

The Survival of the Central American Squirrel Monkey (*Saimiri oerstedii*): The habitat and behavior of a troop on the Burica Peninsula in a conservation context

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I dedicate this paper which documents
my first scientific adventure in the field
to my father.

“It is often necessary to put aside the objective measurements favored in controlled laboratory environments and to adopt a more subjective naturalistic viewpoint in order to see pattern and consistency in the rich, varied context of the natural environment”
(Baldwin and Baldwin 1971: 48).

Acknowledgments

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Abstract

The conservation status of Central American Squirrel monkeys (*Saimiri oerstedii*) on the far southern coast of Peninsula Burica in Panama was assessed over the course of a 13 day study period. Four troops of squirrel monkeys (67 individuals) were located on the southern coast of Peninsula Burica. Using information from local sources it can be estimated that up to 7 troops (157 individuals) live in the 7-8 km² study site. These troops are sharing an estimated 80 ha of habitat which compared to past studies is a fairly low amount of habitat.

One troop of squirrel monkeys which is fed at an eco-lodge (Mono Feliz) was assessed in terms of behavioral characteristics, habitat-use, and membership distribution. The Mono Feliz troop had 32 members the preponderance of which appeared to be males. During the study period, no females were conclusively identified during monitoring or feeding times. The troop had similar behavioral characteristics to other troops studied in the past (lack of play behavior, urine washing, chasing, genital sniffing etc...) except demonstrated intense resource-based aggression, unusual in *Saimiri oerstedii*, in response to being fed bananas. Because the study occurred in the late wet season and fruit and arthropod abundance were at their minimum, the rest of the troop's diet consisted of Huevo de Mono and insects. The monkeys were seen eating ants, katydid, moths, and spiders during the study period.

The troop spent 8% of its time exclusively traveling and 29% of its time juggling travel and forage. Stationary rest and forging took up the majority of the troop's time (43%) while stationary foraging consumed only 19% of the day. The troop almost never exclusively rested during the day (1%). In these activities the troop utilized a total of 28.9 ha of habitat during the study period and spent 29% of their time within 1 ha. of Mono Feliz which the troop returned to multiple times per day. The daily feeding of the monkeys was therefore found to constrict foraging circuits to the area around the central location of Mono Feliz.

The forests that the monkeys utilized contained large patches of early secondary growth forest, corridors of exclusively cultivated trees, an older secondary growth ridge (crowns 30-35 m), and mixed forests containing scattered larger trees as well as dense undergrowth. The average tree height of the areas sampled was 10.6 m high. There were several places within the troop's normal routes where habitat bottle-necked and the monkeys had to run along the ground or make a very difficult arboreal crossing one by one.

The largest conservation challenges in the area go hand in hand. Hunting presents a genuine threat to the populations of squirrel monkeys around Punta Burica due to good prices (5-25 dollars) and the ease of catching one. The reason the babies can be caught by hand is because the monkeys must descend to the ground to connect together their habitat due to their fragmented foraging areas. Hunting is probably at least contributing to the lack of female monkeys in the area and could possibly be much of the reason for their decline. There are two contrastingly different eco-tourism/ private reserve projects developed and in development in the area. These projects have the potential to substantially help the monkeys of the area by creating habitat, educating visitors and locals, and connecting together isolated fragments of land; but much care must be taken with projects especially large-scale ones because unintended consequences can easily render the projects harmful rather than helpful.

El Supervivencia del Mono Ardilla (*Saimiri Oerstedii oerstedii*): el hábitat y comportamiento de una manada de Península de Burica con un contexto de conservación del área.

Se realizó un estudio de la situación del mono titi o mono ardillo (*Saimiri Oerstedii oerstedii*) en el sur de Península de Burica. Este mono vive solamente en el lado de Pacífico a la sur del Costa Rica y en el parte mas oeste de Panamá. No hay muchos de este monos in el mundo. La estimación mas reciente dice que hay menos que 2 mil de estos monos quedan en pequeño bosques en Costa Rica y Panamá. Estos monos comen insectos y frutas y viven en dentro bosques secundarios y tierra molestada por gente.

Por lo menos 67 monos ardillos de 4 manadas se encontraron en el área del estudio de 7-8 km² pero siguiendo a fuentes locales 3 más manadas utilizan el área. Estas manadas son compartiendo alrededor 80 hectáreas de hábitat. Esta hábitat es comprendido del bosque secundario, áreas de los árboles cultivado, bosque secundario joven y bosque de galería que crecen en las orillas de las quebradas. Los otros 6.5 km² del área de estudio son sin árboles y son usado para vacas y agricultura. Comparar a otros estudios, hay menos área para sostener este número de monos que normal.

Una manada del mono ardilla se estudió mas intensivamente que las otras manadas sobre su comportamiento, uso de hábitat, números de miembros y uso de tiempo. Esta manada es alimentada con bananas cada día en un hotel pequeñísimo y reserva de animales se llama Mono Feliz. La manada tiene 32 miembros y durante la época de estudio no se puede encontrar una hembra en las manadas. La manada tiene comportamiento similar a otras manadas que eran estudiadas en el pasado. Exponen comportamiento como perseguir, oler de genitales, una falta de comportamiento de juego y lavar de manos pero esta manada también muestra agresión debido a recursos cuando alimentan bananas a Mono Feliz. Esta comportamiento no es normal para este especie y es probablemente ha desarrollado debido a los recursos de bananas. El estudio era relazado tarde en la estación de lluvia cuando los insectos y los frutos son menos disponible que en cualquier tiempo del año. Adicionalmente a la comida de Mono Feliz, los monos comieron hormigas, mariposas nocturnas, arañas y fruta de Huevo de Mono

La manada pasó mas tiempo descansando mientras buscando para comida que cualquier otra actividad. En total la manada pasó 91% de su día buscando para comida. Quedaron muy cerca de Mono Feliz (más cerca de un hectárea) por 29% del día y muchas veces regresaron de una ruta para buscar comida. Probablemente alimentar los monos ha hecho el rango de la manada más pequeño porque la manada necesita regresar a un lugar central para ver si hay comida.

Los bosques que son el hábitat de la manada contienen partes grande de bosque secundario joven cerca de Mono Feliz y al oeste hay una espinosa de loma que tiene bosque secundario más viejo. Esta espina conecta a dos otros porteros viejo que en este tiempo tienen árboles grandes. Al este hay un corredor de árboles cultivado que conecta un otro bosque secundario mezclado. El promedio de alturas de árboles en el rango es 10,6 metros. Hay lugares en dentro las rutas de la manada donde los monos tienen que caminar por la tierra o saltar entre dos árboles una por uno. Si algunos árboles sean cortado en estos áreas, grande áreas de hábitat seria sin uso a los monos.

Obviamente perdido de hábitat es un problema grande in esta área y afecta mucho los números de monos in el área. La falta de hábitat también lo hace más fácil para cazar los monos y ésta es un problema grande en el área. Muchos bebes son vendido cada año a personas de Ciudad de Panamá y David. Probamente cazar explica por lo menos parte de la falta de hembras obvias en el área de estudio. Finalmente hay dos proyectos de eco-turismo de diferente forma (uno grande con mucho afecto ambiental y uno mas

pequeño con menos afecto ambiental) en el área que están preocupados con la protección de los monos ardillo. Estos proyectos tienen mucho potencial a ayudar las manadas de mono ardillo pero tienen que tener cuidado entonces sus planes no dañan a los monos más que ayudan.

Overview of *Saimiri*

Squirrel monkeys belong to the primate family *Cebidae* and the genus *Saimiri*. These monkeys live in tropical forests extending from Costa Rica through central Bolivia. There are two groups of squirrel monkeys: the Roman type and the Gothic Arch type (this refers to the shape and shading of the fur around the eyes). The Roman type, containing *Saimiri boliviensis*, is found only in South America mainly in Peru, Bolivia, and Brazil. These monkeys are more commonly referred to as Black-capped or Black Squirrel Monkeys. The second Gothic Arch type contains *Saimiri sciureus* (Common Squirrel Monkey), *Saimiri utus* (Bare-eared Squirrel monkey), and *Saimiri oerstedii* (Central American Squirrel Monkey). *Saimiri sciureus* and *Saimiri utus* are both distributed in northern South America.

