back – limbs hanging



Figure 3. Sleeping/resting upright



Figure 4. Climbing – Fore and hind limb alteration



Figure 5. Stretching – back and head

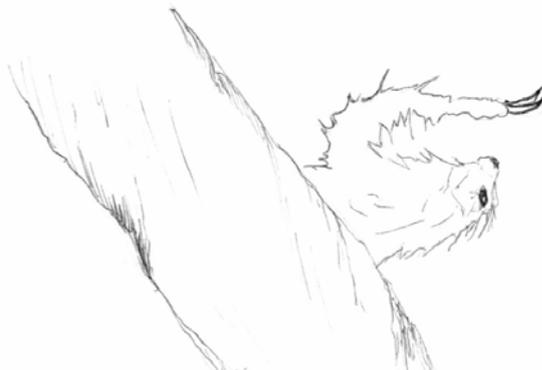
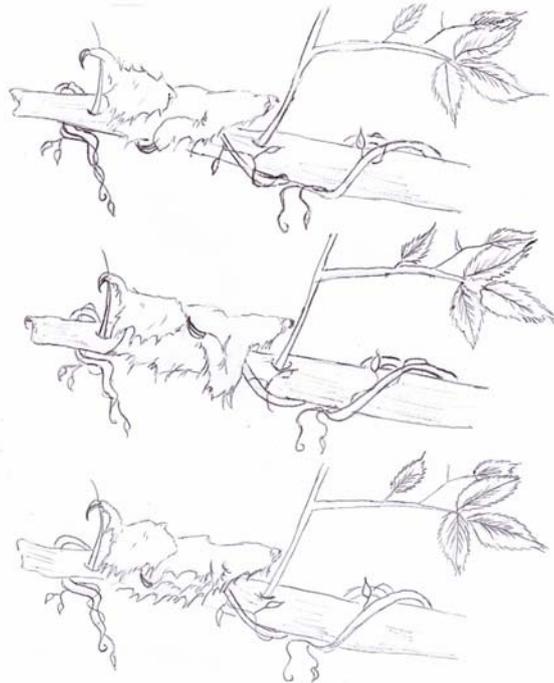


Figure 6. Scratching Side



3. Discussion

3.1 Vertical stratification

In past studies a clear correlation was made between height in the forest canopy and time of day. These studies used sloth radiotelemetric data on sloth body temperature, ambient temperature, and sunlight intensity on the surface of the sloth and two strata of the forest canopy (Montgomery, 1978). Montgomery claimed that “ Three-toed sloths behaviourally thermoregulated by moving in the canopy to places where the light intensity at their body surfaces was increased when they were cold and decreased when they were warm and their temperature was still increasing” (Montgomery, 1978). This may help to explain some of the behaviour observed in the PNM.

The vertical displacement of the sloths was dependent on both time of the day and the forecast. At sunrise and sunset the sloth was at mid height. As solar radiation decreased either after sunset or on rainy days, the sloth ascended the canopy. In Montgomery and Sunquist it was found that the sloth was lower in altitude from dawn until 8 AM, then began moving at 8 AM higher up in the canopy about midway from the bottom to the crown. The sloth then remained at this height until dusk. Our observations differed in the fact that in every morning observation done, the sloths were never mobile and appeared to have chosen their positions before sunrise (see Appendix A). In accordance however to the article, we found that almost all sloths observed between 6 PM to 8 PM started moving up the canopy at sunset. It seems likely that the sloths began moving at this time because their body temperature dropped as the sunlight faded and movement could assist in thermoregulation. Furthermore, the nocturnal two-toed sloths may have ascended to the canopy to eat the new leaves.

Most often on periods following or leading up to rainfall, sloths were found to be low in the trees. Possible reasons for this behaviour might have been that they were attempting to seek cover from the oncoming rain or that there was no reason to expend energy to climb to the top of the canopy if the sky was overcast. However, sloths were no longer observable once the rain had started. One explanation might be that they were seeking cover in dense foliage and could not be seen. Another hypothesis relates the fact that the body temperature of sloths tends to be several degrees lower on rainy days (Montgomery, 1978). The sloths may therefore have ascended to the top of the canopy, out of sight, in an attempt to increase their body temperature by collecting the little solar radiation that was available

3.2 Habitat Selection

We hypothesize that the main reason for sloth selection of Espave trees was because it maintains its leaves throughout the dry season providing camouflage and an ideal habitat for sloths. The presence of large branches along the trunk from a height of about 7 meters to the top of the canopy could enable sloths to move freely up and down the tree and thus thermoregulate as well as offering a resting and sleeping spot. Montgomery (1975) notes the importance of the use of trees for support and concealment of the two-toed sloth. Espave grow to be quite large they are therefore capable of supporting an abundant supply of lianas, which is essential to sloth survival (Montgomery et al, 1978). Montgomery et al. (1978) noted that “...*two-toed sloths chose trees with masses of lianas which would conceal them while they slept and warn them of the approach of potential predators by feeling the vibration along the lianas*”. The abundance of lianas could enable the horizontal displacement of sloths from one tree to the next. It would be interesting to repeat the study during the wet season because park rangers informed us that the sloths are more dispersed among different tree species during the wet season (Sixto Mequizima, personal communication).

Differences in habitat selection between both species of sloth studied were also observed. Three toed sloths were generally found lower in the canopy in more exposed areas than the two-toed sloth. For example, one two-toed sloth was located at the tip of a branch amongst very few leaves, in a tree with almost no lianas. This type of habitat selection disparity between three-toed and two-toed sloth is quite common and is mainly due to their diurnal versus nocturnal life histories, respectively. Since sloths sleep during the day, they are in general much more hidden in order to hide from predators while they sleep (Montgomery, 1978).

During the course of the study, sloths of the same species as well as of different species were found co-inhabiting the same tree. This is very different from previous findings that sloths are solitary and rarely share their habitat with other individuals besides their young (Montgomery, 1985). This may have resulted from the fact that our study was conducted in the dry season, leaving less potential trees with leaves for the sloths to occupy. Although trees such as Espave are common in the park, not all of them contain a high abundance of lianas and therefore the number of potential habitats is further reduced.

A large number of trees inhabited by sloths, as noted in the interviews, are pioneer species (Montgomery and Sunquist, 1978). These trees are therefore likely to be in greater abundance along trails and roadsides making transects along the trails an

effective way of locating sloths. However, this proximity to the road may lead to increased car related casualties for sloths thereby hindering conservation efforts.

3.3 Predator avoidance

The following interesting sloth behaviour is that of a pregnant female sloth. As she was observed and approached, the female climbed up high towards the canopy crown. Her behavioural response to our presence was much more pronounced than all previously studied sloths, which mostly only watched us and did not appear to be particularly bothered by our proximity to their tree. This sloth on the other hand quickly ascended the tree after our arrival. The female could possibly have behaved as such from the motherly instinct amongst mammals to protect their kin.

3.4 Ethogram

Resting was the most common behaviour observed in the study and is necessary for a mammal with low metabolism (Goffart, 1979). Lifting the head is important in order to scan for predators and may have occurred at a higher frequency than usual due to our presence. Scratching and movement of limbs may be a method of grooming and removing parasites and climbing is essential for finding food and thermoregulation as described above.

The ethogram generalized the movements and behaviour of the sloths in the study. It is important to note that the movements listed may have differed slightly from one individual to the next. However, a generalized list of actions is useful because it allows the energy expenditure and allocation to be determined and appropriate diets to be devised for the species in general. The amount of energy in kcal used up on a daily basis is an important aspect that should be studied in the future. Furthermore, a description of a behaviour in the park can be used to compare to other locations such as BCI that are better protected in order to determine the impacts of disturbances on sloths. This could contribute to more effective conservation efforts for the species.

Some of the information contained in the ethogram, particularly the angles, was approximated after the observations in the field had been completed. In future studies, it is important to incorporate as many details into the field notes on site in order to increase accuracy.

3.5 Limitations of the methods

Sloths are extremely well camouflaged and difficult to see particularly at night. We initially conducted our night observation with limited lighting and therefore often lost track of the sloth's whereabouts after sundown. Once we began using the spotlight, we were better able to observe behaviour at night. However, the spotlight battery lasted only a half hour and was only purchased late in the project. A greater number of night recordings could have been done had the light been in use earlier. This might have allowed us to determine feeding behaviour of the nocturnal *Choloepus hoffmanni*. Furthermore, the light may have disturbed the animals, thereby altering their behaviour. Therefore, radio marking the two-toed sloths may be a more effective way of keeping track of the animal (Montgomery and Sunquist, 1978). Analysis of fecal deposits may be useful in determining diet (Montgomery and Sunquist, 1975).

It is possible, although unlikely, that 2 of the sloths recorded as individuals may have actually been the same animal. Five of the sloths observed were definitely different because they were all observed on the same day at similar time. However, we cannot be certain that Margarita was a different individual because it was seen during a separate time. Radio marking would be one way of avoiding this problem.

Sloth Abundance and Distribution

The IUCN, on the Red List of Endangered Species, has been unable to categorize *Choloepus hoffmanni* due to data deficiencies. Although they recognized that this species may be threatened, they have so far been unable to protect the species because of lack of appropriate data on abundance. The development of a feasible census method for this cryptic species would therefore be a huge contribution to their conservation. Not only would it provide the means to establish the state of the population in *Parque Natural Metropolitano* but could potentially allow for larger scale data to be made available to the IUCN (IUCN, 2004).

