Foraging behaviour and characteristics of the Mantled Howler Monkey (*Alouatta palliate*) in the lowland swamp forest in the Barra del Colorado Wildlife Refuge, Costa Rica

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Tortuguero
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1. Introduction

This study is about the foraging behaviour and ecology of the howler monkey in the period 18 February till 31 May 2013. This study will be commissioned by Caño Palma. Caño Palma Biological Station is located at Barra del Colorado and belongs to COTERC. COTERC is providing leadership in education, research, and conservation and the educated use of natural resources in the tropics (COTERC, 2013). Barra del Colorado Wildlife Refuge is part of the Tortuguero Conservation Area, in Limón Province in the northeastern part of Costa Rica. It protects hot humid forests, mangroves, canals and marine areas (Costa Rica National Park, 2013)

The mantled howler monkey (*Alouatta palliata*) is one of the three monkeys in this area of Costa Rica. The other two are the Central American Spider Monkey (*Ateles geoffroyi*) and the White-faced Capuchin (*Cebus capucinus*). The mantled howler monkey takes its name ´mantled´ because of the long guard hairs on its side. The rest of the name does he takes because of the loud roar of the males. They are making the loud vocalization at dawn and dusk. That sound can be heard as far as 1.6km away (Eliot Greenspan, 2013). They are eating a large amount of leaves. Leaves are difficult to digest and are not giving much energy. The howlers spend the majority of the day resting and sleeping. Howling allows the monkeys to locate each other without expending energy on moving or risking physical confrontation. Howlers have a prehensile tail and they are using it as an extra arm to grip or even for hanging on it (National Geographic, 2013). The weight of an adult male can weigh up to 6 to 7 kg and an adult female will be around 4 to 5 kg (Glander, 1983). The body length ranges from 38 to 58 cm (Reid, 1997). Juveniles spend the first month of their life clinging on their mother's belly and then ride on her back (Schoville, 2013). In general a troop consists of 10 to 20 howlers. The alpha male, has preference for food and resting places, and mates with most of the females. The howlers disperse seeds and ensure germination.

It is important to know what they are eating because a difference can have a major change in their lifestyle. Beside the foraging behaviour this study also investigates if troops are recognizable and how many troops there are in this area. There will be looked if different troops move all over the area or that they have their own part in the area. Data will also show if there is a certain order in behaviour that they perform. This study is important because nobody did a resource about the mantled howler monkey in this area before.

1.1 Foraging behaviour

Howler monkeys' diet includes leaves (immature and mature), flowers, fruits, leaf buds, leaf petiole and pulvinus (stem parts). A study that has been done in the Neotropics showed that the howler monkey eat a lot of fruit, flowers and leaves. The Neotropics is the tropical rainforest of south, north and central America. Figure 1 shows the percentages from eating the different parts of the plant. The observations had a total duration of 24 months. The research was in July and August 1983, January to August 1984, January to July 1985 and February to August 1986). During the study they were eating 22 different food items from 11 species of trees (Chapman, 1988).

Fruit	28,5
Flower	22,5
Leaves Mature	27,7
Leaves Young	17,4
Leaves Buds	3,9
Insects	0

Figure 1: Percentages of consumed food in the Neotropics.

Figure 2 shows data of a study that is done from July till August, 2004 (Baum, 2005). Especially the difference in eating flowers is large if compared with the study in the Neotropics. This could be because the right trees doesn't have flowers in those two months. The difference in place could also be a reason.

	Total (n=434)	Male (n=218)	Female (n=216)
Leaf	252 (58.1%)	133 (61.0%)	119 (55.1%)
Fruit	127 (29.3%)	65 (29.8%)	62 (28.7%)
Leaf Bud	55 (12.7%)	20 (9.2%)	35 (16.2%)
Flower	0 (0.0%)	0 (0.0%)	0 (0.0%)
Other	0 (0.0%)	0 (0.0%)	0 (0.0%)

Figure 2: Consumed food in El Zota biological field station, Costa Rica.