The species, upon which this study focuses, *Saimiri oerstedii*, is divided into two subspecies: *S. oerstedii oerstedii* and *S. oerstedii citrinellus*, which are the only species of *Saimiri* that inhabit Central America. In the past there was debate as to whether this species was genetically distinct from the other species of Squirrel monkeys or was introduced in the area by “prehistoric American traders as a hybrid from multiple localities in South America” (S. Croop & Bonski 2000). S. Croop and Bonski determined conclusively using DNA sequence data, fossil records, and taxonomic methodologies that the *S. oerstedii* branch of *Saimiri* is genetically distinct from the South American populations and probably diverged genetically more than 500,000 years ago.

The two subspecies, *S. oerstedii oerstedii* and *S. oerstedii citrinellus*, ranges are thought to be completely isolated with *S. o. oerstedii* inhabiting the Southern Pacific coastal lowlands of Costa Rica and a small piece of the northern portion of Panama. The range of *S. o. citrinellus* is located to the north of the Rio Grande de Terreba north of the Osa Peninsula. The Central American Squirrel Monkey’s range is further reduced because they only inhabit areas less than 300 meters above sea level (Bonski and Sirot 1997: 181).

***Saimiri oerstedii*: Biology and Behavior:**

While earlier laboratory and semi-natural studies on captive populations of *Saimiri* were complete in the 1960’s (Dumond 1968, Baldwin 1968, Ploog 1967), Baldwin and Baldwin did the first long term studies of squirrel monkeys in the field. Their first publication was a comparison of *Saimiri* populations in four different countries: Panama, Columbia, Brazil, and Peru. (Baldwin and Baldwin 1971). Later the couple completed a 10-week field study at a site near the Escerra river in Chiriqui, Panama. The troop consisted of 23 members and utilized a range of .175 km². After the work of the Baldwins, Sue Boinski can be given credit for much of the rest of the information that can be found about *S. o. oerstedii*. She has done extensive research on multiple troops in Costa Rica on topics ranging from ranges and habitat usage to mating and vocalization behaviour.

Physically *S. o. oerstedii* can weigh up to 1 kilo, but generally females weigh less than 600 grams and males weigh about 750 grams (Boinski and Sirot 1997). Their bodies are and legs tend to be a golden brown color with a black and white hairy face. Their tails are black and are not prehensile and therefore are utilized for balance. It is very difficult to definitively determine the sex of a Squirrel monkey unless the female is pregnant or has a baby on her back.

This species, like all other *Saimiri* species is arboreal and diurnal meaning they travel in the trees and forage during the day. Usually the monkeys will forage most of

the morning, rest during the hottest portion of the day, and continue to forage and travel in the afternoon. They prefer secondary and disturbed forests to primary forest because they almost exclusively utilize branches with diameters between 1-2 cm to travel and forage. *S. oerstedii* diet consists principally of phytophagous arthropods such as grasshoppers, katydids, and caterpillars. They also eat small berry-like fruits which tend to ripen gradually over a long period of time. If other food sources are not available Squirrel monkeys will eat cultivated fruit such as guava, banana, mango, and cacao. These food sources are all more abundant in disturbed, secondary, and cultivated forest areas than in primary forest (Boinski et al 1998).

The food sources of *S. o. oerstedii* vary in abundance over the course of the year with a large lack of berries and arthropods occurring at the very end of the wet season. At this point troops extend their ranges by 50% and demonstrate almost constant foraging and travel (Boinski 1988 and Boinski & Sirot 1997). This food stress can be noted by squirrel monkey appearance, the scraping of sticks for arthropods, foraging on the ground, fighting over food, unrolling dead leaves, and eating fruits larger than berries (Boinski and Sirot 1997).

Saimiri oerstedii troop sizes tended to range from 10-35 animals as compared to the other species of South America which had between 120 and 300 members. These numbers however seem to depend largely on range size. In large areas of continuous forest troops can range from 40-70 members (Massicot 2005). These troops tend to be egalitarian and non-aggressive with social structure building out from an adult female core (Mitchell et al. 1991). Costa Rican and Panamanian Squirrel monkeys exhibit almost no play behavior or social interactions as compared to South American Squirrel Monkeys (Baldwin & Baldwin 1972). However the troops do engage in bouts of chasing (generally females chasing away males), genital smelling (to determine sexual condition of females and identify other monkeys), and urine washing (the hypothesis is sexual readiness and identification also) (Boinski 1992).

Unusually the juvenile female squirrel monkeys are the ones who migrate to new troops to maintain gene flow. This means that many of the males in *S. oerstedii* troops are genetically related especially within a group cohort. They also rather uniquely tend to “maintain close spatial and social relationships with other males... exhibit negligible within troop male-male aggression, high levels of predator vigilance and predator deterrence; and cooperate in aggressive olfactory investigation of females” (Boinski and Mitchell 1994)

Males tend to demonstrate a hierarchal structure in terms of mating. Older females show preference for mating with the dominant male of the troop. Around breeding season males become “fatted” meaning they can gain up to 20% more body weight in their shoulders. During this period, genital sniffing to assess reproductive readiness increases (Boinski 1987b). The mating season occurs from early August to early October. Female squirrel monkeys demonstrate birth synchronicity and variable gestation periods meaning that even with a breeding season 2 months long generally all of the young are born within 10 days of each other in March. The grouping of births is thought to increase survival rates by reducing predation pressure on infants (Boinski 1987a). These infants become mobile at 4 weeks old and begin foraging within 6 weeks. Within 4-5 months the infant is foraging normally and is generally separated completely from the mother. (Boinski and Fragaszy 1989)

Lastly *Saimiri oerstedii* demonstrate complicated and sometimes as of yet unexplained relationships with other animals. Both Boinski and the Baldwins note a relationship of *Saimiri oerstedii* with *Alouatta* (Howler Monkeys). The troop which Baldwin and Baldwin studied in Chiriqui spent at least half of 24 days foraging around

Alouatta and were observed to change direction in order to forage near the other troop. However no actual interaction between the two species was observed (1972). Additionally the *Saimiri oerstedii* share most of the same diet as the *Cebus* (White-Faced Capuchin) monkey and demonstrate some fear to this larger and more aggressive monkey. Baldwin and Baldwin observed avoidance of *Cebus* by a Panamanian squirrel monkey troop (1972). Different bird species, double toothed kites (*Harpagus bidentus*), grey-headed tanagers (*Eucometis pencillata*), and tawny-winged woodcreepers (*Dendrocincia anobatina*), appear to follow troops of squirrel monkeys and benefit from the insects, lizards, and other food sources that the *Saimiri oerstedii* uncover (Boinski and Scott 1998).

Conservation Status

S. oerstedii oerstedii was considered to be endangered by IUCN starting in the 1970's and remains on the list today. The conservation situation of *S. oerstedii citrinellus* is even worse with the species considered to be critically endangered (IUCN 2004). While there is a general scientific consensus that the Central American Squirrel monkey is in decline and in serious trouble, exact numbers and methodologies for determining population status differ greatly. Boinski in 1985 estimated that 3,000 *S. o. oerstedii* and 500-1000 *S. o. citrinellus* remained in the world. She could not find any evidence of troops remaining in Panama due to heavy deforestation, but obviously there were troops surviving in these areas (Boinski and Sirot 1997:181). In 1997 Boinski along with a group of other scientists estimated the surviving populations to 2000 and 1500 individuals respectively (Boinski et al. 1998:54). Rodriguez-Vargas however uses a meta-population mathematical model to estimate a population of 4,755 *S.o. oerstedii* in Panama in 2,613.41 km². He estimates the population for Peninsula Burica—the peninsula where this studied was undertaken, to have more than 1000 *S.o. oerstedii* (Rodriguez-Vargas 1998).