There is currently a pilot project underway in Brazil to determine the feasibility of conducting a census of sloths (Adriano Chiarello personal communication to Rafael Samudio). In order to determine the potentiality of using this method to census sloths in the *Parque Natural Metropolitano*, one pilot plot was examined.

1. Methods

1.1 Census

The purpose of the experiment was to determine how useful the methods being developed in Brazil would be for performing a sloth census in the park in the future and we therefore specifically chose a location that would maximize the likelihood of encountering a sloth. The site chosen for the pilot plot was along the Mono Titi trail in *Parque Natural Metropolitano*. We chose a location with a high density of large trees including a high abundance of species that have been observed, from our experience and previous studies, to be ideal habitats for sloths.

The site had a high abundance of *Anacardium excelsum*, a species in which sloths had been located numerous times during our behavioural studies. In the first 50 meters, the understory was relatively scarce. The plot crossed over the path after 55 meters. The understory on the other side of the path was considerably denser and the area had fewer large trees. The site was approximately 10 meters past the canopy crane relative to the main entrance of the park and 4 meters from the trail.

The methodology being tested makes use of a 25 meter by 100 meter rectangular plot (Rafael Samudio, personal communication). The area was sectioned off using a 50 meter measuring tape and 2mm cord. Within the plot transects were walked along the length of the area. A small machete was used to cut the understory along the path. In our case, four individuals walked the length of the plot with approximately 6 meters between each person. A compass was used in order to ensure that a straight line was walked. The branches of trees on the plot, especially key species such as *Anacardium excelsum* and species of *Cecropia* and trees with many lianas were scanned for sloths using binoculars. The plot was walked between 11:30 am and 12:15 pm on April 13th, 2005.

1.2 Interviews

Six individuals working at the park, mostly park rangers, were asked a series of questions including how many sloths they saw in an average week and how much time they spent walking along the paths in the park (Appendix C). This data, along with

personal observations of the number of sloths seen according to the time we spent walking on the trails (not necessarily while directly looking for sloths), was used to gain an estimate of the sampling time required to observe sloths.

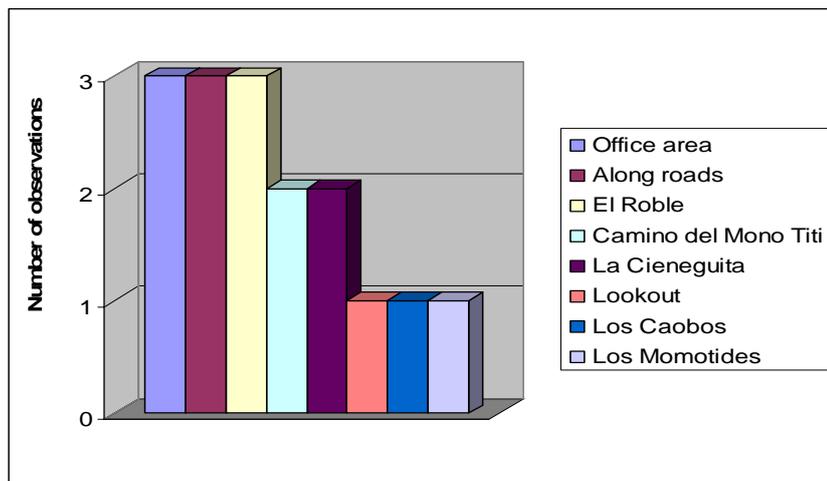
The rangers were also asked what the most common locations of their sightings were and a number of the staff was informally asked which species were observed in order to gain a better understanding of the relative abundance of the two and three toed sloths in different parts of the park.

1.3 Personal Observations

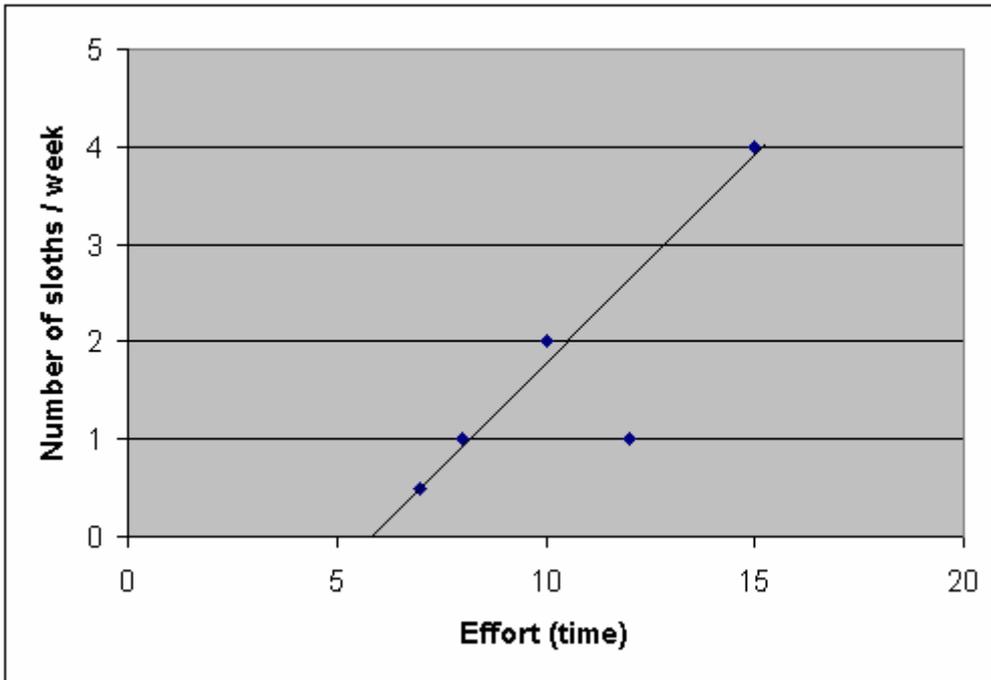
A preliminary estimate of the abundance of sloths in the park was made. This was done using data obtained on the 24th of March, 2005. On this day, 4 individual sloths were present along the Roble and Cenguita paths at the same time in a 70 km² area. This was the greatest number of individuals recorded in one area during our study and was therefore used to calculate a rough estimate of the possible upper limit of sloth density in the park. An imaginary 70 km² plot encompassing the 4 sloths was drawn and used to extrapolate the abundance in the park as a whole (Appendix E).

2. Results

Setting up the plot required approximately an hour and a half and surveying the plot took 45 minutes. No sloths were located during the process although 4 Titi monkeys were seen when we reached the park path. Using data obtained during the behavioural study, the maximum number of sloths within the parameters of the park is 151 individuals or 0.06 sloths per kilometre squared. Park staff indicated that *Bradypus variegatus* is generally seen more often than *Choloepus hoffmanni* (Appendix C). The forest around the main office, along the Juan Pablo road and the El Roble trail were the most common areas to find sloths (Graph 7). Sloths are less common along the Caobos trail (Sixto Mequizama, Appendix C) For a person with experience locating sloths, such as a park ranger or practiced sloth researcher, a minimum time investment walking transects of 8 hours a week was necessary in order to locate a single sloth. The number of sloths observed per week increased linearly with the amount of effort invested (Graph 8)



Graph 7 . Common areas where sloths have been found according to interview and the number of people that noted each location.



Graph 8 . The average number of sloths observed according to the time spent walking along the trails of the PNM.

3. Discussion

It took approximately two and a half hours to census one plot and no sloths were seen during the survey. This indicates that a census of sloths for the entire park would require a large number of plots to get an accurate estimate of abundance requiring considerable amounts of time and effort. Whether or not the actual methodology of using a 25 by 100 meter plot is feasible remains uncertain. Another pilot study should be carried out before the undertaking of a larger scale census.

The understory was relatively scarce along the first 50 meters of the pilot plot and walking was therefore not hindered. In areas with more small plants and bushes each plot may take even longer than two and a half hours to survey. The second half of the plot may not have had as many potential habitats for the sloths and the likelihood of observing the species was likely less than in areas of the park with a greater abundance of large trees. Furthermore, much time was spent attempting to avoid the branches of small trees and a larger and sharper machete may therefore have been useful in order to decrease the time spent looking at the ground. Noise created by trampling over the understory may also have caused the sloths to hide and kept us from observing any sloths that were present.

The plot was surveyed in late morning and early afternoon when the sloths are most likely basking in the sun at the top of the canopy making it difficult to see them (Sunkuist and Montgomery, 1973). The pilot study should be repeated earlier in the morning when sloths are more likely to be lower down in the trees.

There tends to be more pioneer species along disturbed paths and sloths are said to prefer these species (interviews, personal communications). We therefore, chose a plot that crossed over the Mono Titi trail in the hope that there would be more potential

habitats within the plot. We were unable to determine if sloths were concentrated along the path because no sloths were observed within the plot.

In order to perform a census only plots with large trees and along trails should be surveyed for sloths in order to estimate abundance in the forested area of the park. Conducting a census of the entire park area would be impossible due to time requirements and it is unlikely that many sloths would be found in areas where the forest is too young to contain large trees. Plots within the older growth forest could be chosen at random.

