



**Monkey Census in Pejeperrito watershed, Osa
Peninsula, Costa Rica**



Friends of the Osa

**Study sponsored by the El Tigre Fund and carried out by
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ABSTRACT

The four species of monkey that inhabit the tropical forests of Costa Rica, Geoffroy's Spider Monkey (*Ateles geoffroyi*), the Mantled Howler Monkey (*Alouatta palliata*), the White-faced Capuchin Monkey (*Cebus capucinus*) and the Central American Squirrel Monkey (*Saimiri oerstedii*) have reduced populations. The main reasons for this decline are poaching and habitat lost for agriculture and development. The main goal of this study was to estimate the population sizes of the four monkey species in the Pejeperro watershed area, Osa Peninsula. Four transects were walked regularly over a period of 2.5 months. The total area surveyed was approximately 21.7 hectares. Distance estimation suggested Howler Monkeys and Squirrel Monkeys have the biggest troop sizes. Also, the Howler Monkey is the more common species, followed by the Squirrel Monkey, while the Spider Monkey is the least abundant specie in the studied area. The waterfall trail was where most individuals were recorded for Howler and Spider Monkeys, whereas most Squirrel Monkeys where seen on Jim's trail. The Spider Monkeys and Howler Monkeys were seen more in the mornings, the Squirrel Monkeys were seen more often in the afternoons, while the Capuchin Monkeys were seen equally at the different times of day. Even though more effort or a different methodology is needed to have a more accurate population size estimate for the Pejeperrito watershed area, we discuss some of the trends we found. This first monkey census shows how important unprotected areas outside the Corcovado National Park are for monkey species, which needs to be kept in mind as development is on the increase in the Carate area.

INTRODUCTION

There are four species of monkey that inhabit the tropical forests of Costa Rica. They are Geoffroy's Spider Monkey (*Ateles geoffroyi*), the Mantled Howler Monkey (*Alouatta palliata*), the White-faced Capuchin Monkey (*Cebus capucinus*) and the Central American Squirrel Monkey (*Saimiri oerstedii*). Each of these species has a reduced population in Costa Rica with the Squirrel Monkey having the smallest population and being classified as endangered. The main reasons for this decline are poaching and habitat lost for agriculture and development (Boinski *et al.* 2002, Estrada and Coates-Estrada 1996, Ra´ez-Luna 1995).

Many studies on ecology, natural history, genetics and population status of monkeys in Costa Rica have been conducted (Clarke and Sucker 1994, Glander *et al.* 1991, Sorensen and Fedigan 2000, Zaldivar *et al.* 2004). The best known are the Mantled Howler Monkeys and the Central American Squirrel Monkeys. Troops of *A. palliata* have been studied for years at Hacienda La Pacifica and Santa Rosa National Park in the province of Guanacaste (Clarke *at al.* 1986, Clarke and Sucker, 1994, Glander *et al.* 1991) and troops of *S. oerstedii* have been the subject to a lot of research in Manuela Antonio National Park, Puntarenas province (Boinski and Sirot 1997, Wong 1990a, 1990b).

Even when there is not an accurate estimate of the population size of the monkey species for the whole country, there are several estimations for some localities within protected areas (Boinski and Sirot 1997, Clarke *et al.* 2002a, 2002b, Fedigan and Jack 2001, Freese 1976, Massey 1987, Sorensen and Fedigan 2000). At Santa Rosa National Park, Freese (1976) estimated population sizes of 110 individuals for *A. geoffroyi*, 85 *A. palliata*, and 300 *C. capucinus*. Almost 30 years after, the populations of *A. palliata* and *C. capucinus* have increased to 606 and 585 respectively (Sorensen and Fedigan 2000, Fedigan and Jack 2001). At Manuel Antonio National Park, Boinski and Sirot (1997) estimated a population of 100 individuals for *S. oerstedii* and Zaldivar *et al.* (2004) mentioned that the *S. o. oerstedii* range from 200 and 500 individuals in Corcovado National Park.