The causes of the drastic reduction in Squirrel monkey populations in Panama and Costa Rica are logical and multifaceted. The first major wave of habitat destruction in Chiriqui, Panama took place in the 1950's and 60's, replacing forest with banana plantations, cattle ranches, sugar cane, and rice farms. A thriving pet trade during this period also decimated populations as did heavy spraying for malaria and yellow fever (Baldwin and Baldwin 1972). This species is threatened at this point largely by continued habitat destruction and fragmentation, pesticide use, hunting/pet-trading, silviculture, forest progression, electrocution, and tourism (Boinski et al. 1998).

Scientists are just beginning the work of locating and studying the troops of *Saimiri oerstedii* that are surviving in Panama. *Saimiri oerstedii* are at a distinct disadvantage because they inhabit elevations and therefore directly compete with agriculture. Therefore their habitats are generally not incorporated in mountainous protected areas. Vargas did an extensive thesis on a troop of Squirrel monkeys living near San Carlos where she analyzed diet, habitat use, and arthropod abundance (2003). Additionally Seiter (2005) did a brief conservation analysis of a troop near the town of Divali. Conservation plans protecting at least some small areas exist in Costa Rica which contains at the best estimate the most substantial numbers of *Saimiri oerstedii*, however in Panama, conservation efforts are still basically nonexistent. It is important to continue the process of gathering information about *Saimiri oerstedii* populations, behavior, habitat, and diet, so that appropriate conservation plans can be undertaken to try to preserve what small populations of Central American Squirrel Monkeys are left in Panama. Additionally recommended conservation methods for this species remain relatively untested. It is important to know such things as the effect of a feeding station vs. the effect of natural food augmentation on a *Saimiri oerstedii* troop.

Purpose

The purpose of this study was to attempt to understand and document how *Saimiri oerstedii* is surviving in fragmented habitats in Panama. In order to determine the answers, the populations of squirrel monkeys in and around Bella Vista located in the southern the portion of Peninsula Burica in Panamá were chosen as study subjects. The study site was situated on the far western edge of Panama and is actually split by the Costa Rica/Panama border. This study was focused on the southern most 8 km² of the Panamanian side of the Peninsula. This study site was chosen because there were confirmed *Saimiri oerstedii* troops in the area, as well as, it contained Mono Feliz an eco-lodge of sorts is located on the beach on the southern edge of the Peninsula. The lodge is a seven hectare monkey haven run by a couple who feed bananas to the *Saimiri oerstedii* troop that comes to the house. The monkeys of this troop were already fairly habituated to the presence of humans making them a perfect candidate for a model troop because the study period was constrained to only 13 days in length. Since the Mono Feliz troop is being fed for conservation purposes, it provides a good indication of how feeding stations would affect the everyday life of squirrel monkey troops. The ultimate hope of the project is that perhaps with a heightened understanding of the behavior of a specific squirrel monkey troop, the effects of a feeding station on a wild troop, and the conservation status of squirrel monkeys in the area; scientists can better tackle the huge challenge of saving this dying species from extinction.

Questions

Specifically, research was focused on answering the following questions about the general populations of monkeys in the area and specifically about the Mono Feliz troop.

- How many *Saimiri oerstedii* are located in the Southern Peninsula Burica around Bella Vista, and what area of habitat do they have to survive?
- What is the sex distribution, general behavioral characteristics, and activity budget of a *Saimiri oerstedii* troop in Punta Burica?
- What are the habitats, foraging patterns, and sleeping areas of a *Saimiri oerstedii* troop living in Punta Burica?

Using these data which was collected in Punta Burica from November 23 to December 5 2005, this paper will explore and discuss the following more general questions using the study area as a model:

- How do the patterns, habitats, attitudes, and behavior of a troop that is being fed artificially differ from that of troops that do not have additional food sources?
- What are the conservation status and largest threats to *Saimiri oerstedii* in the Bella Vista area?

How many *Saimiri oerstedii* are located in the Southern Peninsula Burica around Bella Vista, and what size of habitat do they have to survive?

Methods

To determine *Saimiri oerstedii* populations in the area, actual observation and surveys for squirrel monkey populations were combined with information gleaned by

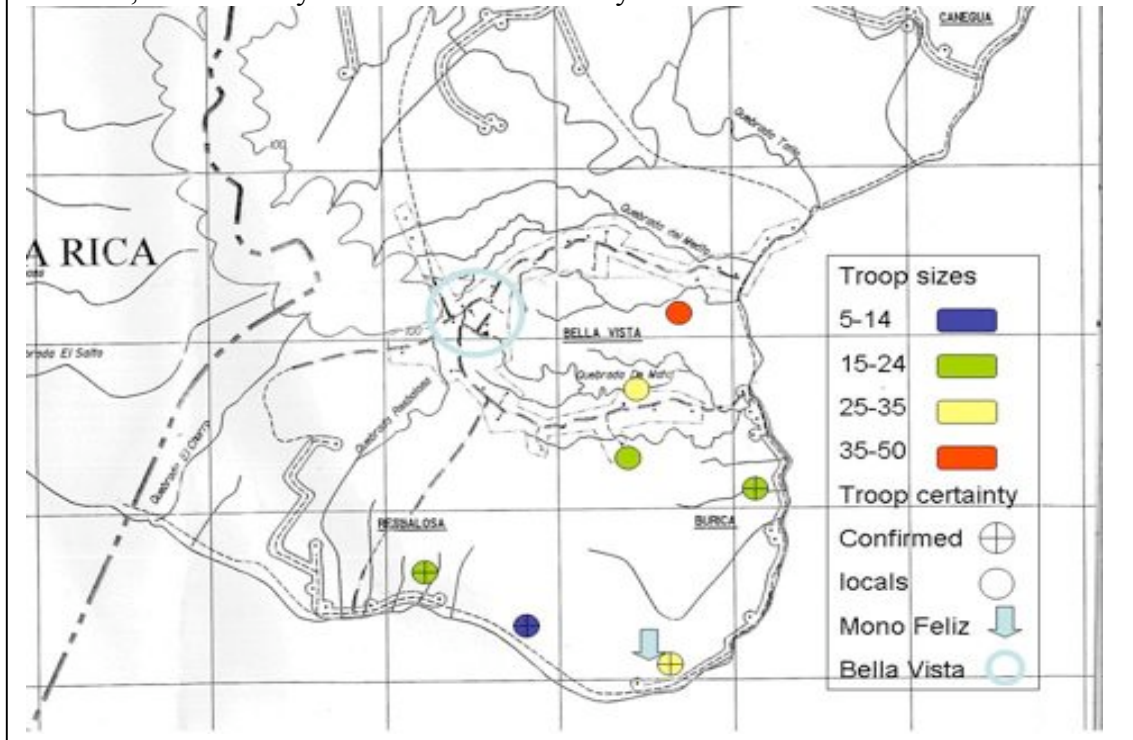
casually interviewing local residents. Simple land surveys were performed by walking in the few forests and gallery forests that can support or be used for transport by squirrel monkeys. Troops were located by listening for vocalizations, scanning the trees for nonrandom branch movements, sighting a double toothed kite (this happened on two occasions), locating howler monkey troops, and noting lack of surrounding bird song. Upon location of troops an attempt was made to count the members in the troop, but when troops were widely dispersed this exercise proved to be futile. Due to the pet-trade in the area, as well as, the close proximity of the monkeys to the inhabitants' everyday life, some locals proved to be very knowledgeable about the squirrel monkeys of the area. Information from some sources was preferred above others based on their general knowledge of monkey behavior, as well as, personal confirmation of informant information. Only troops that were confirmed by multiple local inhabitants were considered to be possible squirrel monkey populations. The size of squirrel monkey troops is very hard to determine when the troop is widely dispersed in a forest. Exact counts of 2 troops could be made but the others were estimated.