Howler monkeys spend up to 80% of their day resting (Estrada et al 1999; Pavelka & Knopff 2004). The digestion of the high percentage of toxin-loaded mature leaves takes a lot of energy (Milton 1980; Milton & McBee 1983). Howlers prefer eating ripe fruit when available (Estrada et al. 1999; Pinto & Setz 2004; Pavelka & Knopff 2004). Although the variation in diet, activity budgets appear to remain constant throughout the year (Pavelka & Knopff 2004). Howler monkeys are one of the few species that survive in disturbed forest fragments. That is because of their adaptable diet. In high densities they adapt their home ranges, diet and activity budgets by consuming all the available food sources and minimize energy use (Cristobel-Azkarate & Arroyo-Rodriguez 2007). This often involves smaller home ranges and an increase of folivory, eating leaves, in the diet (Lopez et al. 2005). This does not necessarily refer to an increase in toxin loaded mature leaves. Previous studies show that population density was expected to be the best predictor of howler monkeys responses to habitat fragmentation and groups with the smallest home ranges were predicted to show a higher degree of folivory in their diet and spend more time resting than groups with larger home ranges and greater food availability.

1.2 Recognize troops

Troops are recognizable because of the group size. The amount of males, females, subadults and juveniles will be counted. Males are identified by the beard, the white testicles and the howell. Females carry their babies around. Howlers breed all year-round with one young. The gestation period takes 6 to 7 months. Approximately one-third of the females have infants (Avery & Cave, 2002). Recording if the infants are on the back or the belly of the mother while traveling, gives an idea of the age of the infants. For the first month the juvenile clings on the belly of the mother and then switches to the back (Denver Zoo, 2013). The juvenile is dependent on its mother for about 6 months. Lactation lasts for a year, when a second baby is born, and the first is rapidly displaced. Then the young are playing very little and are often as slow and heavy as the adult infants (Avery & Cave, 2002). Before the juveniles reach sexual maturity, they leave the troop and will find a new one. Females reach sexual maturity after 36 months and males after 42 months. The mantle of the subadult female starts to develop. The subadult males are getting a beard, mantle, enlargement of the head, scrotum becomes pendulous and changes from black to white with many black spots. The testes are in the scrotum and he begins to produce a loud call (Glander, 1980). A troop is also distinguishable if an individual has abnormalities. That can be scars, different color of the hair or a missing tail.

1.3 Territory

Males howl to let the other troops know where they are. Howlers do not defend their territories, but they overlap with other troops. However, if two troops meet they will be aggressive towards each other. On average, troops travel up to 750 meters a day (Di Fiore et al, 2007). Home range sizes are

influenced by diet, habitat quality, distribution of resources, degree of arboreality, body weight, group size and total biomass. Home range sizes are highly variable across sites. Glander (1978) reported a home range of 9.9 hectares (0.76 hectare/monkey) for one troop at La Pacifica, whereas Chapman (1988) reported a home range for a troop at Santa Rosa National Park between 80.8 and 90.7 hectares (respectively 2.01 and 2.27 hectares/monkey). Milton reported a 45 hectares (2.8 hectares/monkey) home range on Barro Colorado Island, Panama. Clutton-Brock and Harvey (1977) were using other data from Barro Colorado Island and they found a home range size of 18 hectares (1.06 hectares/monkey).

1.4 Order in behaviour

One troop howling stimulates others to do so, warning each other against trespassing. After howling, the troop begins to feed, moving around slowly and often stopping to rest in the sleeping-tree. The animals begin to move out to food trees away from the center of their territory in the middle of the morning. They then rest again until mid-afternoon. Later they begin to feed again, traveling around and finally calling again before settling down for the night (Avery et al, 2002).

2.Methods

2.1 Study area

Caño Palma is found 8 km north of Tortuguero (N 103536.1/W 833139.4). A distance of 200 m separates the station from the Caribbean Ocean. The station's land comprises 40 ha of Atlantic lowland tropical wet rainforest (Holdridge, 1967). The land is situated on the boundaries of Tortuguero National Park (18 947 ha) and the Barra del Colorado Wildlife Refuge (92 000 ha). Combined these reserves connect with forests in Nicaragua to form the largest area of lowland Atlantic tropical wet forest in Central America. The area counts several rivers and canals and areas are changed for mainly agricultural use.

Caño Palma's annual rainfall is around 5000 mm. The daily temperature is around 26 °C and 70 % RH. The dry season is from March till September and the wet season is from September till February. In November-January there can be heavy rainfall and extensive flooding coupled with storms.