Effective camouflage and lack of movements as well as the high elevation in trees render sloths extremely difficult to locate. A census of actual sloths in the park would therefore most likely lead to an underestimation of abundance in the park. The data obtained could be supported by an additional census based on counts of fecal mass deposited by sloths in a known time period. This type of census would be feasible given that sloth feces require several months to decompose (Montgomery and Sunquist, 1975). Furthermore, it may be useful to mark the sloths that have been counted. The census would require numerous days of work as a result of the low density of the species and recounting might therefore become an issue. This would be especially important in the case of the *C. hoffmanni*, which usually changes trees from one day to the next (Montgomery and Sunquist, 1978). The number of sloths observed also depends on the time of year and season; sloths are easier to find in the dry season when trees have less leaves (Jessica Rosas, personal communication). The feasibility of the census would therefore be greater during the dry season in Panama.

The approximation of the density of sloths in the park (maximum = 0.06 sloths per kilometre squared) is a rough estimate based solely on data collected on one day in one particular location with trails and a large abundance of pioneer species that does not necessarily represent the physical attributes of the remainder of the park. However, this area in which the sloths were found contained the types of habitats that would bring sloths to the area. Therefore, it was an appropriate choice for determining a rough maximum density as the highest density would most likely be found at this location. A census with many plots would be required for a more accurate estimate. Glanz (1990), calculated a density of *C. hoffmanni* to be 100 per kilometre squared and the number of observations per hour was recorded to be 0.06. However, BCI is a considerably more protected area than the park and the accuracy of these values is not certain.

Park rangers indicated that sloths were found mostly along the trails where the abundance of key species was observed to be the greatest as noted in the behavioural section (Table 6). Fewer sloths may have been observed along the *Caobos* trail because there were many palm species, which are not usually inhabited by sloths, and there seemed to be less *Cecropia* and other pioneer species. The locations noted by the greatest number of interviewees were in areas close to where people worked and spent most of their time (around the office, along the *Roble* trail). The observation that sloths are more common in these areas may therefore be due in part to sampling effort; people are more like to see sloths there because they spend more time observing the trees in the area. However, the forest in these areas is disturbed and may have a greater abundance of pioneer species preferred by the sloths. Determining how much time was spent on each individual trail would have increased the accuracy of the results obtained.

Greater amount of effort logically led to an increased number of sloths seen. Although all people questioned regarding the number of sloths observed per week had ample experience in the park and identifying wildlife, some individuals may have been more skilled at locating sloths than others. Characteristics of the observer such as ability, experience and fatigue as well as their rate of travel will influence sightability.

This led to a large discrepancy between certain observers and others for similar amounts of effort (Graph 7). A larger sample size of observers would therefore be useful in order to determine an average value for observability and time required to locate sloths. The minimum of 8 hours needed to locate a sloth is not an estimate for all people, but only a rough estimate for park rangers walking through the park. This value would likely be less had the observers been purposely looking for sloths the entire time and not patrolling the paths or giving tours. Each individual sloth may have been observed more than once and may have been considered independently. Locating a large number of individual sloths may therefore require more effort than indicated on the graph. Recounting is difficult to avoid without marking the located animals.

Eco-tourism

According to Bill Weber from the Wildlife Conservation Society Eco-tourism requires some sort of flagship species attraction such as the mountain gorillas, the monkeys, tapirs, toucans, macaws, anteaters, and coatis. There is no doubt that the sloth can be categorized as a flagship species since many come to Panama to see the sloth (advertisement from Smithsonian Research Institute). PNM provide guides however this alone cannot guarantee sloth location. For this reason we wanted to provide the park with an idea of sloth abundance, location, and behaviour. A sloth information booklet, providing procedures to locate sloths along the main trails was also given. Furthermore, we painted a park for children near the entrance of the park in order to increase the attractiveness of the park and to provide a venue for the *Feria Ecologica* held at the park on the 24th of April, 2005.

General Conclusions

Choloepus hoffmanni and *Badypus variegatus* are important flagship species for *Parque Natural Metropolitano* that are currently being threatened by disturbances in the park. Their abundance in the park may reflect the current status of populations of these species throughout Central America. It is therefore imperative that new methods be developed to study behaviour and abundance of this cryptic animal in order to improve our understanding of the factors contributing to their current state.

The study of sloths in the future will require a great deal of patience, experience and the use of technology such radio tracking. However, promising new methodology for conducting a census is currently being devised and new technology geared at surveying mammals is being made available every year.

Hopefully, with the recommendations obtained from the various zoos, rehabilitation centers and park staff, the infant sloths of the park will have a greater prospect of surviving thus moving one step closer to the conservation of the species.

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Appendix A. Field Notes for sloth behaviour studies

Date: Saturday March 12th, 2005

Observers: **Annie and Zofia**

Sloth species: *Choloepus hoffmanni*

Nickname: **George**

Tree Species: Espave

Description of tree: Large tree, about 30m high, diameter of 1 meter, contains lots of green leaves, flowers and lots of Lianas.

Location in Park: On the left of *La Cieneguita* trail (see map).

Location of sloth in tree: Mid-canopy height, approximately 15m above the ground, on along a main branch, 2-3 meters from the trunk.

Hours of observation: **10:00am to noon, 2:00 to 4:00pm. Total hours observing: 4**

hours.

Number of sloths observed: 1 sloth

Movements: No movement observed, sleeping in the same position.

Date: Monday, March 14th, 2005

Observers: **Morning: Gen and Zofia, night: Annie and Zofia**

Sloth species: *Choloepus hoffmanni*

Nickname: George

Tree Species: Espave

Description of tree: Same tree as March 12th

Location in Park: See map for March 12th

Location of sloth in tree: At a forking point, between two branches, among a bundle of lianas at mid-canopy height or about 15 meters high. Very close to March 12th location but approximately 1 meter off to the observers' rights.

Hours of observation: **9:00am to 1:00pm, 7:00pm to 9:00pm. Total hours observing: 6 hours.**

Number of sloths observed: 1 sloth

Morning movements:

Time	Actions
9:15am	sleeping, upright position with head to our right .
9:30am	lowering left arm, lowering and lifting head, licking left leg or branch.
9:50am	sleeping stretched sideways (see Figure), lowering and lifting head, body shift to the right.
10:15am	lifting and lowering left leg.
11:15am	no movement.
12:35pm	sleeping.

12:39pm	lifting right arm .
12:45pm	sleeping, curled up.
12:53pm	lifting right leg.

Night movements: No movement, the sloth was not found.

Date: Tuesday, March 15th, 2005

Observers: **Morning: Annie and Zofia, night: Annie and Zofia**

Sloth species: *Choloepus hoffmanni*

Nickname: George

Tree Species: Espave

Description of tree: Same tree as March 12th

Location in Park: See map for March 12th

Location of sloth in tree: Almost the same position as March 14th, but slightly more to our right (< 1 meter). He is still amongst a bundle of lianas.

Number of sloths observed: 1 sloth

Hours of observation: **6:30 to 8:00am, 6:00-8:00pm. Total hours: 3.5 hours.**

Morning movements: No movement between 6:30 and 8:00am. Sloth is in an upright sleeping position (see Ethogram illustrations for figure)

Night movements:

Time	Actions
6:30pm	sleeping, curled upright
6:35pm	opening eyes, hanging, upside down, two legs, facing ground stretching left leg licking shoulder climbing, fore and hind limb alteration hanging, upright, right arm stretching, left arm pull-up, all limbs climbing, each limb individually climbing, fore and hind limb alteration stretching, left leg stretching, right arm
6:37pm	crawling, to the left (towards trunk), on a large branch
6:40pm	20 meters up in the canopy, went out of sight.
6:47pm	in upper canopy, cannot see it.

Date: Wednesday, March 16th, 2005

Observers: **morning: Gen night: Annie and Zofia**

Sloth species: *Bradypus variegatus*

Nickname: Herald

Tree Species: **Espave**

Location of sloth in tree: 1/2-1 meter from the top of the canopy crown.

Observers: **night: Annie and Zofia**

Sloth species: *Choloepus hoffmanni*

Nickname: George

Tree Species: Espave (same tree as Herald)

Location of sloth in tree: About 1-2 meters higher than on March 15th.

Description of tree: same tree as March 12th

Location in Park: See map for March 12th

Number of sloths observed: 2 sloth (but at separate times)

Hours of observation: **6:10 to 8:10am, 5:30-7:00pm. Total hours: 3.5 hours.**

Morning movements:

Time	Actions
6:10am	sleeping, curled up
7:55am	stretching left arm

Night Movements:

Time	Actions
5:30pm	sleeping, curled upright
6:03pm	open eyes head turn sleeping
6:04pm	left arm lifting
6:05pm	left arm lowering
6:07pm	left arm gripping liana, sleeping
6:23pm	left arm lifting, hanging from left arm
6:24pm	scratching side with right arm
6:25pm	scratching right shoulder with right leg, hanging with left arm scratching left side with left arm climbing, diagonal coordination crawling, each limb individually, to the left along main branch towards trunk.
6:26pm	stopped crawling, scratching head with left paw
6:27pm	crawling slowly reaching right arm towards branch grabbing branch with right arm climbing, each limb individually and fore and hind limb alteration
6:28pm	climbing on branch and then Lianas, went out of sight

6:30pm	sloth located, still climbing
6:32pm	crawling slowly to the left
6:40pm	hanging, upright, left arm scratching belly, right arm
6:42pm	hanging upside down, two legs
6:43pm	crawling on small branches

Date: Thursday, March 17th, 2005

Observer: **Gen**

Sloth species: *Choloepus hoffmanni*

Nickname: George

Tree Species: Espave

Description of tree: Same tree as March 12th

Location in Park: See map for March 12th

Location of sloths in tree: Same position as previous night observation.