The same methodology of personal survey and local interviewing was used to estimate habitat area available to the monkey populations of the area. For large areas of forest a GPS unit accurate to 15-30 meters was used to estimate forest size. Additionally, creeks which are surrounded by thin bands of trees of variable thicknesses were surveyed and forest widths were estimated. The habitat area provided by the two permanent creeks that were not surveyed was estimated generously based on the general patterns of the other creeks. Additionally when no other information was available, information of local inhabitants was utilized to supplement habitat estimates

Results

Using personal surveying methods 4 *Saimiri oerstedii* troops were found in the forested areas that line the southern coast (Figure 1). Additionally three other troops (one allegedly containing 40-50 members) were described by multiple local people in the study area. In total about 67 squirrel monkeys were visually confirmed to be in the area and it is possible that about 157 monkeys inhabit the 7-8 km² area of the Peninsula explored by this study. The troops in the area according to the locals are largely lacking in females (only 3 or 4 females in a 30 member troop). This was tentatively confirmed in the Mono Feliz troop where no female monkeys could be found. Boinski and Sirot recommend a 40% proportion of adults female (>3 years old) for healthy squirrel monkey troops (1997). This would mean a troop of thirty monkeys should contain 12 adult squirrel monkeys. The locals also describe the number of babies this year as much lower than in the past which is further evidence that females in the area are not as abundant as they should be. Lastly older members of the community say that there are less than half the number of squirrel monkeys in the area compared to 10-15 years ago.

Figure 1: Estimate of number of squirrel monkeys in each troop, general troop location, and certainty of existence in the study area around Bella Vista



In general the area is largely agricultural with huge expanses devoted to cow pasture. There are also some agricultural crops planted in the area, as well as, a few older oak plantations. General local history describes the area as beginning to be first cleared about 40 years ago with a second wave of clearing occurring 10 to 15 years ago. Most of the large patches of land in the study area are either owned by Panamanians from Panama City and David or foreigners. Some of the owners hire locals to maintain their vast landholdings and keep cows on the property while other absentee owners have left the property as forest. At the moment, most of the land is cleared but a few overgrown early secondary growth pastures remain, as well as, non-continuous forest corridors that run along the year-round creeks of the area (Resbolosa, Burica, Mate, and Medio). These spotty corridors remain due to the Panamanian law that requires a 12.5 meter buffer zone on both sides of the permanent waterways (Seiter 2005). The early and mid secondary forest that is left is mostly within a 500 meters of the southern coast and runs along a 30-35 meter high ridge (Figure 2).

The 7 *Saimiri oerstedii* populations that probably inhabit the area appear to have by generous estimation 80.7 hectares of habitat, excluding 20 ha of Oak plantation (Table 1). This is not to say that all of the forested areas accounted for in this estimate are accessible to squirrel monkeys who must normally have trees to connect habitats. However locals of the area say that the *Saimiri oerstedii* are using barbed wire fence to connect habitat areas. This observation was confirmed during the study period, indicating a lack of other, more protected ways to connect the fragmented 100 hectares that forms the monkeys' habitat

Figure 2: Map of habitat areas of squirrel monkeys around Bella Vista. Enclosed areas indicate viable habitat areas while lines along streams indicate patchy gallery forest.

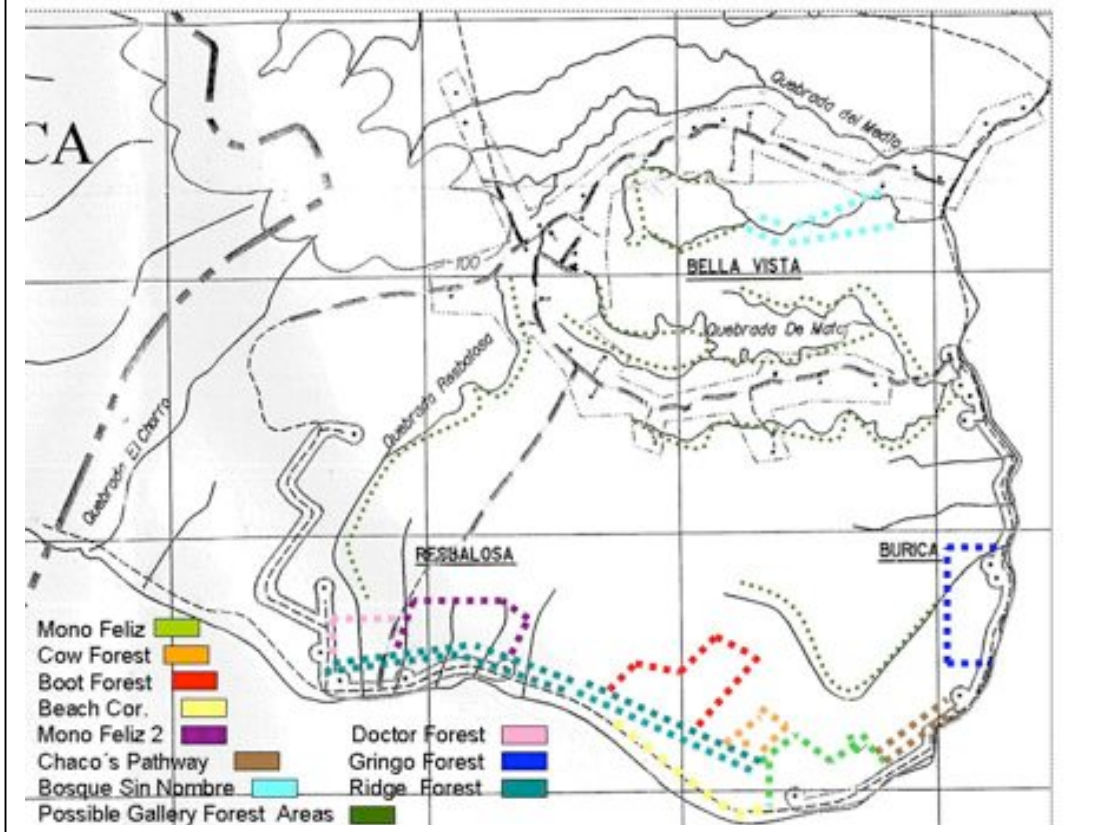


Figure 3: Estimation of habitat available to *Saimiri oerstedii* in the almost 8 km² area of the study area.

Table 1: Description of forest type of habitat areas, method of delineation, and area.

CF- forest made up primarily of silviculture, palms, or fruit trees

ESG-early secondary growth

MSG-mixed secondary growth

SG-secondary growth

GF-gallery forest

Habitat Areas

Name	Classification	Method	Area (hct)
Gringo Forest	MSG	GPS	4
Chaco Path	CF	GPS	1.8
Mono Feliz	ESG	GPS	7
Cow Forest	ESG	GPS	2.4
Boot Forest	MSG	GPS	6.15
Robles 1	CF	GPS	8.32
Robles 2	CF	Walked	10
Doctor Forest	ESG	Walked	4
Mono Feliz 2	MSG	GPS	10.7
Ridge	SG	GPS	12
Beach Loop	ESG	Walked	4
Q. Resbolosa	GF	Estimated	3.6
Q. Medio	GF	Estimated	4
Q. Mate	GF	Estimated	8
Q. Burica	GF	Estimated	2
Q. sin nombre	GF	Walked	10.9
Total			99

The approximately 400 inhabitants of the area seemed fairly knowledgeable but indifferent to the squirrel monkeys and other monkeys in the area. All but one local who lives along the same creek corridor on the way to Bella Vista from the coast reported identical frequencies of squirrel monkey passages per week even if they had never attempted to count troop size. The locals also reported that the monkeys eat their bananas and mangos as they pass by. There are certain members of the community, as well as children, who hunt the squirrel monkeys of the area. Ironically, this monetary incentive of monkey hunting could have increased local knowledge of the squirrel monkeys of the area. There is not much permanent work in the area. Besides agricultural work and odd construction jobs, the locals dive for conch and fish to make money. This situation makes the easy money of catching a squirrel monkey or cutting down area trees logical economic strategies.

What is the sex distribution, dietary components, general behavioral characteristics and activity budget of a *Saimiri oerstedii* troop in Punta Burica?