The study area is on the canal and in the Cerro. A kayak was used for data collection on the canal. The transect on the north side of the canal is approximately 3,5 km long and ends at Hotel Turtle Beach Lodge. The south side is approximately 2,5 km and ends at Rio Suerte. The Cerro is a forest with a hill. The 1,2 km transect for this study area ran around the hill (Figure 3). When Howler monkeys where seen on the way back to the station, they were still recorded. Of Costa Rica's 12 ecological life zones, tropical wet forests account for 5 % (2 352 km²) of the national territory (Janzen 1983, Myers 1990). Most lowland wet forests are characterized by a combination of palm swamps in saturated high canopy forest. The palms are predominantly Raphia and Manicaria genus. Caño Palma's forests are Manicaria swamp. The predominant vegetation type is Manicaria palm with Raphia. There are mainly large trees and palms of the Lauraceae, Fabaceae, Moraceae, Rubiaceae, Sapotaceae, Annonaceae and Arecaceae families (Lewis et al, 2010). The Manicaria habitat at Caño Palma contains a mean plant species density of 7.0 per 0.1 ha (Myers 1990).
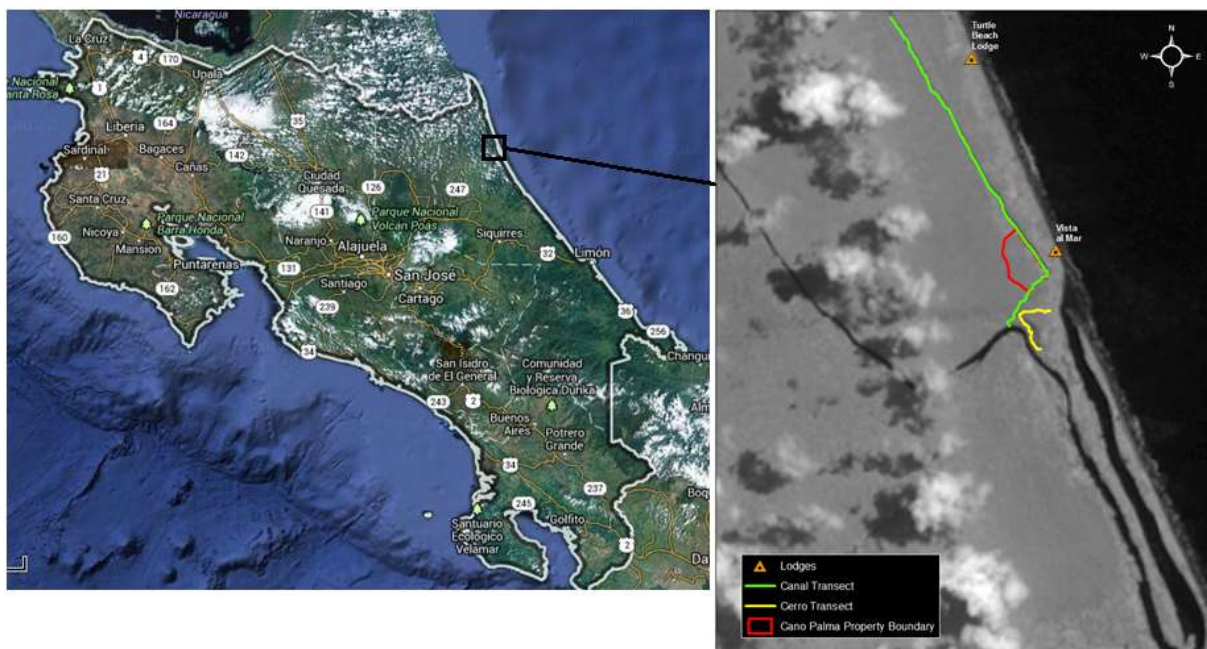

Figure 3: Location of the study area at the northeast corner on the Caribbean side. The transect, lodges and the property of Caño Palma are shown.

2.2 Data collection

Observations of *A. palliata* were made between February 18 and May 31, 2013. Data collection was carried out on four mornings and three afternoons per week. The morning surveys started at 5.30h till 8.30h. At that time it is light enough to see them and they are still howling, so they are easier to locate. The afternoon surveys started at 14.00h till 16.00h. The monkeys will probably move to the place where they sleep.

The focal animal sampling and the scan sampling are the two methods that are used to collect data. The focal animal sampling focuses on a singel individual in a troop. In scan sampling, an individual is scanned at set time intervals, and the behaviour that the individual is doing at the moment of the scan is recorded. One individual from each troop was observed. The observation takes ten minutes and every fifteen seconds the behaviour is written down. If the monkey is out of sight, the observation stopped. If the observation took less than 6 minutes, another monkey was observed. The observations that took less than 6 minutes are not used. The study aimed to observe an equal number of males, females, sub-adults and juveniles.