Number of sloths observed: 1 sloth

Hours of observation: **6:30-6:40pm. Total hours: 0.16 hrs (10 minutes).**

Night movements:

Time	Actions
6:36am	stretched out body, lifting left arm.
6:37am	climbing.
6:40am	lost from sight.

Date: Friday, March 18th, 2005

Observers: **Annie and Zofia**

Sloth species: *Choloepus hoffmanni*

Nickname: Gwen and Lance

Tree Species: Espave

Description of tree: Large tree, about 27m high, diameter of 0.8 meter, as the previous Espave it contains lots of green leaves but much less Lianas than the above mentioned Espave. The sloths in this tree are usually located at branching points.

Location in Park: Along the *El Roble* path, about 500 meters from the path entrance, before the alligator pond. When entering the forest from the main entrance, this Espave tree is located to the right, immediately before a curve in the path leading up to a small bridge made out of a rusted metal sheet.

Location of sloths in tree: Both sloths are located at branching points in the tree, very close to on another about 10 meters up from the ground. Lance is below and Gwen is above him, they are very close to one another, practically touching.

Number of sloths observed: 2 sloths

Hours of observation: **11:30am to 12:30pm, 5:00pm to 7:00pm. Total hours: 3 hrs.**

Morning movements:

LANCE

Time	Action
11:50am	sleeping, stretched, upside down. Legs wrapped around main trunk, arms gripping lianas
12:05pm	eyes opening head lifted curled body head lowered (tucked into body) sleeping, curled on back
12:06pm	head turn
12:07pm	watching observer
12:10pm	climbing tree, fore and hind limb coordination sleeping, stretched, upright, back leaning against trunk of tree
12:14pm	moved head towards tree chin on trunk, head facing up
12:15pm	moved head left
12:17pm	moved head more left

Night Movements:

Lance and Gwen sleeping less than 1 meter from each other, almost touching.
Around the main trunk of the tree next to the Espave about 20m off the ground.

LANCE

Time	Actions
5:00pm	sleeping, stretched, upside down, legs wrapped around trunk, arms in lianas
5:25pm	reaching towards other sloth with right arm, touched gently climbing tree, fore and hind limb coordination
5:28pm	stopped climbing
5:29pm	climbing again
5:30pm	climbed into the next tree
5:44pm	sleeping in the canopy
5:50pm	sleeping 10m higher than Gwen, curled in dense leaves of upper canopy
6:28pm	shifted body
6:37pm	sun is setting, can no longer see them, no motion

GWEN

Time	Actions
5:00pm	sleeping position, higher up than Lance.
5:29pm	same sleeping position, does not respond to Lance
5:47pm	same sleeping position, no movement
6:28pm	moved right arm

Date: Saturday, March 19th, 2005

Observers: **Annie and Zofia**

Sloth species: *Choloepus hoffmanni*

Nickname: Gwen and Lance

Tree Species: Espave

Description of tree: See March 18th.

Location in Park: See Friday, March 18th.

Location of sloth in tree: Lance is sleeping along a main branch (broken off at the end), which is protruding from the tree towards the road (Corridor Norte). Gwen is about 1-2 meters higher up, to the right of the observers, amongst a bundle of death leaves.

Number of sloths observed: 2 sloths

Hours of observation: **11:30am-3:00pm. Total hours: 3.5 hours**

Movements:

LANCE

Time	Actions
11:53am	sleeping, stretched, upside down, legs gripping main trunk.
11:55am	lifting and lowering head
12:04pm	opened eyes scratching side with right arm
12:06pm	sitting up, sleeping in sitting position
12:15pm	sleeping, stretched out onto back
1:10pm	hanging, upside down, 2 legs
1:20pm	moved left arm across body
2:39pm	stretched neck moved head shifted body position
2:45pm	sleeping

GWEN

Time	Actions
11:53am	sleeping, curled, upside down, in a pile of dead leaves
12:16pm	moving head and right arm
12:18pm	moved left leg
1:26pm	moved left leg
2:45pm	sleeping

Date: Thursday, March 24th, 2005

Observers: **Annie, Zofia and Gen**

Sloth species: *Choloepus hoffmanni*, *Bradypus Variegatus*

Nickname: Gwen, Lance, George, Cosmo and Herald

Tree Species: Espave

Description of tree: Same as March 18th for Gwen and Lance, same as March 12th for George and Herald. As for Cosmo the tree species is again Espave, it is approximately the same height as the two others, between 20 to 25 meters high. It has thinner branches than the other two Espaves but much more foliage. There are practically no lianas in this tree.

Location in Park: Same as March 18th for Gwen and Lance, as March 12th for George and Herald. The Espave in which Cosmo is located is before the entrance to the *El Roble* path, to the left 150 meters, bordering the grass field (which is behind the museum). The tree is in fact very close to a large birdcage.

Location of sloth in tree: Lance and Gwen are located about 15 meters apart, and Lance which is the lower of the two is about 15 meters above ground. Lance is almost at the tip of the same branch as observed during previous observation, Gwen is up among litter. George is still at the same place in the tree, and Herald is among dead lives. Cosmo is on a branch protruding towards the field at about 8-10 meters up from the ground. He his sleeping on a branch among green leaves (quite visible).

Number of sloths observed: 5 sloths

Hours of observation: **11:30am to 7:05pm . Total hours observing: 7.5 hours.**

Movements:

LANCE

Time	Actions
11:40am	sleeping, stretched, upside down, gripping main branch with back legs
11:47am	lifting head stretched right arm
11:48am	scratching neck with left arm
11:49am	sleeping
11:50am	opened eyes lifted head
11:51am	lowered body from tree branch hanging, upside down, 2 legs
11:52am	grabbed branches below branch with 2 arms let his body drop below the main branch
11:53am	crawling on lower branch, fore and hind limb alteration
11:54am	sniffing branch as he crawls
11:55am	crawling, sniffing hanging, upside down, 2 legs, at the end of cut tree branch
11:56am	sleeping, stretched on back arms and legs gripping branch above, back resting on branch below
12:01pm	head leaning back on main branch
12:06pm	moved his left arm
12:16pm	moved head to the left, eyes stayed closed
12:32pm	sleeping, on his back, head leaned back resting on branch below both legs gripping a smaller branch, left arm gripping another small branch

12:44pm	moving left foot towards body left foot gripping branch
12:49pm	lifted head, sitting up
12:50pm	lowered head scratching head with left arm shifted body so head facing left sleeping
12:51pm	lifted and lowered head, leaned head back on branch
1:02pm	lifted right leg lifted left leg moved both legs back and forth 2 times stretched head out backwards
1:10pm	moved left leg towards body
1:23pm	moved head to the left left hand resting on branch right hand gripping small branch above
1:35pm	lifted left leg from branch (3 inches) then lowered it right arm stretched, grabbing branch above
1:38pm	lifted and lowered left arm
1:40pm	shifted body so head facing left lifted and lowered head lifted head and sat up slightly arm bent around a branch head not resting on branch
1:56pm	moved head to the left
2:00pm	lifted head
2:50pm	turned head slightly to the left
2:46pm	shifted body arms gripping branch above
3:29pm	moved head to the right gripping small branch, right arm legs curled towards body left leg hanging over side of branch
3:45pm	moved right arm over body shifted body diagonally legs wrapped around small branch
4:22pm	moved head to left right leg curled around branch right arm hanging over main branch, gripping smaller branch left arm crossed over body
4:52pm	changed position, arms wrapped around body right leg wrapped around lower branch
5:09pm	sleeping, stretched on back

6:28pm	shifted body slightly
6:35pm	observers started using spotlight
6:38pm	sitting up, squinting eyes
6:42pm	opened eyes watching sleeping, sitting position
6:44pm	opened eyes gripped branch with right hand
6:42pm	lifted right arm 2 inches
6:48pm	lowered head between legs (possibly because of the light)
7:03pm	turned head towards us
7:05pm	the spotlight died, we can no longer observe him

GWEN

Time	Action
11:40am	sleeping, curled, upright, in dead leaves, legs curled around a branch
3:44pm	moved head to the left
4:10pm	breaking small branch
4:30pm	shifted body diagonally (head to the right)
5:35pm	moved head to left
5:42pm	moved head to right
6:03pm	opened eyes hanging upside down, 2 legs climbing, fore and hind limb alteration crawling on large horizontal branch, each limb individually
6:09pm	lost sight of her, she is in the upper canopy

GEORGE

Time	Actions
1:30pm	sleeping, curled, upside down
1:34m	yawned moved right arm
1:35pm	sleeping, curled upside down

HERALD

Time	Actions
1:36pm	sleeping, stretched upright
1:40pm	moved left leg sleeping, stretched upright

Date: Friday March 25th, 2005

Observers: Annie and Zofia

Sloth species: *Choloepus Hoffmanni* and *Bradypus Variegatus*

Nickname: Cosmo, Lance and Gwen, Herald and George

Tree Species: Espave

Description of tree: Same as March 24th.

Location in Park: Same as March 24th.

Location of sloth in tree: None were found.

Hours of observation: **A round trip of *El Roble* and *La Cieneguita* to locate sloths,**

which began at 3:07pm and terminated at 3:27pm

Number of sloths observed: None

Movements: No movements, none of the five sloths were found. It rained in the morning and early afternoon.