Methods:

In order to better understand the sex distributions, activities, diet, and behavior of the squirrel monkeys of the area, the Mono Feliz (MF) troop was chosen as a model for a more in depth study of Bella Vista *Saimiri oerstedii* behavior. This decision was made for a variety of reasons. This population was already fairly well habituated to human presence as they eat bananas out of human hands at Mono Feliz. In addition their morning feeding cycle allowed the perfect opportunity to easily encounter the troop in the morning if the sleeping area had not been found the night before. These characteristics were very important for successful data gathering as the study only spanned 13 days. Following of this particular troop also provided the opportunity to observe the effect of a reliable outside food source on a squirrel monkey troop.

The monkeys were followed as much of the day as possible over a 7 day period. Every 10 minutes a group scan was done which recorded weather, number of visible individuals, troop activity, troop dispersion, location, and foraging height. Weather was recorded under the simple labels sunny and cloudy and during data collection no rain ever took place. To determine visible individuals, one minute was spent scanning the area for visible squirrel monkeys. Troop foraging activity was defined in the same manner as Boinski (1987) (Table 2).

Troop activity	Definition
<i>Travel/forage</i>	Entire troop is traveling and foraging in a determinable direction
<i>Stationary foraging</i>	Troop does not move in obvious direction and every member is foraging
<i>Stationary rest/forage</i>	Troop not moving in an obvious direction and at least one member is observed to be foraging and one to be resting
<i>Stationary rest</i>	No troop members are observed to be either foraging or traveling
<i>Travel</i>	All troop members traveling in same direction and none were foraging

Table 2: Definitions taken from Boinski (1987)

Troop dispersion was measured as one of five categories (*widely dispersed, dispersed, linearly dispersed, line, and cluster*). The troop was described as *widely dispersed* when only 1 or two members could be seen at a time. *Dispersed* occurred

when 4 or 5 monkeys could be seen at one time but the troop was not moving in any particular direction. *Linearly dispersed* describes the troop traveling or foraging in a fairly wide band where the width of the troop can be determined. The troop was in a *line* formation when the monkeys were basically one right behind the other using the same pathway. Lastly *cluster* describes a closely packed formation where multiple monkeys are touching each other. An estimate of maximum troop dispersion was also administered by walking slowly through the squirrel monkey while the troop was widely dispersed.

Location was described in terms of predetermined habitat labeled areas. Foraging height was simply a rough estimate of the range of foraging heights of all the visible squirrel monkeys. If one or no monkeys were visible, then the estimate from the last scan was used in its place.

Data of this manner were collected for almost 40 hours on the Mono Feliz troop during the 13 day study period. The distribution of data gathered is skewed strongly towards the morning hours and slightly skewed towards the evening hours (Figure 4).

Diet was determined mostly by direct observation of monkey foraging and by collection of fecal samples which were examined for exoskeletons of insects and seeds without a microscope. Since these monkeys eat many bananas from Mono Feliz, all but one of the fecal samples obtained were mostly banana.

This study was not focused objectively on the behavioral characteristics of the troop, but with so much time spent observing the troop, patterns of internal troop behavior and obvious reactions to humans, monkeys, and birds were noted while troop following was occurring. Bouts of aggression, urine washing, genital smelling, the presence of kites, and the proximity of other monkeys were noted, but no attempt was made to quantify or objectively study these characteristics.

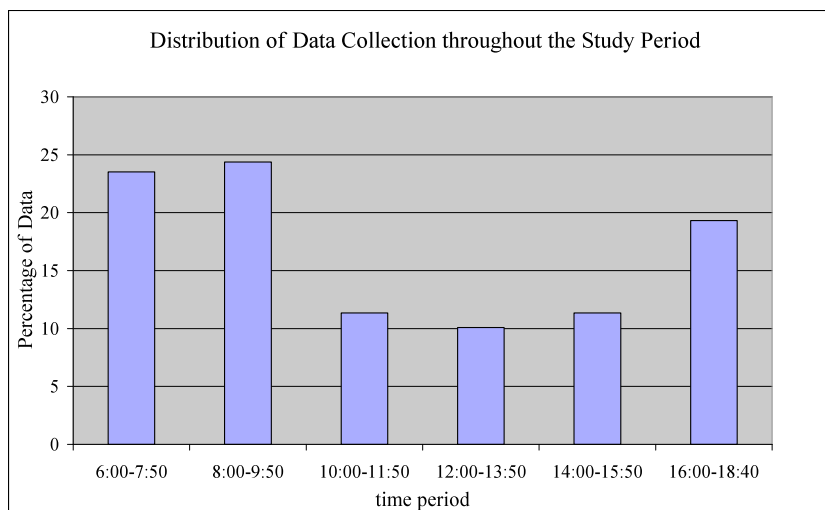


Figure 4: The distribution of scan data collected on the Mono Feliz squirrel monkey troop organized per 2 hour time period. *Note that the last time block actually accounts for a 2 hour 40 minute time slot of which the extra 40 minutes were always spent in the sleeping area.

Results:

The Mono Feliz troop contains 32 individuals most of or possibly all of which are males. It is very difficult to conclusively determine squirrel monkey sex unless babies are on the mother's back. There are 2 infants in the group who were never seen with a mother. There were at least 2 younger juveniles (2 years old), as well as, at least 9 older juvenile troop members (3-4 years) all of which are confirmed males. Additionally 6 members of the troop were confirmed to be adult males in the same count. Much time was spent searching for females in the troop when feeding occurred at

Mono Feliz, and it was easier to determine the monkey's sexes. More than once an older juvenile was followed who appeared to be a female and who ended up being a less developed male. Other times recipients of genital sniffing were followed because generally genital sniffing is initiated by males on females (Baldwin & Baldwin 1972 and Boinski & Sirot 1987). Sometimes the recipients of genital sniffing were identified as males and other times the sex could not be conclusively determined. It is possible also that the females of the troop did not come to Mono Feliz for food as they would be pregnant at this point. It is worth noting here that the owners of Mono Feliz say that an adult squirrel monkey disappeared with 4-5 of the troop's infants earlier this year.

The troop's diet consists heavily of the bananas fed to them at Mono Feliz. Additionally the troop foraged 91% of the day for insects. The insects that monkeys were capturing among the leaves of plants appeared to be for the most part very small. In addition to scanning branches for insects, the monkeys were also seen to unfurl dead leaves, especially large balsa (*Bombacaceae Ochroma*) leaves, and investigate the undersides of palm fronds. On two occasions members of the troop were seen to catch large brown moths (approximately 10 cm including wings). Also a few troop members were seen eating katydids and grasshoppers although these finds appeared to be rare and generally were caught within 3 meters of the ground. The monkeys also ate green Huevo de Mono fruits as well as green Guyava. As the study was conducted in the late wet season when arthropod and fruit availability is at its lowest, the troop was probably under some level of food stress and spent much time around Mono Feliz waiting for bananas.

The Mono Feliz (MF) squirrel monkey troop spent 8 % of its time traveling, 29% of its time traveling and foraging, 19% of the day in stationary foraging, 43% of the day in resting and foraging and only 1% of its time in stationary rest (Figure 5). In all, the troop invested over 91% of its time in foraging related activities (stationary forage, travel forage, and stationary rest forage). The amount of time expended in each category varied substantially over the course of each day with the percentage of time spent in stationary foraging (8.8-40.9%) varying the most over the study period and the percentage of time spent in stationary rest (0-4.2%) varying the least (Figure 6). Unlike in Boinski's study, travel occurred throughout the day and stationary forage dropped off in frequency in the middle of the day when the troop rested more while it foraged (1987) (Figure 7).

The troop spent the majority of its time foraging between 3.02 and 10.7 meters from the ground with an average height of 6.87 meters. As far as troop shape and distribution is concerned, the troop spent the majority of its time dispersed (34.03%), in a dispersed line (23.1%), and widely dispersed (19.7%) the least amount of time was passed in a line formation (7.9%). The 15% of time spent in a clustered formation is basically all accounted for by time spent at Mono Feliz. The general dispersion of the troop when widely dispersed spanned between 1.5 and 2 hectares which can be compared with the mean dispersion of Boinski's troop (1.6 ha) in the late wet season cumulatively through the day (1987). The Mono Feliz troop only spent 19.7% of its time this widely spaced out. Therefore the MF troop spent much more time close together than Boinski's troop in unobstructed habitat."