The Osa Peninsula, in the south-western Pacific coast of Costa Rica (Fig. 1), contains the last remnants of Central American Pacific tropical rain forest. Approximately 71% of the forest in the Peninsula is protected under different categories: two national parks (Corcovado National Park and

Piedras Blancas National Park), a Wild Life Refuge (Golfito Wild Life Refuge), an Indian reservation (Gauymi Indian Reservation) and a forest reserve (Golfo Dulce Forest Reserve). However, only national parks have total protection and no economic activities are allowed, whereas some economic activities are approved in the other categories.



Figure 1. Map showing the location of the Osa Peninsula in Costa Rica. Source: <http://www.1costaricalink.com/eng/web/maps/dominical-osa-map2.jpg>

Few studies have been done on the Osa's monkey species (Carrillo *et al.* 2000, Solano 2007). Carrillo *et al.* 2000 found that monkey species are in general more abundant within Corcovado National Park than in the Golfo Dulce Forest Reserve, due mainly to higher rates of poaching outside the National Park. Also, abundance during a four year period remains constant for the Mantled Howler Monkeys, White-faced Capuchin Monkey and the Central American Squirrel Monkey within Corcovado National Park, while Geoffroy's Spider Monkey populations increased during this period (Carrillo *et al.* 2000). Solano (2007) evaluated the Central American Squirrel Monkey habitat outside Corcovado National Park. *S. o. oerstedii* troop size was positively correlated to forest cover and forest edges and negatively correlated to the presence of *A. geoffroyi* (Solano 2007).

Pejeperrito watershed is located in the Carate area, one of the main entrances to Corcovado National Park (Fig. 2). The Carate area has been free of big infrastructure and has maintained populations of all four

monkey species. However, in the last year some new development projects have begun. Traditionally, the main threat to monkeys outside Corcovado National Park was poaching, but now this new threat of development is increasing the need to evaluate the population status of monkeys in the area in order to develop conservation strategies.



Figure 2. Map showing the location of Carate in the Osa Peninsula. Source: http://www.guariadeosa.com/img/maps/osapeninsula_area_locator.jpg

The main goal of this study was to estimate the population sizes of Geoffroy's Spider Monkey (*A. geoffroyi*), the Mantled Howler Monkey (*A. palliata*), the White-faced Capuchin Monkey (*C. capucinus*) and the Central American Squirrel Monkey (*S. oerstedii*) in the Pejeeperro watershed area. Also, we want to address the following questions: 1. Are monkey species uniformly distributed within the Pejeeperro watershed?; 2. What are the optimum times of day to observe the different monkey species?

METHODS

Study Area

According to the Life Zone System proposed by Holdridge (1947, in Janzen 1983), the Pejeeperro watershed (Fig. 3) in Carate is Topical Wet Forest. This is the second most extensive life zone in Costa Rica and the most species-

rich one. Tropical Wet Forest is tall, multistratal, evergreen forest, with a few deciduous canopy species (Janzen 1983).



Figure 3. Pejeperrito lagoon seen from “El Palomar”.

Most of the lowlands in the study area were dominated by cattle farms until the 80’s, and have now been allowed to develop secondary forest; however, there are some spots with primary forest. The highest parts were less disturbed and it is possible to find primary forest in most of the area.

Study Species

Geoffroy’s Spider Monkey (*Ateles geoffroyi*), also known as the black-handed Spider Monkey, is found mainly in Central America from south Mexico through to Panama and potentially as far as Colombia. It gets its name from its long limbs which make it look like an arachnid. Like many of the New World monkeys, it has a prehensile tail which it uses as an extra limb. They are quite specific in their diet, mainly eating ripe fruit, and as such, require large areas of forest (Estrada & Coates-Estrada 1996). The nearby Corcovado National park is estimated to have one of the largest populations of this species (Weghorst 2007).