Time	Action
3:07pm	undetected
3:13pm	undetected
3:27pm	undetected

Date: Monday April 11th, 2005

Observers: **Annie, Gen, Zofia and Rafael**

Sloth species: *Choloepus hoffmanni*

Nickname: **Margarita**

Tree Species: Espave

Description of tree: Same as March 12th.

Location in Park: Same as March 12th.

Location of sloth in tree: The two-toed sloth is resting 9-10 meters off the ground. She was curled up in a branch, her back in a basket of lianas below, and above her there was a large branch functioning as a cover. Important note: this female sloth appears to be pregnant female as she has a large stomach.

Hours of observation: **1/4 of an hour or 15 minutes**

Number of sloths observed: 1 sloth

Movements:

Time	Action
10.35am	resting, curled up on back.
10:45am	began to climb up along the branches.
10:47am	possible predator response -climbing up tree.
10:50am	stopped climbing, resting on branches, all four limbs hanging off the branch, height is now upper canopy

Date: Wednesday April 13^h, 2005

Observers: **Gen and Zofia**

Sloth species: *Choloepus hoffmanni*

Nickname: **Margarita**

Tree Species: Espave

Description of tree: Same as March 12th.

Location in Park: Same as March 12th.

Location of sloth in tree: The two-toed sloth is resting about 2 1/2 meters from the top of the canopy, on the left side of the tree (in referenced to *La Cieneguita* path, when coming from the forking point with *El Roble*). Her head was extended outwards from the branches as she lay on her back, arms gripping lianas above.

Hours of observation: 1/12 of an hour or 5 minutes.

Number of sloths observed: 1 sloth

Movements: None, she was sleeping throughout our observation. (Note: this short visit was just a check up on her position in the canopy).

Appendix B : Interviews : the diet of *Choloepus hoffmanni* in Captivity

OREGON ZOO

Date: Friday, April 8th, 2005.

Name: David Thomas

Location: Portland, Oregon

Phone Number: 503-226-1561

Sloths: They have one adult female *Choloepus hoffmanni*. She was given to them as an adult, so they do not have any experience raising sloths in captivity and did not have any advice about specifically what to feed the baby sloths.

Diet:

- 7 pieces of leaf eater chow (monkey chow, Marian Zoological brand)
- 100g of primate diet
- 75g of greens (lettuce, Kale Spinach)
- 37g cooked yams
- 60g apple
- 20g carrot, green pepper or broccoli
- 13g of bananas or grapes

Other information: The Primate diet has protein and fibre that is important for the sloth.

TORONTO ZOO

Date: April 19th, 2005

Name: Michelle Shaw (Nutritionist)

Location: Toronto

Phone Number: 416-392-5900

Sloths: Have one *Choloepus hoffmanni* female and a pair of *Choloepus didactylus* (Male and Female).

Diet:

- 200g apple
- 40g pear
- 40g avocado
- 60g banana
- 30g spinach
- 15g romain lettuce
- 15g cantelope
- 10g broccoli
- 10g yam
- 15g hard boiled egg
- 25g soft gel (like zooprime primate diet)
- 15g fruit gel

Sometimes they feed her fresh browse: branches with leaves on them from apple, willow or poplar leaves.

Other information: Do not feed them liquids directly, but there is water in the exhibit.

AVIARIES DEL CARIBE : SLOTH RESCUE AND REHABILITATION CENTRE

Date: March 20th, 2005

Name: Judy and Luis Arroyo (spoke with Judy)

Location: Costa Rica (North of Puerto Viejo)

Phone Number:

Sloths: They have been successful raising baby *Choloepus hoffmanni*. They have lived past one year and are healthy.

Diet:

Carrots (in slices)

Green beans

Sweet potato

Cayote

Platanos

Green mangos

High fibre bread (7-grain etc.) cut in cubes and mixed with water.

Apples, pears and grapes (should only start feeding them these when they are at least 4-5 months old. Sometimes they have problems with the seeds of the grapes).

Anything green (spinach lettuce etc.)

Pedigree dogfood for puppies. (Dry pellets) They seemed to think this was a good brand. They soaked the food in water to feed the sloths. Very good source of Protein.

They usually cut vegetables and fruits into thin slices so the sloths can eat with their hands. The sloth diet should be varied (like it would be in the wild).

Food from the forest:

Mango leaves

Cecropia leaves

New pink leaves of Chocolate bush (the newer the leaves are the better).

Note: Most leaves are toxic if eaten in too large of a quantity or for too long.

Their sloths have survived past one year, however the problem they are now having is that when sloths are reintroduced into the wild, they have not been taught which trees are safe to eat by their mothers, so they do not get the proper nutrition, and eat toxic leaves, and therefore do not survive past a few months. The rehabilitation center is starting to try to do research into this and find a way to successfully reintroduce their sloths into the wild.

Suggestions:

Judy provided 2 suggestions of what changes should be made in the diet of the *Choloepus hoffmanni* in *Parque Natural Metropolitano*.

2 main problems with nutrition:

1- Cows milk is not good for sloths.

The Chicago zoo recommended feeding the sloths evaporated milk, however Judy and Luis found that evaporated milk (cows milk) was not good for baby sloths, and their sloths kept dying. They switched to goats milk, which is much easier for the sloth to digest. They feed their baby sloths fresh goats milk, or powdered goats milk from California. The sloths can be fed goats milk up to 10 months, and they fed some of their sloths fresh whole goats milk up to 18 months old.

2- The Gerbers baby food in Panama has onion in it, which is poison to sloths.

The Gerbers baby food with onion is poison to sloths, and their solution was to puree their own baby food using carrots and green beans. After a month, the sloth babies can eat solid food.

SUMMER PLACE

Date: Friday, April 17th, 2005.

Name: Roger B. Crokin & Grace Binford du Clés

Location: Puerto Lindo, Colon.

Phone Number: 507-676-7266.

Sloths: This American couple rescued and rehabilitated 3 sloths that lost their mothers as babies. They now have 3 adult *Choloepus hoffmanni* living in their house. There are 2 males and one female. Their ages are one and a half, three and four years old. They sleep in their bed and they have made them a climbing structure inside and outside.

Diet:

- almond leaves and almond nut (not mature): rinsed in water so they are wet
- Hobo leaves (wild plum tree): compound leaves and small round fruit, eat leaves and fruit (must still be green and immature so that the pit is soft and chewable/digestible. They will not eat it if the center is hard and the fruit is sweet and ripe)
- Long green beans (also washed several to both get rid of pesticides and provide water)
- Avocados (unripe are best, although prefer riper avocados, they prefer feeding them the harder ones since it doesn't make as great of a mess)
- Popos: Red hibiscus flowers (Like dessert for the sloths)
- Fresh white cheese
- Mangos (the sloths prefer the ripe mangos to the sourer green ones) and young mango leaves
- Flowering vines (blue, white, yellow and pink flowers are eaten, and we in fact saw one of the "wild" sloths in a vine tree with white flowers)

They prepare the almond leaves by chopping them and soaking them in a bowl of water so they are wet when the sloths eat them. The avocados are thinly sliced and the long green beans are also rinsed. The cheese is diced. They feed them 1 and a half pounds per week. They tried feeding them goats milk and powdered milk, but they did not like

it and would not drink it. It is very important to feed them fresh greens so they get enough water (the sloths really don't like to drink water). They seem to prefer acrid things such as the leaves and unripe fruit of the almond tree. It is best to feed them young tender leaves (when he pointed out which leaves he was referring to it turned out to be the newer leaves, those with less biomass invested used as a mode of protection for the tree. These leaves are therefore much easier to digest, as cellulose is not yet well established in the leaf structure. The breakdown of food by cellulose is one of the problems in sloth rehabilitation; they starve because they can't digest their food). They are fed three times a day and it is important they get enough water through the food (the food is fed to them wet). They do not drink water or milk, they get all their liquids from the greens. (Maybe one of the problems with the babies is that they are dehydrated). 2-toed sloths do not like *Cecropia* and do not eat the leaves of the Espave. To the contrary, three-toed sloths eat just that (*Cecropia*).

Suggestions:

They like to have something to hold on to, such as soft teddy bears, and they like to be covered with a towel when they are sleeping.

Other observations and comments:

He observed the **predator response** motion:

- Hangs arms along the sides of body
- Puffs up fur, just like a cat, thereby becoming twice its own size
- Makes a howling or barking noise like a dog
- Open and closes mouth, chopping its teeth together
- Refuse to grip on to teddy bear, and appears quite threatening
- Once bear is grabbed as before, the sloth calms down and returns to normal behaviour

Have 3 adult 2-toed sloths in their house; Thunder, Lightning and Hurri. Hurri is one and half years old and the other 2 are about 3 and 4 years. One female and 2 males. They sleep in their bed and they made a climbing structure for them in their bedroom and outside. All three sleep with their own teddy bears, gripping four limbs around, and each have kept the same bear up to date. Since these animals are fed three times a day, with lots of water droplets on the beans, they urinate more than once a day and defecate every second day. When they defecate, two do not need their teddy bear but one of the sloth still clings onto his, simulating those in the wild that grasp the tree trunk as they stick out their behind and defecate. The sloths urinate every day and defecate every second day. It takes them about 5 minutes to pee. This is much more frequent than in the wild (usually every eight days), because they are fed 3 times a day which is of much greater quantity than in the wild.