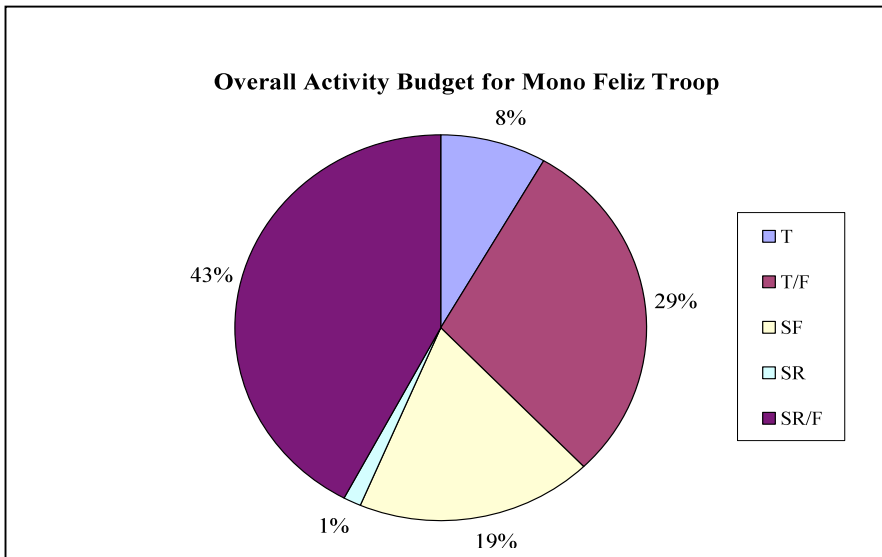


Figure 5: Percentage of total time monitored that the MF troop spent in each of the 5 activity categories. T: travel T/F: travel/forage SF: stationary forage SR: stationary rest SR/F: stationary rest/forage

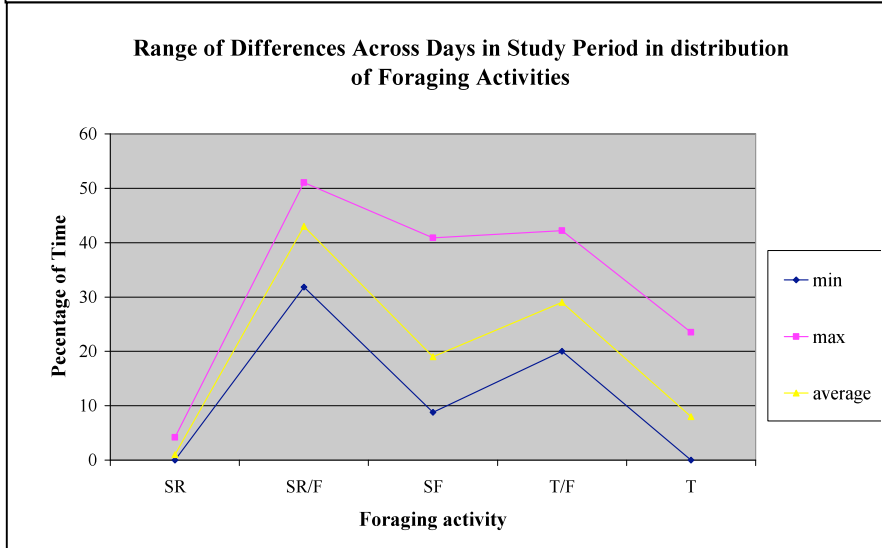


Figure 6: Maximum, minimum, and average percent of time spent in a day in each of the 5 activity categories.

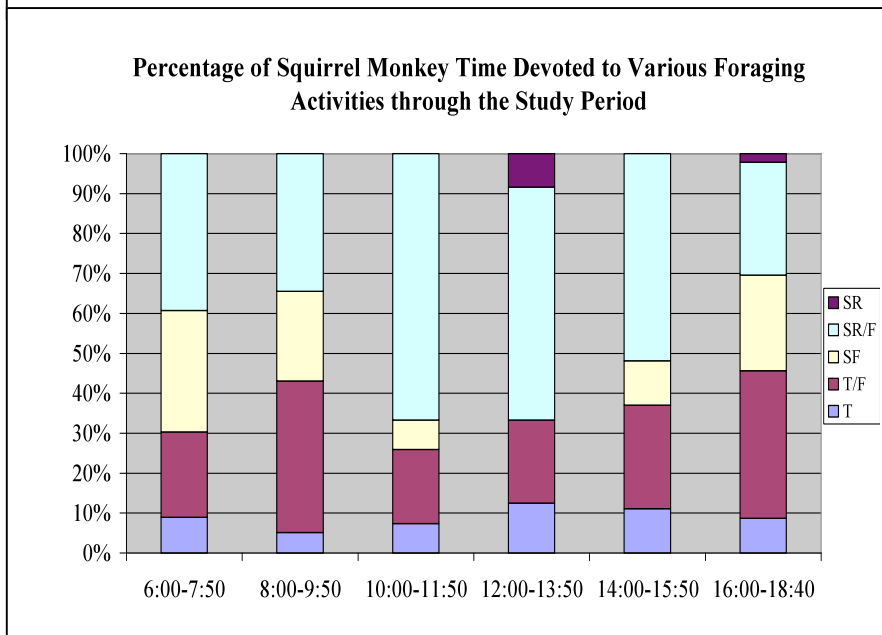


Figure 7: Distribution of 5 foraging activities in 2 hour periods throughout the day *Note again that the last category contains an extra 40 min.

SR: stationary rest
 SR/F: stationary rest/forage
 SF: stationary forage
 T: travel
 T/F: travel/forage

Troop interactions

Behaviorally the MF squirrel monkey troop showed some interesting characteristics. As noted in other studies there was a complete lack of play behavior between members of the troop including juveniles (Baldwin and Baldwin 1976). When members of the troop were in close proximity to each other they generally were ambivalent to the other members' presence. The troop was closest together when feeding, foraging, and resting at Mono Feliz. It was very common for 4-5 monkeys to be sitting along one 2 meter section of a branch sprawled and touching each other. In other environments, troop members were spaced further apart except when clustered on a huevo de mono or other fruit tree feeding.

The troop generally foraged as a whole in the mornings, but in the afternoon at times the troop fragmented into foraging parties. The compositions of these parties varied but often contained all animals of about the same age class (4 older juveniles or 5 adults and an older juvenile). The two infants were often seen traveling close to one another.

Up to 15 occurrences a day of chasing between members were observed mostly between two adult males and an adult and a juvenile. These instances did not appear to be motivated by food and other troop members would join in the chase readily and lend their voice to the chorus. Aggression increased markedly when the troop was at Mono Feliz competing for bananas (of 19 instances of aggression observed in one day, 12 took place during 40 minutes at Mono Feliz). Other food related aggression occurred when monkeys were competing over a semi-ripe orange-sized fruit that was still on the branch. This is very unusual behavior for *Saimiri oerstedii* (Mitchell et al. 1991).

Five occurrences of genital sniffing and mounting were observed. The recipient seemed non-plussed by the maneuver and normally moved casually away after a few seconds. In two instances of this behavior both participants were male, but in the other three instances confirmation of sex could not be determined. Six instances of urine hand washing occurred 2 of which happened directly after an aggressive chase between two males. The loser, who was chased away from the original tree, washed hands within 15 second of the end of the chase.

There were plenty of other monkeys that used the same foraging areas as the MF *Saimiri oerstedii* troop. There was one large troop of *Ceiba* (white-face capuchin or cariblanca) that came to Mono Feliz often to forage. The troop contained about 20 monkeys (one infant), but split off into smaller foraging groups at times. These monkeys are much more aggressive and larger than the squirrel monkeys and dominated the squirrel monkey troop. The white-face capuchins chased them away from MF and elicited alarm vocalizations when the monkeys entered the same area. These monkeys spent a lot of time near each other; and while *Saimiri oerstedii* were very vigilant while the white face were in the area, they did not appear to actively avoid these monkeys as has been documented by (Boinski 1987 and Seiter 2005).