The Mantled Howler Monkey (*Alouatta palliata*) is one of 9 species of howler monkey inhabiting the New World. This specie is well known for their loud calls that can be heard from more than one kilometre in dense forest. These vocalizations are a spacing mechanism between troops and a means of communication within social groups (Janzen 1983). They are made up of complex multifemale-multimale groups (Janzen 1983, Mora

2000). They are strict herbivores, surviving mainly on the consumption of leaves, but also flowers and fruits (Janzen 1983).

The White-faced Capuchin Monkey (*Cebus capucinus*) is considered the most intelligent of the New World monkeys and its wild population has suffered from its removal for the pet trade as well as from habitat loss. It is known to use tools such as sticks to remove insects from holes and stones to crack dried fruit (Waga *et al.* 2006). It is omnivorous and is known to prey on small mammals such as young Coatis.

The Central American Squirrel Monkey (*Saimiri oerstedii*) is the most endangered monkey species in Costa Rica. It is the only one of Costa Rica's Monkeys that does not have a prehensile tail. These monkeys spend time in large troops of more than 20 individuals (Mora 2000). These are the most active monkeys of the four species studied for this census. Like the White-faced monkeys, they are also omnivorous and so have a varied diet. There has been debate about the origin of this Central American species as it had been suggested it was a hybrid species that had been introduced into Costa Rica and Panama. However, Cropp and Boiski (2000) tested and rejected this hypothesis, concluding that they are a native species.

Census methods

Five transects were chosen to represent this area (Fig. 4). The Palomar trail was used to begin with, but soon had to be dropped due to hazards caused by the start of the rainy season. There were also no monkeys seen on this trail. The four remaining trails were walked mornings and afternoons over a period of 2.5 months between the second week of April and third week of June 2008. The survey was undertaken two times a day during the early morning and mid-afternoon as monkeys are more active at these times (Solano, pers. com.). Also, we restricted the data recording to these periods in order to control the sample effort. For any primates encountered along these transects, the species and group size were noted. When possible, their sex and age was also determined. Transects were walked at a relatively constant pace and stops to take down data took a maximum of ten minutes. It was not possible to keep the lengths of the trails constant as already existing trails were used to minimise impact (Table 1).

Table 1. Length of trails used during census and habitat type.

Trail Name	Length (m)	Habitat type
Palomar	3200	Mainly primary forest
Lagoon	2300	Old secondary forest and young secondary forest
Jim's	1000	Half deforested and half old growth forest
Waterfall	2000	Part Palma real plantation, part road and part primary forest
Main Road	2200	The road passes through mainly secondary growth, exotic garden plants and deforested areas