The age/sex of the monkey is written down. The species of the tree that they are in are noted and in which part of the tree they stay. This can be low, middle or high. Figure 4 gives a visualization of what low, middle and high is in a tree. Table 1 shows a definition of the part of the tree. Where plants can not be identified in the field, samples will be taken for later identification.
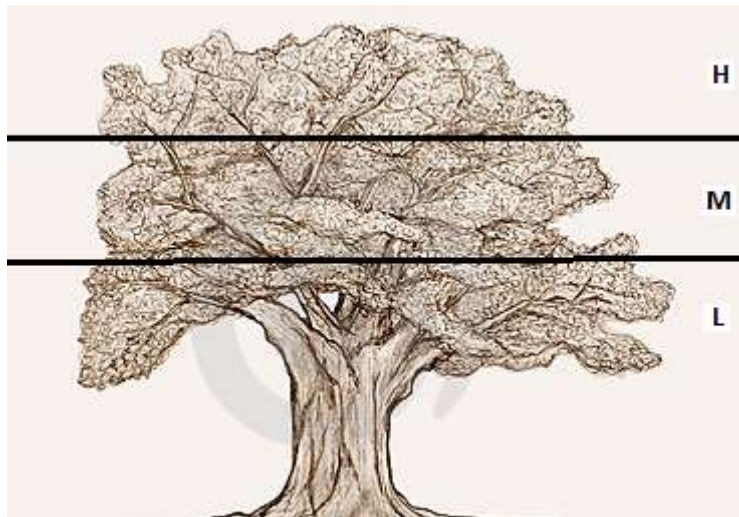
Figure 4: Visualisation of the parts low, middle and high in a tree.

Three different types of behaviours were recorded: Eating, resting and moving. Within 'eating' eight different categories of food were distinguished: leaves, stems, flowers, leaf buds, fruit, leaf petiole and pulvinus. In appendix 1 is an example of the datasheet attached.

Part of tree	Abbreviation	Explanation
Low	L	The first third of where the leaves start in the tree.
Middle	M	The second third of the leaves.
High	H	The last third till the top of the tree.
Behaviour		
Resting	R	The monkey is laying or sitting on a branch with his eyes open or closed.
Moving	M	Going to another tree or moving to another place in the same tree is the definition of moving.
Eating	E	Chewing, looking for food and grab food.

Table 1: Overview of the abbreviation and explanations.

As told in the introduction you can recognize troops by the number of males, females, sub adults and juveniles. Juveniles that are still on the belly or back of their mother are recorded. Also the abnormalities will be recorded.

Every time the howlers were found, the GPS coordinates have been taken. By recognizing the troops it is possible to tell if they have their own territory and how big the territory is.

2.3 Statistical analysis

The collected data is filled in an Excel file and the analyses are made in SPSS. The Shapiro-Wilk test was used to test the data for normal distribution. For sex/ages and behaviour it is (p_{min}=0.079) and (p_{max}=0.050). Homegeneity of variance is analyzed with a Levene's test (p_{min}=0.274). The normal distribution for sex/ages and the position in the tree is (p_{min}=0.110) and (p_{max}=0.034). Homogeneity of variances is (p_{min}=0.679). Above data is both analyzed with the Kruskall-Wallis test.
Time and behaviour have a normal distribution of (p_{min}= 0.075) and (p_{max}=0.005). The normal distribution of time and the position in the tree is (p_{max}=0.005). Further analysis is done with the Mann-Whitney test. For none conclusive transformations were found.