There is problem with hunting in the area. Kids bring them baby sloths and try to sell them animals. The captive sloths cannot be reintroduced because they are not scared of dogs or humans or cars. Sloths are hunted for meat. However the rehabilitation center that used to be in the area is now closed.

They Give them a bath every week and use baby shampoo.

Sloths sleep during the day and become active at night.

They are willing to help the PNM, and they feel sloths are very intelligent (answer to their names, and are toilet trained and have learned not to be aggressive), deliberate creatures. They said the park should contact them. The rehabilitation center is closed.

On the walk back we saw a mama and baby and another sloth in an almond tree. We also saw another one in a tree with lots of Lianas. Roger said there are 5 on the property. They are all *Choloepus hoffmanni*.

They stay with the mom 13 months (clinging to her) but at 7 months they start to become more independent and explore by themselves during the night to feed, returning to the mother at dawn. After 13 months the baby is almost as big as the mom.

Appendix C : Interviews : PNM Employees about sloth behaviour

INTERVIEW 1.

Date: Thursday, April 14th, 2005.

Name: Justo Camargo

background: Student at the Universidad de Panama in Biology. Has a detailed knowledge of the plants, animals and birds in the PNM and walks the trails for about 15 hours a week.

1- How often do you see sloths in the park?

I see about 2 sloths per day. I see sloths of both species. Sometimes I see two of the same species, and one of the other species. Usually see at least 2 different individuals. I see more three toed-sloths (*Bradypus variagatus*) than two toed (*Choloepus Hoffmanni*). See about an average of 3 per day, but these could be the same individuals as other days. During a 15 hour week he sees approximately 4 separate individuals.

2- What trees do you see the sloths in (species, size, height)

2-toed: Espave, Guasimo Colorado, Lianas, Guarumo, Corontu, Barrigon, Guasimo sp.

3-toed: Es[ave, Barrigon, Lianas, Corontu, Guarumu (*Cecropia*). Never seen in Guasimo.

3- Where do you most often see sloths in the park?

Where the two trails meet (Corotu)

Behind the offices

Along the road (near the children's park)

The mono titi lookout (lots)

I have only seen one on the sendero los coabos. (It was high up in the canopy).

4- What time of day do you most often see the sloths in the park?

Mostly see sloths at noon. High in the trees. Most seen at 2-3 in the afternoon.

5- When are the sloths the most active?

They move the most in the morning. Mid day they are just sunbathing.

6- Where in the tree do you mostly see them, have you ever seen them on the ground?

Usually see them in branches and sometimes in Lianas. I have never seen them on the ground.

7- How many sloths do you think have been killed in the park, and how were they killed?

Once I saw one that fell out of a branch and died. (Sendero Roble). They also die frequently by getting run over when crossing the road (Corredor Norte).

8- Is there usually more than one sloth in a tree?

Sometimes there is more than one sloth in a tree. They are always the same species of sloth. About 2 times each week.

9- Have you ever seen sloths mating?

Yes, once I saw sloths mating.

10- Describe any unusual sloth behaviour that you have seen.

Sleeping, climbing in the Lianas, breeding (not moving, just staying together).

11- Have you ever seen a sloth eating in the park?

Yes, I have seen a 3 toed sloth eating the Guarumu at the Mirador (look-out). It was midday and it was eating the leaves. Some say that 3-toed eats flowers of the Barrigon.

12- Do you have any suggestions for what tourists should look for when they want to see a sloth?

2-toed : Look for Lianas, and the trees listed above that they prefer. Large trees with Lianas.

3-toed : Look for *Cecropia* (Guarumu) with Lianas.

Walk slowly and quietly, look carefully using binoculars.

13- How often do you see sloths moving?

Rare to see them move. About once a week. Lift heads, move a little. See movement about once a week.

14- have you ever seen a sloth with a baby?

Today we saw a sloth with a baby. Mother sleeping with baby on her stomach.

INTERVIEW 2.

Date: Thursday, April 14th, 2005.

Name: Fidelino Siméñez (Igua)

background: Employee at the Parque natural Metropolitano.

1- How often do you see sloths in the park?

I see about 1 sloth every week. I have seen more 2-toed than 3-toed, but almost the same amount.

2- What trees do you see the sloths in (species, size, height)

3-toed- *Cecropia* (Guarunda)

2-toed- Espave, monkey ear tree (Coruntu)

3- Where do you most often see sloths in the park?

Cenegita trail. Only once on the Caobos trail.

4- What time of day do you most often see the sloths in the park?

Mid day. They are high up in the trees with lots of leaves. They are in the canopy, near the top of the tree. In the morning I have seen them in the *Cecropia* looking for food.

5- When are the sloths the most active?

They move more in the morning. To change trees they do not go down to the ground. Climb from branch to branch.

6- Where in the tree do you mostly see them, have you ever seen them on the ground?

In the morning, I see them climbing in the middle of the tree. Once I took a sloth from the road to put it in the forest. I have taken 3 from the road since 2002. They sleep in the branches. I have never seen them sleeping in the Lianas.

7- How many sloths do you think have been killed in the park, and how were they killed?

He saw three dead sloths. 2 were hit in the road. One was dead in the trail. It was in the Roble trail (near the ranger station. It was already dead when I arrived. There was an Espave branch nearby, but I am not sure if that is how he died.

8- Is there usually more than one sloth in a tree?

Twice he saw three sloths in one tree. Sometimes he sees 2 in one tree.

9- Have you ever seen sloths mating?

One time he saw one mating (with Gen and Justo)

10- Describe any unusual sloth behaviour that you have seen.

I saw a sloth swimming (but not in the Parque Natural Metropolitano). They are good swimmers. They never drown.

11- Have you ever seen a sloth eating in the park?

Yes. I have seen a sloth eating flowers from the Bombacaceae tree (not sure which species). I also saw the 3-toed eating *Cecropia* leaves.

12- Do you have any suggestions for what tourists should look for when they want to see a sloth?

Look carefully, because they are silent and camouflaged and do not move. Do not confuse them with termite nests (some people do) but good idea to look for brown balls that look sort of like termite nests.

13- How often do you see sloths moving?

In the morning they move, but after 10:00 they go back to sleep. He heard they come down to go to the bathroom once a week.

14- Have you ever seen a sloth with a baby?

No.

INTERVIEW 3.

Date: Thursday, April 14th, 2005.

Name: Aristide Montilla (Ari)

background: Park Ranger at the PNM.

1- How often do you see sloths in the park?

I am not sure. I Saw one recently close to Jessica's house.

2- What trees do you see the sloths in (species, size, height)

Not sure what species.

3- Where do you most often see sloths in the park?

Mono titi trail

4- What time of day do you most often see the sloths in the park?

All times of the day

5- When are the sloths the most active?

Mostly move in the morning 7-8 AM.

6- Where in the tree do you mostly see them, have you ever seen them on the ground?

In general they are not extremely high in the trees. One was in a small tree near the guard hut and almost fell out. Stay in the trees at most 2 days. Could be up to a week. 2 days is fairly normal. Most has been about 5 days. (Lance and Gwen : he had seen them for 3 days before he showed us.) Saw sloth on the ground on the road.

7- How many sloths do you think have been killed in the park, and how were they killed?

Sloths die in the road (Avenida Amistad and Corredor Norte). One or 2 dead sloths per week. Or sometimes one every 2 weeks (varies). Contaminated water in the rio Corundu is also a problem for the sloths (oil)

8- Is there usually more than one sloth in a tree?

Has seen 2 in a tree (Lance and Gwen).

9- Have you ever seen sloths mating?

No.

10- Describe any unusual sloth behaviour that you have seen.

There was a sloth in the tree Annie likes (Fabaceae). The branch broke and the sloth fell out, but did not die.

11- Have you ever seen a sloth eating in the park?

Food : Guarumbo leaves. In his house the three toed sloth eats his planted Maracuja. Climbs quickly. Takes one minute to get from one tree to the next.

12- Do you have any suggestions for what tourists should look for when they want to see a sloth?

Go to the mono titi trail. Look for big trees with Lianas.

13- How often do you see sloths moving?

I am not sure.

14- Have you ever seen a sloth with a baby?

Saw sloth with a baby. Held it on its stomach. Was a 2-toed. Sees this about 2 times a year.

INTERVIEW 4.

Date: Friday, April 15th, 2005.

Name: Sixto Mequizama

background: Employee at the Parque Natural Metropolitano. He works in Invest. Y Manejo ambiental.

1- How often do you see sloths in the park?

Can see sloths everyday in the park. Each time I walk in the park, I see one or 2. Usually on the Roble trail. When they have a baby (in January) or are mating there are more than one in a tree. Saw 2-toed sloths mating. Did not see more than one sloth in a tree at other times.

2- What trees do you see the sloths in (species, size, height)

Sleep in trees with lots of leaves. At night they can be in trees without leaves. During the day they usually stay in trees with leaves. Saw a 3-toed sloth in the Anona tree near the monkey rehabilitation center.

3- Where do you most often see sloths in the park?

Seen sloths mostly on the Mono Titi trail, the Cenagita and the Roble trail. Caobos – rare to see sloths, probably because there is no *Cecropia*. He walks all trails.

Mostly see sloths beside the road, beside the trails. This is because the sloths like the pioneer species that grow in these open areas. Pioneer species beside the road: Guaramu, balso, Corteso, Guasimo Colorado. The three toed likes to eat the leaves of these species, but the 2-toed is more varied in its diet.

4- What time of day do you most often see the sloths in the park?