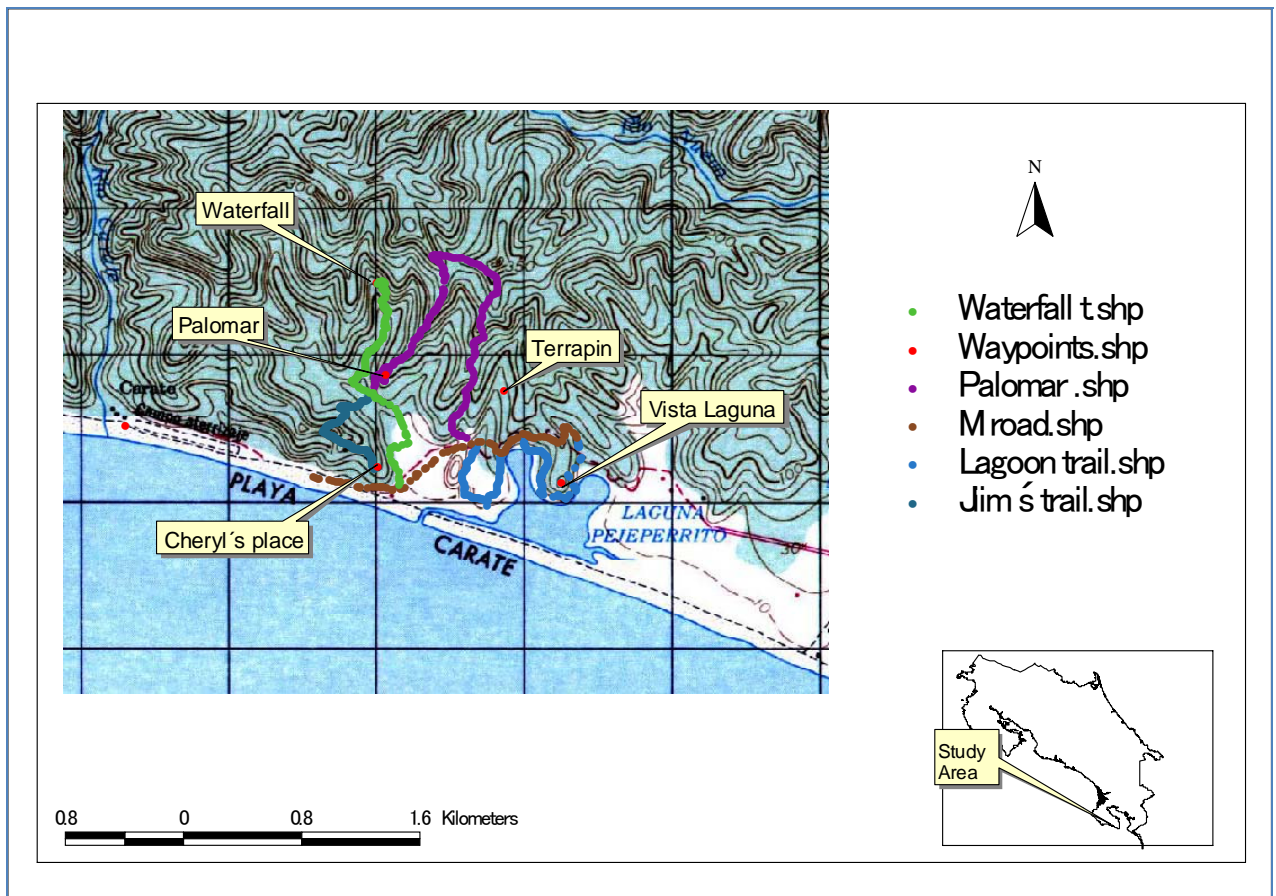


Figure 4. Trails used for the monkey survey in the Pejeperro watershed. Osa Peninsula.

Data analysis

Troop size and population estimate

To estimate the cluster (troop) size and the number of individuals present in the study area for each species of monkey, we used Distance software (Thomas *et al.* 2006). This software has been used successfully for estimating mammal populations (Chiarello 2000). For the analysis, we used the mean of observed clusters as the cluster size estimation method in the model definition. The total area surveyed was estimated as the product of the trail length and twice the average of the distance of the troops from the trail.

Habitat and daytime preference

To determine whether the different species are uniformly distributed within the Pejeperro watershed area, we compared the total number of individuals recorded between transects with a Chi² test. We used the same test to determinate whether the total number of individuals recorded was equal at the different times of day they were surveyed (am/pm).

To establish whether the different monkey species were found at similar heights from the ground, we used an ANOVA, with monkey species as the factor and height as the dependent variable. We used Tukey as a post hoc test. The analysis was computed using Systat 10 (SPSS Inc. 2000).

RESULTS

The total area surveyed was approximately 21.7 hectares. This area comprises open areas, gardens, secondary forest, real palm plantations and old growth forest. In the 2.5 months of survey, 58 sights were recorded for the four monkey`s species. Distance estimation suggested Howler Monkeys and Squirrel Monkeys have the biggest troop sizes. Also, the Howler Monkey is the more common species, followed by the Squirrel Monkey. The Spider Monkey is the least abundant in the studied area (Table 2). It is important to note that the small sample size (i.e. the small number of observations during this survey) means that results from Distance may not be accurate. A larger sample effort or a different methodology is needed to get a better estimate of population size for the four monkey species in the studied area.