3. Results

During this study there have been 81 observations of which 25 were males, 28 females, 12 sub-adults, 13 juveniles and three unknown. That gives 3240 counts in total. The activity 'Resting' has been seen for 2132 times, moving 279 times, eating 659, playing 17, mating 2 and the howlers were 151 times out of sight. Figure 5 shows these numbers in percentages.
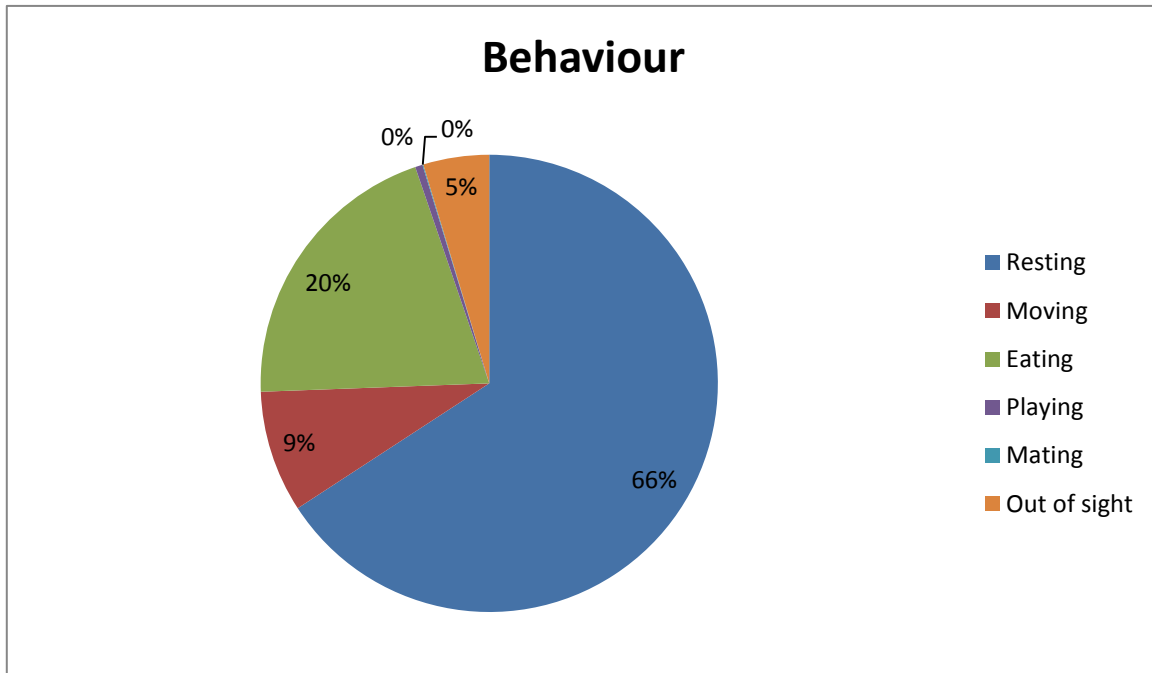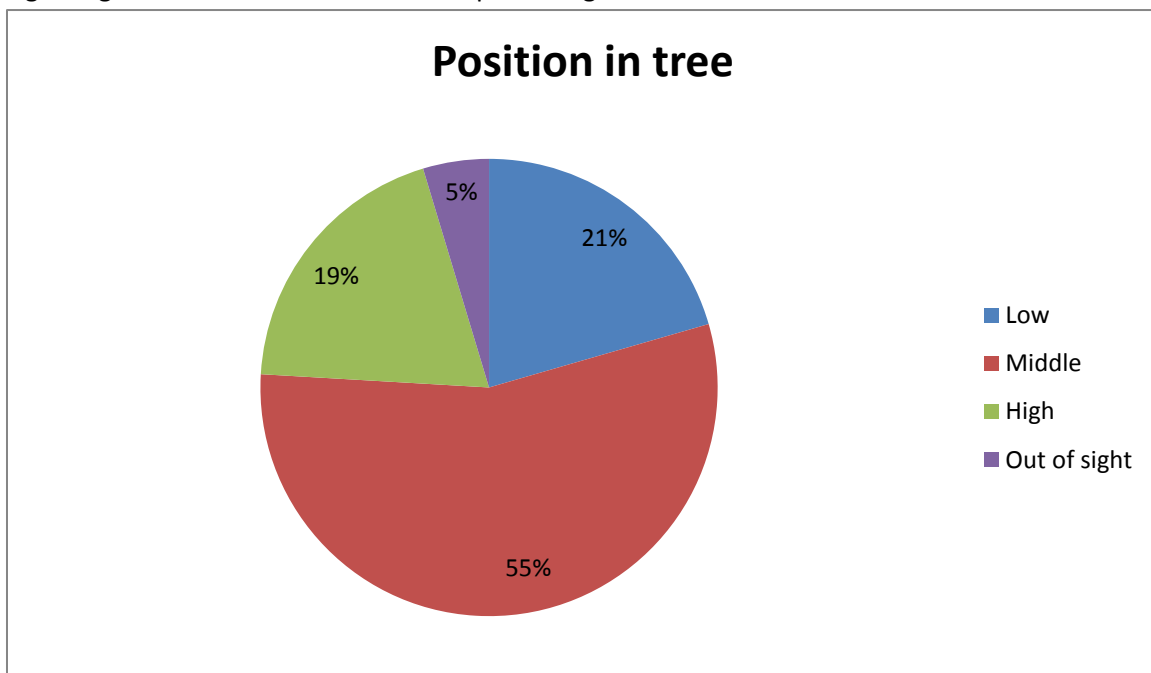