Best time to see sloths: morning, before 9 Am. In the morning and the night the sloths can be in trees which have few leaves, but as soon as the sun comes out, they try to find shade, and move to trees that have lots of leaves.

5- When are the sloths the most active?

In the morning

6- Where in the tree do you mostly see them, have you ever seen them on the ground?

In general, the 3-toeds are lower in the trees, and in open areas. The 2-toed are usually high in the tree and in more secluded areas and trees.

Sloths usually found in branches and Lianas. In trees with Lianas and lots of leaves, because they look for shade. Clima : sabroso, make hammocks in Lianas.

Yes, I have seen one on the ground. I saw one defecating (same one as Jessica). He climbed down the tree to the ground at the roots of the tree. He had both arms wrapped around the tree, and his bum facing the ground. He squatted in this position for about 10 minutes, pooping a little at a time. Then he climbed back into the tree. This was at about 10:00 AM. It was a male 3-toed sloth.

7- How many sloths do you think have been killed in the park, and how were they killed?

Sloths die every year. They die by themselves for unknown reasons. They find them in the forest and do not know how they died. They found one sloth that had some sort of disease (flesh eating disease?). Some sort of disease that affects sloths.

They also get killed by cars in the road. This is because they like the pioneer species at the edge of the road, and there is lots of food at the edge of the road. They are therefore more likely to try to cross the road. Lots of sloths have been killed crossing the road.

8- Is there usually more than one sloth in a tree?

Have never seen more than 2 sloths in a tree. Can have both species in a single tree.

9- Have you ever seen sloths mating?

Saw sloths mating in January behind the offices. Not mating for long, about the same amount of time as a dog.

10- Describe any unusual sloth behaviour that you have seen.

Sloths do swim, I saw them swimming in the Rio Chagres when I was a kid. When they cross rivers they go with the currents. Never swim against the current.

11- Have you ever seen a sloth eating in the park?

Sloths eat the new leaves of the Espave as a last resort.

Eat the flowers of the Borrigon, the Poro Poro and Espero galiente?. Eat fowers of almost everything. 2-toed has lots of variety in its diet. Have never seen them eating fruit.

Food: 2-toed : New leaves of Lianas.

Barrigon flowers (white puffy ones)

Also eat the Barrigon flowers when they are closed, because they contain a lot of water. They get the water they need from the food they eat and therefore they eat at night, because it is humid and there is dew on the leaves. They eat when it is humid, so in the dry season, they eat late at night when there is dew on the leaves. They eat between 2 and 6 in the morning, when the leaves are the most humid. In the rainy season they will start to eat earlier, because the leaves are wet when it rains, and they do not have to wait for the dew. They only eat new leaves, so at this time of year there is an abundance of food (lots of new leaves).

Eat the new leaves of the Spondia Monving (jovo).

3-toed (and 2? And other animals) eat the *Cecropia* (Guaramu) because it has a chemical called Alcaloide, which is also found in Marijuana. They become addicted

to this drug. They eat the *Cecropia* leaves so that during the day they can sleep. They use the Alcaloide for digesting, because they digest while they are inactive. Eat the leaves to drug themselves so they can sleep for extended periods of time. Example, snakes can eat Alcaloide and sleep for 22 days, digesting their food and then they defecate.

Good time to look for sloths eating : Luna Obscura. Do not eat in the full moon. Only eat when it is very dark. It is very rare to see them eating when there is any light. Only eat on very dark nights when there is no moon.

Can go for one week without eating. They do eat often, but they wait for it to be completely dark.

Only eating 2 (12?)- 6 in the morning. Winter : they can start eating at about 6-7 pm, because there is enough moisture on the leaves. Leaves are wet with rain and moisture in the air.

12- Do you have any suggestions for what tourists should look for when they want to see a sloth?

Tourists: reforestation with species that sloths eat. Also need to reforest with fruit trees that other mammals and birds like. Combination of trees need to be reforested so they support a community of mammals, birds, insects...

13- How often do you see sloths moving?

14- Have you ever seen a sloth with a baby?

I have seen sloths with babies in September. The sloths keep the babies for three months after they are born. The babies stay on the mothers stomach, drinking the mothers milk until it grows teeth. The mother shows them how to eat leaves. When it has teeth, the mother leaves it in a tree that it can eat.

15- Do sloths have predators?

No predators for the sloth in the park.

Predators in general: tigre (eats adults)

Harpy eagle (eats babies)

Boa : maybe. Never seen, may eat baby sloths. Do not eat adults.

16- What are some of the other mammals in the park?

Other mammals in the park: Nieke, Hardia, gato solo, emmigelos, salromis negra, ratones, sloths, mono nocturno, mono titis, puerospino. Gato Solo – eat cortiga flowers.

17- Is there competition with the sloths in the park?

No. The Ardia? , gato solo and musilagos? Eat the *Cecropia* seeds, but the sloths only eat the leaves. Birds also eat the Semillas de *Cecropia*.

18- What do sloths do when it rains?

When it rains, they simply curl up in the tree.

INTERVIEW 5.

Date: Friday, April 15th, 2005.

Name: Ricardo Bastidas

background: Park Ranger at the PNM.

1- How often do you see sloths in the park?

See about one sloth a week. In general, see more 3-toed than 2-toed. He works 2 days a week for 6 hours a day. Mostly sees sloths around the offices, does not have much time to walk the trails.

2- What trees do you see the sloths in (species, size, height)

Guarumo (2 and 3 toed) fairly high in the tree (15m). In the morning they are lower in the tree. During the day they seem to be higher in the tree. During the evening they are lower. (10m).

3- Where do you most often see sloths in the park?

Usually see sloths on the Roble trail and in the area surrounding the childrens park and the offices. He does not walk in the park a lot, but often sees sloths in the Guaruma by the park offices.

4- What time of day do you most often see the sloths in the park?

He usually sees them in the morning and at 3-4 in the afternoon. They are usually sleeping in branches.

5- When are the sloths the most active?

Not sure.

6- Where in the tree do you mostly see them, have you ever seen them on the ground?

He has seen one on the ground crossing the road. It took about 10 minutes for it to cross the road. He got a call, and came to help it cross the road safely.

7- How many sloths do you think have been killed in the park, and how were they killed?

2 sloths were killed last year (between 2002-2003). 2 sloths were killed in the road.

8- Is there usually more than one sloth in a tree?

Has never seen 2 sloths in a single tree

9- Have you ever seen sloths mating?

Never seen mating

10- Describe any unusual sloth behaviour that you have seen.

No unusual behaviour

11- Have you ever seen a sloth eating in the park?

Saw a sloth eating the leaves of the Guarumo (Not sure which species)

12- Do you have any suggestions for what tourists should look for when they want to see a sloth?

No suggestions for tourists

13- How often do you see sloths moving?

Sees sloths moving more than sleeping. See them crawling (morning and afternoon).

Need about one day to move from one tree to the next.

14- Have you ever seen a sloth with a baby? No.

INTERVIEW 6.

Date: Friday, April 15th, 2005.

Name: Jessica Rosas

background: Our supervisor, she is in charge of the park Rangers and the Rescue and rehabilitation Centre.

1- How often do you see sloths in the park?

In the winter- it is more difficult to see sloths. It is much easier to see them in the summer. Sees about one sloth each week (different individuals). Sometimes can be 2 weeks or a month before she sees one. Does not go walking to look for them. She just sees them when she goes to collect food for babies or when there are injured ones. In the summer she saw an average of one per week, but this varies. Once every 15 days she sees a new individual. Mostly sees 3-toed, spends about an hour a day walking on the trails. Sees the most on Sendero Roble, but has also seen some on sendero Mono Titi. However, I hardly ever see sloths on this side.

2- What trees do you see the sloths in (species, size, height)

3-toed: Guarumu, Barrigon, Roble

2-toed: Guarumu – was not eating but was in *Cecropia*.

Cecropia, India Desnudo, Barrigon.

3- Where do you most often see sloths in the park?

Sloths always in trees: 2 toed in the Barrigon, no lianas, it was in the branches. In other trees, do not usually see them in the lianas. Usually are high in the tree sunbathing.

4- What time of day do you most often see the sloths in the park?

Sees them generally between 7 and 10 in the morning. They move a little at this time but not much.

5- When are the sloths the most active?

Tiernas, in the morning. Active mostly in the morning between 7 and 10. In the afternoon, the adults in the trees around her house move a little (stretching, crawling a little). Saw both species.

6- Where in the tree do you mostly see them, have you ever seen them on the ground?

Saw both 3-toed and 2-toed in the upper part of the Mirrador. In the Cedro Cebollo. Often seen in that tree. Usually sleeping.

7- How many sloths do you think have been killed in the park, and how were they killed?

Lots of sloths die in the park, about 6 per year. All because they were hit in the road. (crossing the road on the ground at night) Babies dying for various reasons. When they die in the woods, they disappear very quickly. Do not often find sloth remains. Just fur is left.

8- Is there usually more than one sloth in a tree?

Never seen more than one per tree unless it is a mama and a baby.

9- Have you ever seen sloths mating?

No.

10- Describe any unusual sloth behaviour that you have seen.

3-toed defecating (same one as sixto) Came down from the cecopia, had a small tail the size of a thumb. Was clinging to the tree with both arms. Twirled tail in the ground to make a hole, pooped in the hole then climbed up a little and covered the hole by scratching the ground with its back paws.

11- Have you ever seen a sloth eating in the park?