Table 2. Distance software results for the four monkey species studied.

Monkey spp	Average troop size	Troop size coef var	N	N coef var
<i>A. geoffroyi</i>	4,42	0,17	54	0,443
<i>A. palliata</i>	9,73	0,19	169	0,494
<i>C. capuchinus</i>	5,46	0,17	95	0,416
<i>S. o. oerstedii</i>	8,3	0,22	106	0,643

There were differences between the total number of individuals of each species recorded per transect (Chi2= 91,05, gl= 9, P<0.001)(Fig. 5). The waterfall trail was where most individuals were recorded for Howler and Spiders Monkeys, whereas most Squirrel Monkeys were seen on Jim's trail.

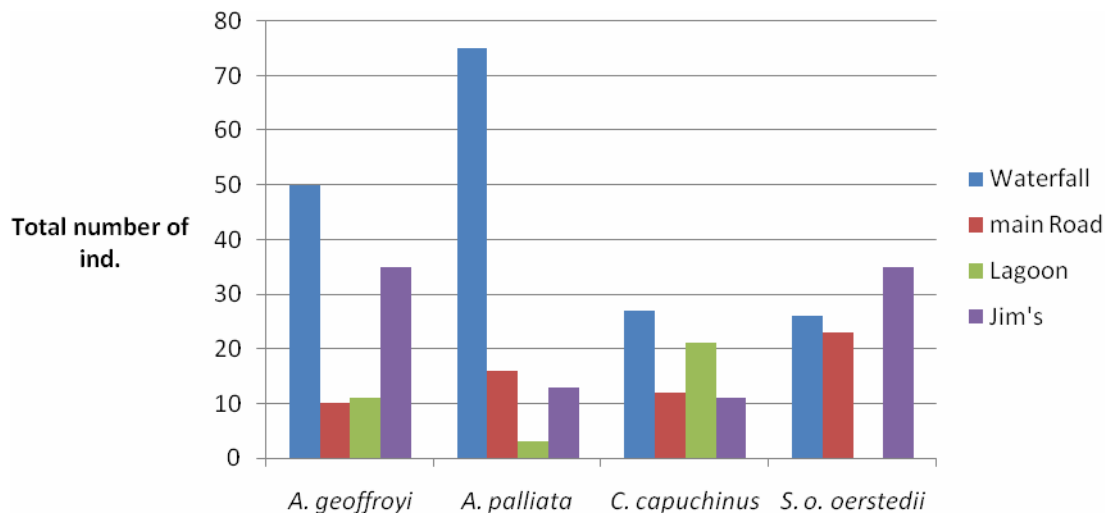


Figure 5. Total number of individuals recorded for each monkey species by trail.

We found a significant difference between the total number of individuals recorded for each monkey species between mornings and afternoons (Chi2= 84, 44, gl= 3, P<0.005) (Fig. 6). The Spider Monkeys and Howler Monkeys were seen more in the mornings, the Squirrel Monkeys were seen more often in the afternoons, while the Capuchin Monkeys were seen equally at the different times of day.