**Figure 5:** Behaviours of all observations.

Of the 3240 counts there have been 665 low, 1795 middle, 629 high in the tree and 151 were out of sight. Figure 6 shows these numbers in percentages.

Figure 6: The place where the individual was in the tree during the observation.

The behaviour 'Eating' has 611 counts. Eating leaves is seen for 88% (534 counts) of the observations. Monkeys who were eating flowers have been seen for 6% (39 counts) and 6% (38 counts) for eating fruit.

Figure 7 shows points where all the data is found. On the Cerro transect are less troops found than on the canal and at Hotel Vista al Mar. In figure 8 there are three recognizable troops. The blue points are of a troop with 14 individuals. This troop is recognizable by a male with an orange tail and a female with orange foot. The orange points are a troop with a female with an orange right foot and have six individuals. The purple points represent a troop with 5 males, 5 females and 2 sub-adults. This troop is found in the Cerro and on the canal.
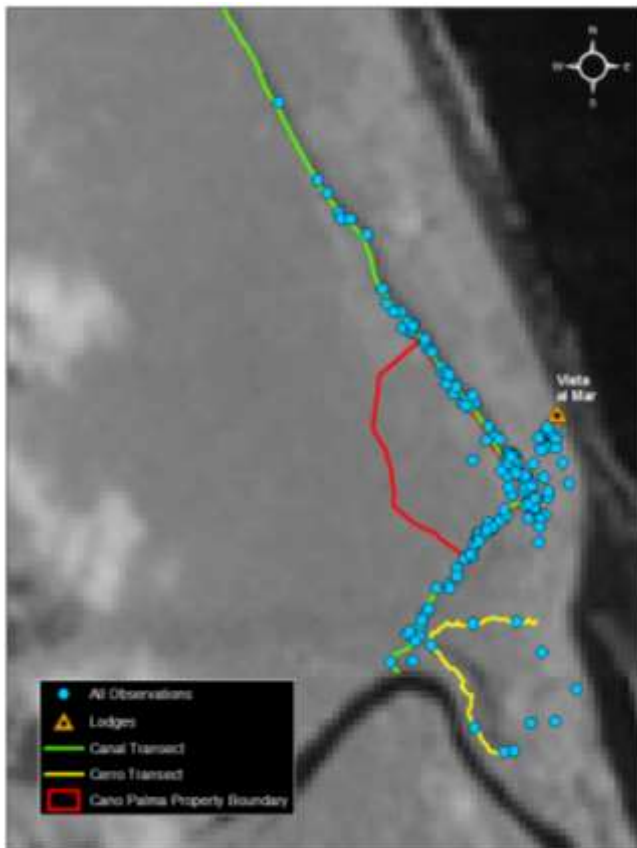
Figure 7: Map with points of all the collected data.
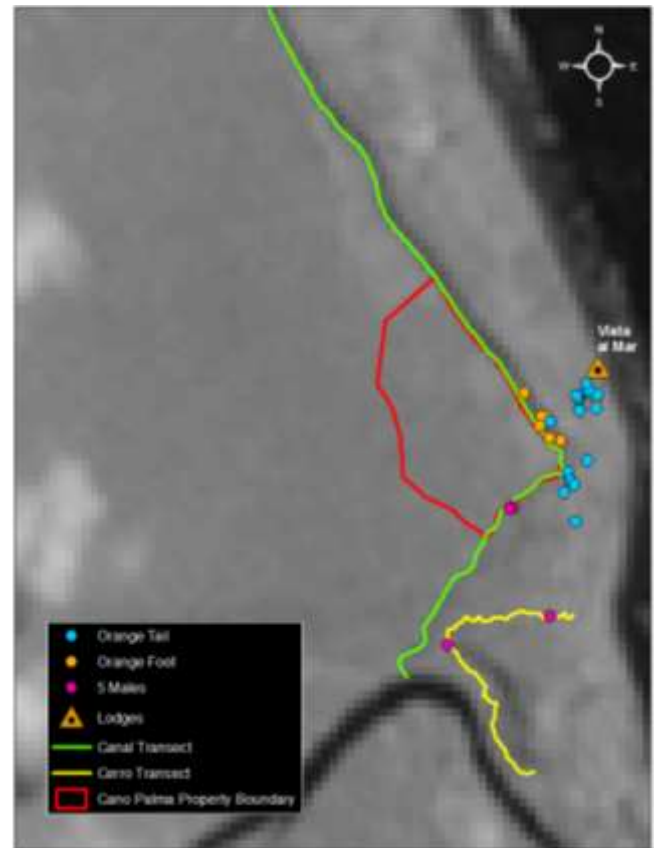
Figure 8: Map with three recognizable troops