There appear to be four small troops of *Alluata* (howler monkeys or mono allador) each with 5 or 6 members that live in and around MF and are easily found. The *Saimiri oerstedii* troops were very often found foraging in and around the howler monkeys for extended periods of time. The squirrel monkeys' paths crossed that of the howler monkey and average of 5 times a day and often times the troop foraged and rested for long periods in the vicinity of the howler monkeys (more than 30 min). The howlers appeared to ignore completely the presence of the squirrel monkeys and even allowed them to clamor over their bodies without a reaction.

Lastly the relationship of *Saimiri oerstedii* with double toothed kites (*Harpagus bidentus*) was extremely apparent. From dawn to dusk an hour of observation did not go by where one of these birds was not perched within the troop. At one point three different Kites were observed amongst one troop of monkeys. The monkeys had no fear of these birds and were often seen sitting within 2 meters of the kite which for its part made occasionally swoops at the forest floor.

What are the habitats, foraging patterns, and sleeping areas of a *Saimiri oerstedii* troop living in Punta Burica?

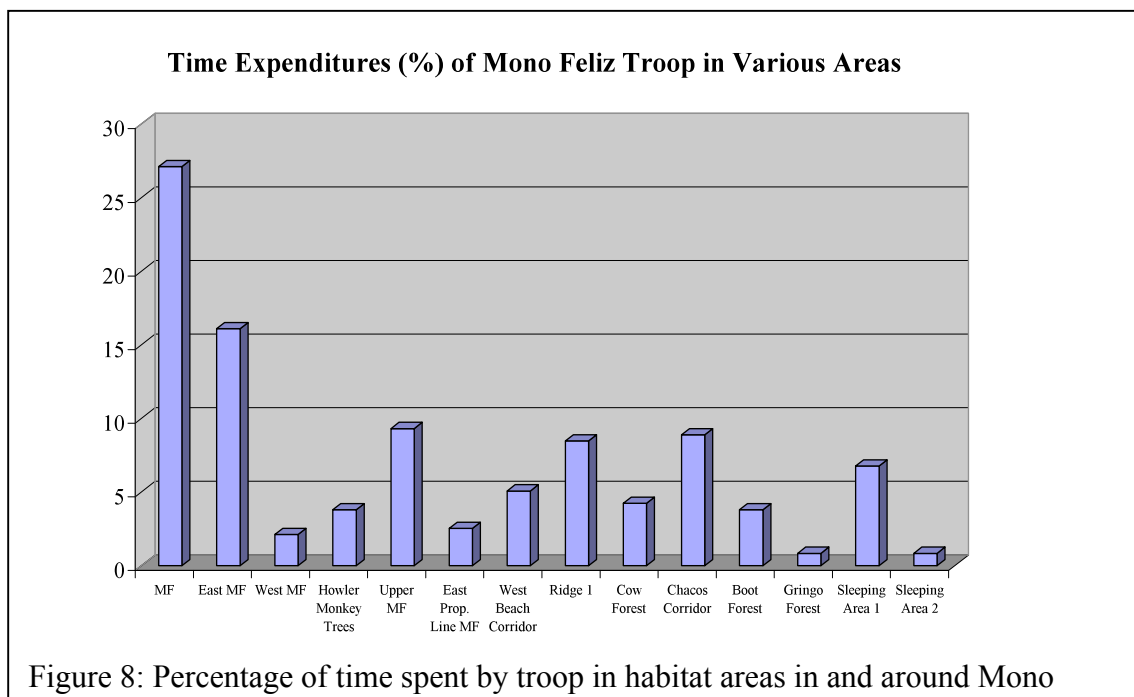
Methods:

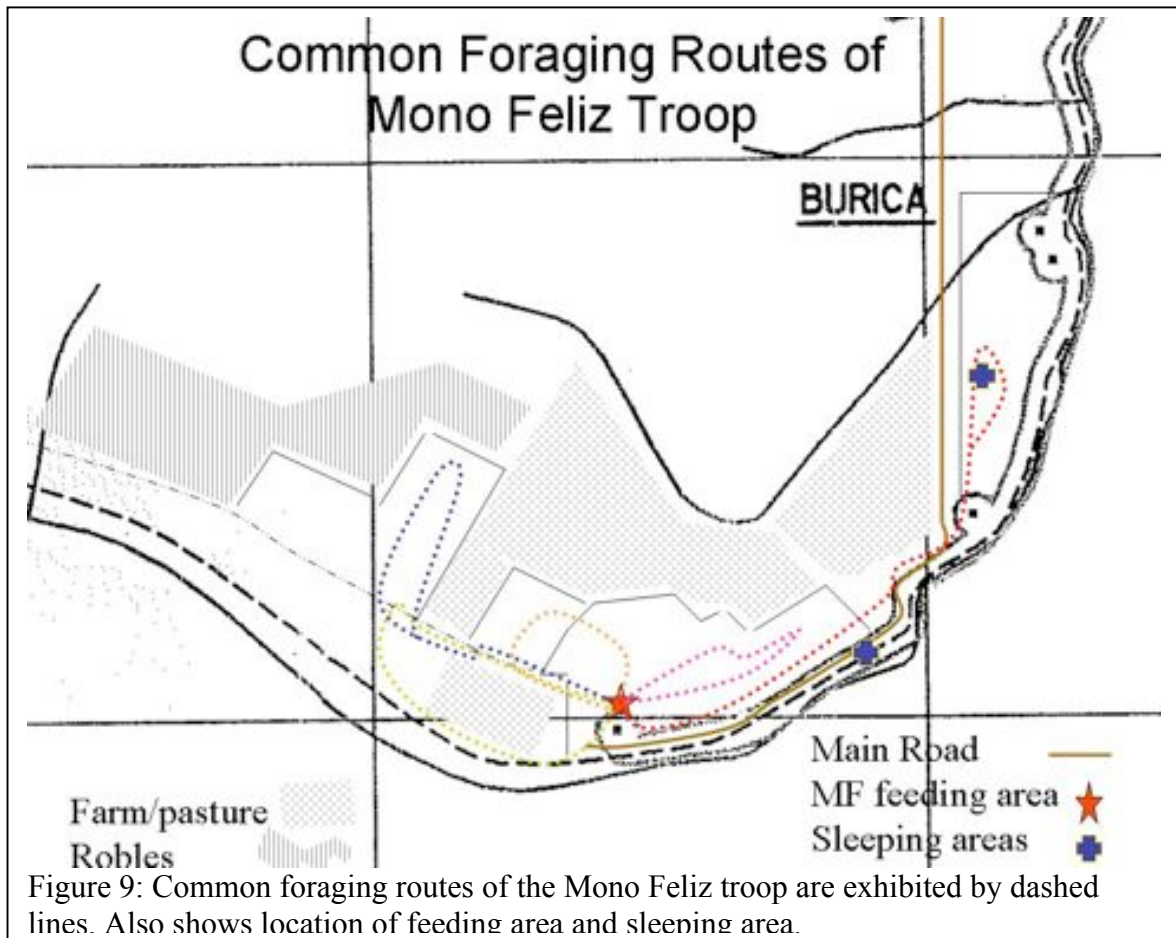
Eight 10m x 10 m plots were characterized for height (m), diameter (cm), undergrowth (%) and treecover (%) in 8 different areas that the Mono Feliz troop used frequently for foraging, sleeping or as a travel route. The plot location was chosen randomly within established habitat areas. All trees with circumferences larger than 10 cm were recorded along with height, local name, and latin name if possible. Additionally undergrowth and tree cover in each 1m by 1m quadrant were estimated by eye.

Troop movements were monitored with 10 minute scans, and common troop routes recorded. Sleeping areas were discovered by following the troop until dusk and visually watching where the monkeys slept. Sleeping areas were confirmed by returning the next morning before daybreak to see if the monkeys were still in the same area as the night before. Troop movements and patterns could have been affected by the presence of an observer.