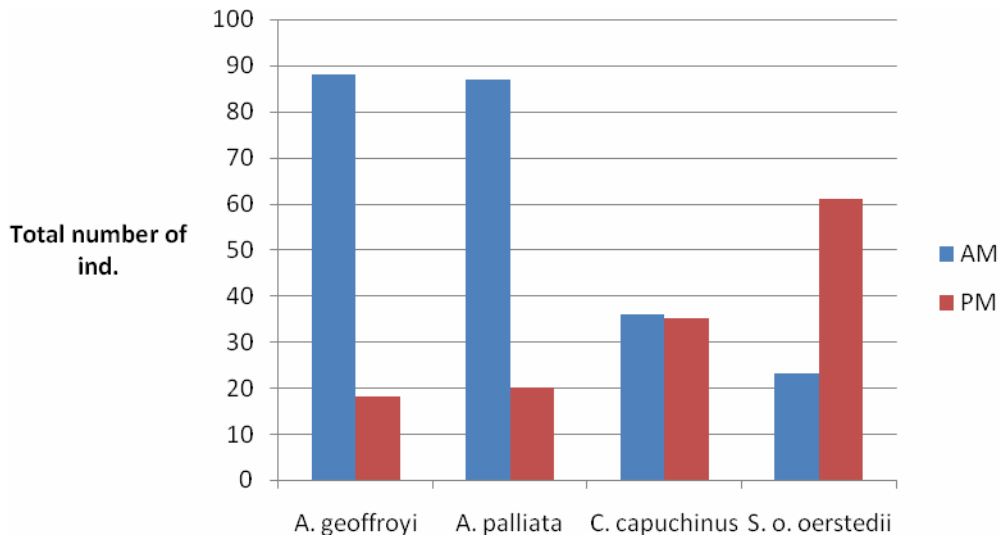


Figure 6. Total number of individuals for each monkey species according to the time of day surveyed.

There are significant differences between the average height at which the species were found ($F= 4.595$, $df= 3$, $P= 0.007$)(Fig. 7). There is a trend that *A. geoffroyi* and *A. palliata* were seen at higher average heights than the other two species. However, the only significant difference is between Howler Monkeys and Squirrel Monkeys (Table 3).

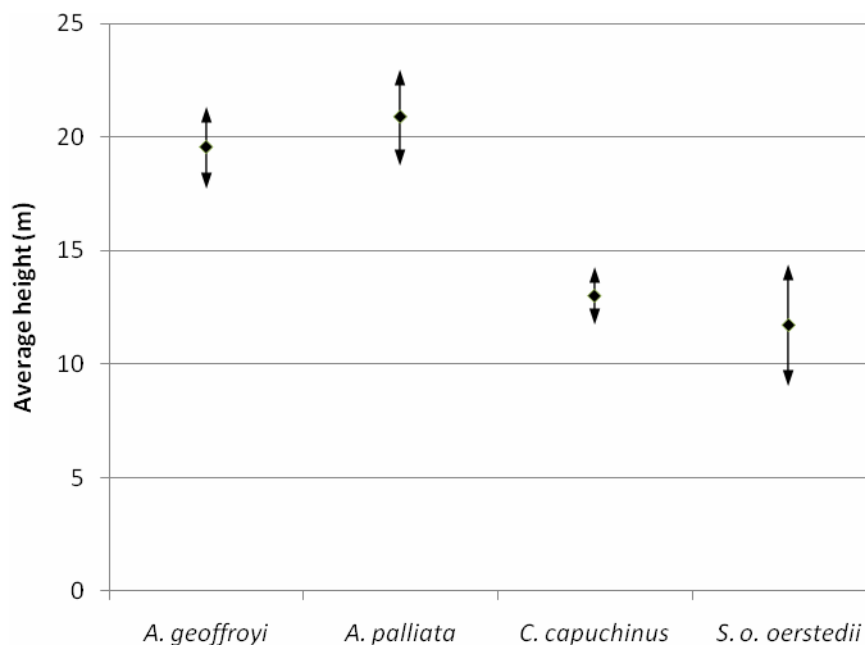


Figure 7. Average height from the ground and standard error for each monkey species

Table 3. Matrix of pairwise comparison probabilities for Tukey HSD.