There is no significant difference between sex/age and the behaviours resting, moving and eating (p=0.236, p=0.803, p=0.990). However there is a difference between females and sub-adults in the behaviour resting. Females rest significant more than sub-adults. There were too little counts of the behaviours playing and mating, that they could not be recorded in the tests.

Sex/age and the position of the monkeys in the tree are not significant. Low, middle and high give p values of (p=0.583, p=0.887, p=0.813).

Time and resting and eating is not significant (p=0.480, p=0.932). Between time and moving is a significant difference (p=0.038). During mornings they travel more often.

No significance is found between time and the positions low, middle and high in a tree (p=0.262, p=0.328, p=0.591).

4. Discussion

The howler monkey rests the majority of the day. 66% of the counts were noted as 'Resting'. This is related to the big amount of leaves they are eating (88%). The digestion of leaves takes a lot of energy (Milton, 1980; Milton & McBee 1983). 'Moving' is noted during 9% of the counts and 'Eating' for 20%. Estrada et al (1999) and Pavelka & Knopff (2004) state that the monkeys spend up to 80% of their day resting. A possible reason for the higher number in the current study could be that if a troop was found and a monkey was eating, that specific monkey was observed. Only one sub-adult was observed while 'Playing' and one male during 'Mating'. Between females and sub-adults a significant difference is found. Females rest more than sub-adults. Time and 'Moving' give a significant difference (p=0.038). They travel more during mornings. Between time and 'Resting' or 'Eating' is not a significant difference. During the observations while eating, 6% of the counts they were eating flower. Another 6% showed that they were eating fruit. The study that has been done in the Neotropics by Chapman in 1988 shows that the monkeys ate 22,5% flowers and 28,5% fruit. They were also eating leave buds. The study in the Neotropics that has been done by Baum in 2005 shows that they were eating flowers for 0,0% and fruit for 29,3% of the time. This difference could be because the time of the year. The fruits and flowers they eat the most were maybe not present. The tree species are also different.

The howlers were 55% of the counts in the middle of the tree. They were low in the tree for 21% and high for 19% of the counts. The test for sex/age and the position in the tree was not significant. Neither was a significant difference between time and the position.

More troops are found during the canal transect than on the Cerro transect. Three individual troops could be distinguished. A troop with 14 individuals that could be recognized by a mail with an orange tail and a female with orange foot lived on the property of Hotel Vista al Mar and a little further south. Another troop have been seen at the property of Vista al Mar as well. This troop consists of six individuals. This troop was recognizable by the female with an orange right foot. The last troop that is distinguished is a troop with 5 males, 5 females and 2 sub-adults.

References

- Avery, R & Cave, R & e.a.. (2002). *International Wildlife Encyclopedia.* Third edition. Marshall Cavendish Corporation.

- Baum, J.A. (2005) Foraging Behaviors of Alouatta palliata, Mantled Howling Monkeys. Nebraska Anthropologist.

- Canadian Organization for Tropical Education and Rainforest Conservation (2013) COTERC mission statement - http://www.coterc.org/., accessed on 10th of April, 2013

- Chapman, C. (1988) Patterns of Foraging and Range Use by Three Species of Neotropical Primates. Primates, 29(2): 177-194.

- Costa Rica National Parks (2012) Barra del Colorado Wildlife Refuse - http://www.costarica-nationalparks.com/tortugueronationalpark.html., accessed on 10th on April, 2013.

- Cristobel-Azkarate, J. & Arroyo-Rodriguez, V. (2007) Diet and activity pattern of howler monkeys (Alouatta palliata) in Los Tuxtlas, Mexico: Effects of habitat fragmentation and implications for conservation. American Journal of Primatology 69: 1013-1029.