I saw a 3-toed eating *Cecropia*. I have never seen the 2-toed eating.

12- Do you have any suggestions for what tourists should look for when they want to see a sloth?

look for trees : Guasimo, Barrigon, *Cecropia*.

Walk in silence and have lots of patience. Look for a long time at each tree.

13- How often do you see sloths moving?

14- Have you ever seen a sloth with a baby?

Yes. The mother was climbing and the baby was clinging onto her stomach. Saw them in the upper part of the mirrador in a tree covered with Lianas. (2-toes)

15- Do sloths have predators?

Ocelot (manigoro) (in the park!) they eat sloths.

Harpy Eagles are predators but there are no harpy eagles in the park.

Not sure if Boa constrictors eat sloths. Never seen, does not know.

Appendix D : Chronogram of Activities

Dates	Activity
Wednesday, January 5	Arrival
Thursday, January 6	Social meeting with host institutions and professors
Friday, January 7	Meeting with Jessica; briefing on potential project ideas and problems with juvenile sloth rehabilitation and observation of two baby sloths. Walk by ourselves in the park order to become familiar with our surroundings
Saturday, January 8	General Research on sloths at STRI
Thursday, January 13	Walk in park accompanied by Jessica to look for sloths from 8 to noon, STRI reading at night from articles obtain in the previous week
Friday, January 14	Went to Parque Metropolitano at 7 AM to look for sloths until noon, continued reading of articles during for the remainder of the day
Saturday, January 15	Reading / research
Sunday, January 16	Reading / research
Thursday, January 20	AM - meeting at the park, then we went to look for aerial maps (places included Panama University, map institution, and ANAM). Unsuccessful mission and return to park to obtain desired maps
Friday, January 21	STRI research / reading. Went to park in order to attempt our construction of plots and transects. Work on literature review.
Thursday, January 27	Reading / research. Brainstorming and refinement of project (specific research on other zoos, literature, different methodologies on project planning). In the afternoon, bought supplies for field work (including hammack, strings, helmets for bike ride to park, etc.)
Friday, January 28	Regrouping and decision making on project following research
Thursday, February 3	Walk in the park and observation of three sloth locations with a student from Panama university
Friday, February 4	Marking of sloth location, and reading of numerous articles
Thursday, February 10	<i>Carnaval - Spring break, no work on internship</i>
Friday, February 11	<i>Carnaval - Spring break, no work on internship</i>
Monday, February 14	Reading of books specifically on methods and summary of possible methods of use to our project
Tuesday, February 15	Establishing methodology and write-up
Wednesday, February 16	Brainstorming in the morning due to change in project objectives after realizing following literature research and field work that a sloth census would not be possible under our budget restraints. Research and reading for project alternatives. Visit to park in the afternoon to present our proposed project ideas and changes to Jessica in order to receive acceptance of project. After approval, we went inside the park and observed one sloth
Thursday, February 17	Work on proposal

Friday, February 18	Work on proposal
Saturday, February 19	Research / proposal
Sunday, February 20	Research / proposal
Thursday, March 3rd	sloth Map, list of food preferences (BCI)
Friday, March 4th	Preparation of research for informal presentation
Wednesday, March 9th	Informal presentations
Thursday, March 10th	Research on methodology and sampling
Friday, March 11th	Research on behaviour methodology
Saturday, March 12th	Behaviour data collection
Sunday, March 13th	Research, ethogram
Monday, March 14th	Behaviour data collection
Tuesday, March 15th	Behaviour data collection
Wednesday, March 16th	Behaviour data collection
Thursday, March 17th	compiling data, cleaning park
Friday, March 18th	Behaviour data collection
Saturday, March 19th	Behaviour data collection
Sunday, March 20th	interview with Costa Rica Centre,
Thursday, March 24th	Cleaning park, behaviour data collection
Friday, March 25th	Behaviour data collection
Saturday, March 26th	Cleaning park, behaviour data collection
Thursday, April 7th	Research, pamphlet
Friday, April 8th	Painting the park, zoo interview
Saturday, April 9th	Painting the park
Sunday, April 10th	Painting the park
Monday, April 11th	mammal transect, behaviour observations
Tuesday, April 12th	compiling data
Wednesday, April 13th	Census, behaviour data collection
Thursday, April 14th	Interviews with guards, behaviour data collection
Friday, April 15th	Interviews with guards, painting park
Saturday, April 16th	Making ethogram and pamphlet
Sunday, April 17th	Interview in Puerto Lindo, compiling data
Monday, April 18th	Finished painting the park, writing report
Tuesday, April 19th	Writing report, preparing presentation, zoo interview
Wednesday, April 20th	Preparing presentation
Thursday, April 21st	Symposium
Friday, April 22nd	Writing final report
Saturday, April 23rd	Writing final report
Sunday, April 24th	Earth Day festival at the park, writing final report
Monday, April 25th	Finished writing final report.

APPENDIX E

Map of the location of the sloths that we observed along the trails of the park.

Legend:

1. Cosmo
2. Gwen
3. Lance
4. George
5. Harold
6. Margarita
7. Other sloths located but not studied.

Order: Xenarthra (Strange Joint)

Class: Mammalia (Animals with Milk Glands)

Subclass: Eutheria

Family: Megalonychidae

FACT SHEET

Range & Habitat: Central to South America, their habitat includes lowland and upland tropical forests.

- Sloths are similar in size to a small dog. Their fur often has a greenish tinge caused by blue-green algae, which may provide nutritional benefits through skin absorption, in addition to helping camouflage the animal.
- Sloths are **arboreal** mammals that feed on the leaves and fruits of trees using a large ruminant-like stomach and long intestinal tract.
- Sloths have a very **slow metabolic rate** and they can therefore survive on minimal food consumption.
- They descend the tree to defecate about once every week and urinate only when rain can mask their urine stream.
- They spend much of their time hanging upside down from branches, **sunbathing** and **resting** on branches and lianas. Although movement is slow, sloths do move about the forest and change trees every few days.
- Sloths use the sun to **thermoregulate** and their body temperature is the most variable of mammals.
- The most important sense for sloths is **smell**.
- Sloths are the **slowest mammals** on the planet.
- There are two species of sloths inhabiting the park: *Choloepus hoffmanni* and *Bradypus variegatus*

Two-toed Sloth (*Choleopus hoffmanni*)



Range: Nicaragua, Central America (Panama), Colombia, Venezuela, Guiana, Ecuador, Peru, Brazil and Bolivia.

Description: The two-toed sloth has a dark blond coat, with a dark brown face outlined by light blond fur. Two-toed sloths can be differentiated from three-toed sloths by difference in coat colour (three-toed being grey-coloured) and by the number of claws on the front paws. As hinted by the name, two-toed sloths have two long and curved claws. The two-toed sloth is visibly larger than the three-toed sloth.

Behavior: Two-toed sloths are herbivores, feeding mostly on leaves, and have a less specialized diet than three-toed sloths. They are nocturnal and so more active after sunset. They prefer trees covered in lianas and are usually found at mid to upper canopy heights.

Reproduction: Each year the female gives birth, most often upside down, to a single baby after a gestation period of approximately 11 1/2 months. Babies are born with claws and cling to their mother for about 7 months, and only become completely independent after 13 months.



Three-Toed Sloth (*Bradypus variegatus*)



Range: The three-toed sloth inhabits tropical forests from southern Central America to north-eastern Argentina

Description: The arms of the three-toed sloth are visibly longer than that of the two-toed sloth. This species is generally smaller than the two-toed sloth and has a small tail. Adult males can be differentiated from females by a patch of shorter hair on their backs that is colored pale to bright yellow, with a dorsoventral black stripe through the center.

Behavior: the three-toed sloth is said to eat mainly the leaves of the *Cecropia* tree or lianas leaves but has been observed to feed on 96 different species of plants in certain locations in panama (BCI). This species can be active during the day as well as at night.

Reproduction: Pregnancy lasts 6 months and one young is born at a time



How do you locate a sloth?

- 📷 Upon arrival, ask park rangers whether they have spotted any sloths on that day. If so, ask them to direct you to that location.
- 📷 If you are on your own we recommend walking along the paths, paying special attention to large trees, such as Espave, with profuse foliage and/or lianas.
- 📷 Once such a tree is detected, proceed to examine any branch, copse of trees, or branching points that appear to have suspicious shapes resembling a nest using binoculars.
- 📷 If any fur is discerned, chances are a sloth has been successfully located. Continue observing, often time sunrays from above illuminate the hair and the wind blows through it as well.
- 📷 To identify the species, analyzing the fur color is easiest, as the toes will most likely be hard to identify when the animal is curled up into a ball.
- 📷 If the intention of the observer is to perceive movement, observation should be conducted at dusk or dawn especially in the case of the two-toed sloth. If going into the woods at night, a flashlight is recommended.

The Ideal Sloth Habitat



- Many lianas
- Large trees árboles grandes
- Many branches for resting
- Lots of leaves and shade
- high up in the canopyEspave
- Remember: There can be one than one in a tree.

Species of trees to look out for...

Cecropia species (Guarumo)
Anacardium excelsum (Espave)
Pseudobombax septenatum (Barrigon)
Luehea species (Guacimo)
Luehea seemannii (Guacimo colorado)
Cedrela odorata (Cedro cebollo)
Apeiba species (Cortezo)
Ochroma pyramidale (Balso)
Spondias species (Jobo)

Appendix F