	<i>A.</i> <i>geoffroyi</i>	<i>A.</i> <i>palliata</i>	<i>C.</i> <i>capuchinus</i>	<i>S.</i> <i>oerstedii</i>	<i>o.</i>
<i>A. geoffroyi</i>	1.000				
<i>A. palliata</i>	0.961	1.000			
<i>C. capuchinus</i>	0.075	0.062	1.000		
<i>S. oerstedii</i>	0.054	0.044	0.979	1.000	

DISCUSSION

Troop size and population estimate

The results show that howler monkeys spent time in the largest troops. This may not paint an accurate picture as squirrel monkeys are usually seen in the largest troops. These results might have been biased due to the large troop of howler monkeys repeatedly seen on the Waterfall trail. Squirrel monkeys are also much harder to count than howler monkeys as they are constantly on the move. For this reason, it was often impossible to tell the real size of the squirrel monkey troops and these were often underestimated. The average troop size of 4.42 for spider monkeys and 5.46 for capuchin monkeys is consistent with what was observed. Spider monkey troops are said to be made up of 20-40 individuals. However, spider monkeys form fission-fusion groups, which means that the troop breaks up into smaller groups to forage during the day and come together to sleep at night-time. This would explain the small troop sizes that were observed during the study.

Even though more effort or a different methodology is needed to have a more accurate population size estimate, there are some trends that can be discussed. Zaldívar *et al.* (2004) mentioned that in several monkey censuses carried out, mainly in the Guanacaste area, Spider Monkeys were least common. This is consistent with the results of this study (Table 2). The estimate of 106 Squirrel Monkeys within the studied area could be an overestimate considering that the whole Corcovado National Park has an estimated population of between 200 and 500 Squirrel Monkeys (Zaldívar *et al.* 2004). However, Squirrel Monkeys seem to have a preference for secondary forest which is found outside the park, so this estimate might also be accurate.

Habitat and daytime preference

The results show that Howler Monkeys were most commonly seen on the waterfall trail. The main reason for this result may have been one particular Howler Monkey troop that was repeatedly seen on this trail. This troop consisted of 18 individuals at first and later 21 individuals after the birth of three offspring.

Sightings of Spider and Howler Monkeys were much more frequent in the mornings than afternoons. This is because they are often sleeping high up in the canopy until the weather cools down in late afternoon. Squirrel Monkeys, however, were seen more frequently in the afternoons. This

species is a lot more active than the other three and does not seem to pause for rest during the day. They were regularly seen on the move in late afternoon, on their way to their sleeping grounds. The capuchin monkeys were seen equally in the mornings and afternoons.

Howler Monkeys are found significantly higher up in the canopy than squirrel monkeys. The difference between the height at which Howler Monkeys and Capuchin Monkeys are seen is almost significant, as is the difference in canopy height that Spider Monkeys and Squirrel Monkeys are found at. This may be due to several factors, the first being that Howler and Spider Monkeys spend more time in primary forest and the canopy in these areas is higher. Another factor may be that Capuchin and Squirrel monkeys are omnivorous and feed on a wide variety of foods whereas the howler and spider monkeys are more specific in their tastes of foods, which are often found higher up in the canopy.

The endangered Squirrel Monkey

The Central American Squirrel Monkey is endangered and troops have only been documented outside two national parks in Costa Rica (Corcovado and Manuel Antonio) (Boinski & Sirost 1997). This makes the population in Carate very important to the survival of the species and special protection should be granted in this area. During the study, development in the area was already underway which included deforestation, building and planting of exotic, ornamental plant species. This would be disastrous for the Carate population of Squirrel Monkeys.

Further observations

In carrying out this census, several interesting observations were made. First, contrary to common belief, it is not only the white-faced monkey that comes down the ground. Squirrel monkeys and spider monkeys were both observed leaving trees, either to collect food or while playing. Another interesting observation, which deserves further investigation, is the inter-specific associations between birds and monkeys. Toucans, Aracaris, Double-toothed Kites and White Hawks were all observed following troops of monkeys through the canopy. The birds eat the insects and small vertebrates the squirrel monkeys flush out (Boinski and Scott 1988, Boinski and Tim 2005). A final interesting point to make is that on several occasions, two or even three species of monkey were seen foraging in the same tree. Their association bore no structure or discipline, unlike what has previously been observed in other areas. This lack of structure may be due to the reduced populations of aerial predators.

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