- Denver Zoo (2013) Black howler monkey - http://www.denverzoo.org/downloads/dzoo_black_howler_monkey.pdf., accessed on 30th of March, 2013.

- Di Fiore, A. and Campbell, C. (2007). "The Atelines". In Campbell, C., Fuentes, A., MacKinnon, K., Panger, M., & Bearder, S. Primates in Perspective. New York: Oxford University Press. pp. 155–177.

- Estrada, A., Solano, S. L., Martinez, T. O. & Coates-Estrada, R. (1999) Feeding and general activity patterns of a howler monkey (Alouatta palliata) troop living in a forest fragment at Los Tuxtlas, Mexico. American Journal of Primatology 48: 167-183.

- Glander, K. (1983) Alouatta palliate- (congo, howling monkey, howler monkey). p. 448-449.

- Glander, K. (1980). Reproduction and population growth in free-ranging mantled howling monkeys. American journal of physical anthropology 5325-36 (1980).

- Greenspan, E., (2013) Costa Rica. Frommer's 2013

- Holdridge, L. R. (196) Lifezone Ecology (revised edition). San José Tropical Science Centre, San José. 206 p.

- Janzen, D. H. (1983) Costa Rican Natural History.University of Chicago Press, Chicago. 823 p.

- Lewis, T., Grantz, P., Quesadas, M., Ryall, C., La Dukes, T. (2010) A botanical survey of Caño Palma Biological Station (Estación Biológica Caño Palma), Tortuguero, Costa Rica. BRENESIA 73-74: 73-84.

- Lopez, G. O. Terborgh, J. & Ceballos, N. (2005) Food selection by a hypersense population of red howler monkeys (Alouatta seniculus). Journal of Tropical Ecology 21: 445-450.

- Milton, K. (1980) The foraging strategy of howler monkeys. Columbia University Press, New York.
- Milton, K & McBee, RH. (1983) Rates of fermentative digestion in howler monkeys. Comparative Biochemical Physiology 74: 29-31.

- Myers, R. L. 1990. Ecosystem of the World 15; Forested Wetlands. Elsevier, Amsterdam. 527 p.

- National Geographic (2013) Howler monkey - http://animals.nationalgeographic.com/animals/mammals/howler-monkey/., accessed on 22th of March, 2013.

- Pavelka, M. S. M. & Knopff, K. H. (2004) Diet and activity in black howler monkeys (Alouatta pigra) in Southern Belize: does degree of frugivory influence activity level? Primates 45: 105-111.

- Pinto, L. P. & Setz, E. Z. F. (2004) Diet of Alouatta belzebul discolor in an Amazonian rain forest of Northern Mato Grosso State, Brazil. International Journal of Primatology 25: 1197-1211.

- Reid, F. (1997) A field guide to the mammals of Central America and Southeast Mexico. New York: Oxford University Press, Inc..

- Schoville, S. (2013) Animal Diversity Web, Alouatta palliate mantled howler monkey – http://animaldiversity.ummz.umich.edu/accounts/Alouatta_palliata/., accessed on 23th of March, 2013.

- Zucker, E., Clarke, M., Glander, K., Scott, N. (1996). Sizes of home ranges and howling monkey groups at Hacienda la Pacifica, Costa Rica: 1972-1991. Brenesia 45-46: 153-156 (1996).

Appendices

Appendix 1

Datasheet for observing a howler monkey.

Time of visualization: GPS: Accuracy:

\# Males: \#Females: \#Subadults: \#Juveniles:

Time (min)	Age/sex	Genus species	Where in tree	Behaviour	Portion of plant
0.15					
0.30					
0.45					
1.00					
1.15					
1.30					
1.45					
2.00					
2.15					
2.30					
2.45					
3.00					
3.15					
3.30					
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8.00					
8.15					
8.30					
8.45					
9.00					
9.15					

9.30					
9.45					
10.00					

Comments:

Legend

Age/sex	**M**= Male
	F= Female,
	SA= Sub adult
	J= Juvenile,
	U= Unknown
Where in tree	**H**= High
	M= Middle
	L= Low
Behaviour	**E**= Eating
	R= Resting
	M= Moving
Portion of plant	**L**= Leaf
	LB= Leaf buds
	LP= Leaf petiole
	P= Pulvinus
	Fl= Flower
	Fr= Fruit