Results:

The troop spent more than 27% of the time monitored within 100 meters of Mono Feliz, and spent almost 80% of the time monitored on the 7 hectares of Mono Feliz (Figure 8). These data could be and probably are skewed because it was easiest to find and follow the monkeys around Mono Feliz. Nevertheless, a huge proportion of the troop's time was spent in an around Mono Feliz Property.





The troop generally woke up a little bit before sunrise and then quickly and almost silently traveled to Mono Feliz. Generally they arrived at Mono Feliz exactly at 6:20 am, but arrived at 7:00 when they used a sleeping area further away. They stayed in the area of Mono Feliz foraging for part of the morning until they were fed (many times around 7:30) and then set off on one of 4 common foraging loops which changed each day. The monkeys would travel and forage slowly to one of their preferred foraging areas and disperse and forage for a variable amount of time. Normally they foraged between 30 minutes and 2 hours after which they would return to Mono Feliz, wait to be fed, and then set off on another foraging path only to return to Mono Feliz and the eastern portion of Mono Feliz for the slower early afternoon. Parts of the troop would wander over to the feeding area throughout the afternoon to forage and look for food. Around 3 or 4 in the afternoon the troop would begin heading east to where both of the sleeping areas were located. The troop would casually head towards the sleeping area about an hour before sunset and forage in the sleeping area until the sun was almost gone. They would then scuttle up the coconut trees (3 or 4 in each one) and sleep amongst the fronds. The troop utilized the same major foraging routes in different orders over the course of the study period, but tended to stay to the north and east of Mono Feliz in the morning and to the west of Mono Feliz in the afternoon (Figure 9).

As an exception to this general pattern, the troop disappeared completely from its normal habitat areas around Mono Feliz for a full 72 hours during the study period and could not be located. The troop's use of habitat and the behavior of the troop during this

time period are not accounted for in the analysis. The troop was last seen at 12:30 on November 30 at the far edge of its normal territory in Boot Forest heading west. On the night of the December 2 the troop was seen by a reliable local at a house near the eastern edge of Quebrada de Mata. At 9:30 on December 3 the troop was spotted by me and a trusty companion in Gringo Forest. Finally it returned to Mono Feliz for food at 12:30 that same day and remained at Mono Feliz until heading to the sleep area. I suspect that the troop performed a circuit of available creek gallery forest of approximately 4-5 kilometers in length. The implications of this unusual (according to the owners of Mono Feliz) pattern of habitat use will be discussed later in terms of conservation. Even including the two days when the monkeys did not come to Mono Feliz, the troop spent over 2 hours a day directly in front of Mono Feliz.

The forests and corridors used by the troop varied widely in habitat type. The seven hectares of Mono Feliz land, which used to be a pig farm 15 years ago, can be divided into two sections with different habitat characteristics. Additionally, the troop used a ridge of secondary growth forest to move between otherwise unconnected forested areas to the west of Mono Feliz. The troop also used a corridor of palms and mangoes along the road to the east of Mono Feliz to connect to another patch of mixed secondary growth forest. Each of these areas will be briefly described below as it is important to understand which types of forest *Saimiri oerstedii* use on a day to day basis when continuous forested areas are not available. In general the forests that the monkeys use have average tree heights of about 10.6 meters with some older trees with much larger maximum heights (Figure 11). In general as underbrush increased in plots tree cover decreased.

Descriptions of Habitat areas:

Mono Feliz: Directly around Mono Feliz are Almendro, Cecropia, Banana, Breadfruit, Avocado, Guava, Jobo, Tica, Chapolin, Mango, Panama, Palma de Pipa, and Roble. This area has almost no undergrowth. Some of the trees are fairly tall exceeding 15 meters in height.

Upper Mono Feliz: the upper portion is all early secondary growth forest interspersed with trails. It contains Guacimo, Balsa, Santa Barbara, Guava Huevo, de Mono, Palma de Pipa, Jobo, Guaruma and has in parts a very dense underbrush. The trees in this area tend to be around 11 meters tall with the tallest around 17 meters.

Lower Mono Feliz: the lower portion of Mono Feliz is more open with Jobo, Almendro, Guacimo, and Roble dominating. The undergrowth is variable but small with huge swaths of Sangre de Perro.

To the west of Mono Feliz:

Cow Forest: This is a small (2.4 hectare), patchy over grown pasture on top of the ridge to the west of Mono Feliz. Cows still roam on this area but it is being taken over by dense undergrowth. It contains an interesting mix of larger Mango and Balsa that were present in the pasture when it was being heavily used. This is surrounded now by small Jobos, dense lianas, Santa Barbara, Palma de Pacora, and Guacimo.

Ridge: This ridge 30-35 meters high runs along the cost and contain large trees (25-40 m) that have survived the chainsaw of man for now. There is little undergrowth but one can find, Panama, Espave, and Chapolin in this forest haven.

Boot Forest: This now forested and over-grown pasture (6 hectares) contains some areas of very large (25m) Balsa, Roble, and other smaller Gaucimo, and Palma de Corosa, as well as, lianas and Santa Barbara.

Roble Plantation: As it sounds, this is simply an area of large Oaks (roble) with pasture underneath that borders Boot Forest. The Robles are fairly large, between 15 and 20 m tall. *Saimiri oerstedii* were only seen once in this area.

To the east of Mono Feliz:

Chaco's Pathway: this area follows along the dirt road to the west of Mono Feliz. It is a variable width corridor of Palma de Pipa, Banana, Mango, Calabasa de Playa, Avacodo, Mamon, Chapolin, Guava, and Roble. Basically a forest of cultivated trees. It continues for about 350 meters along the beach were it ends abruptly at Gringo Forest.

Gringo Forest: This area is yet another mixed bag of old pasture trees and dense undergrowth. It spans about 4 hectares of beachfront forest made up of Balsa, Gaucimo, Heliconia, Santa Barbara, Palma de Pipa, Cecropia, and Bamboo.

Data collected in forest plots:

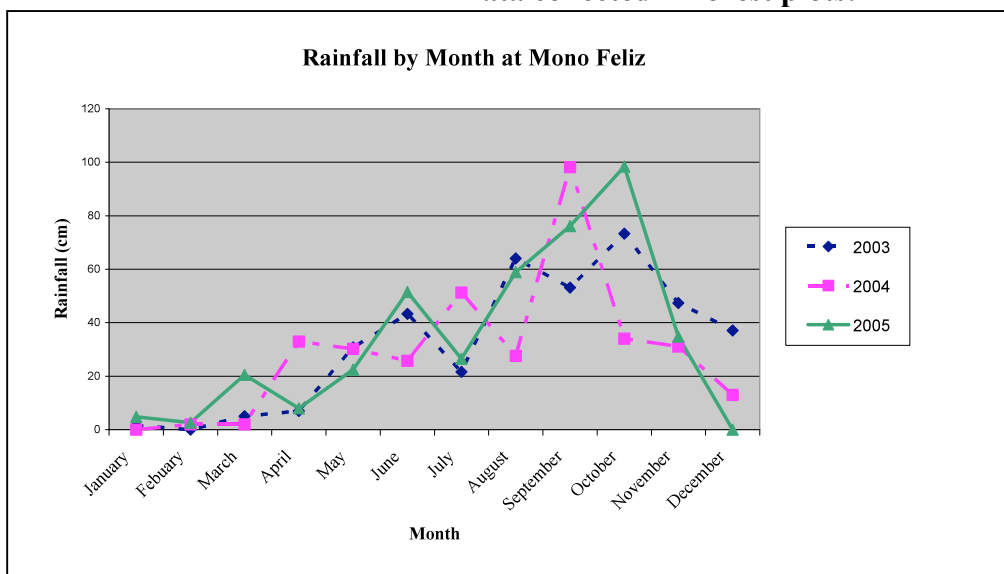


Figure 10: Rainfall per month for the past three years at Mono Feliz (cm)

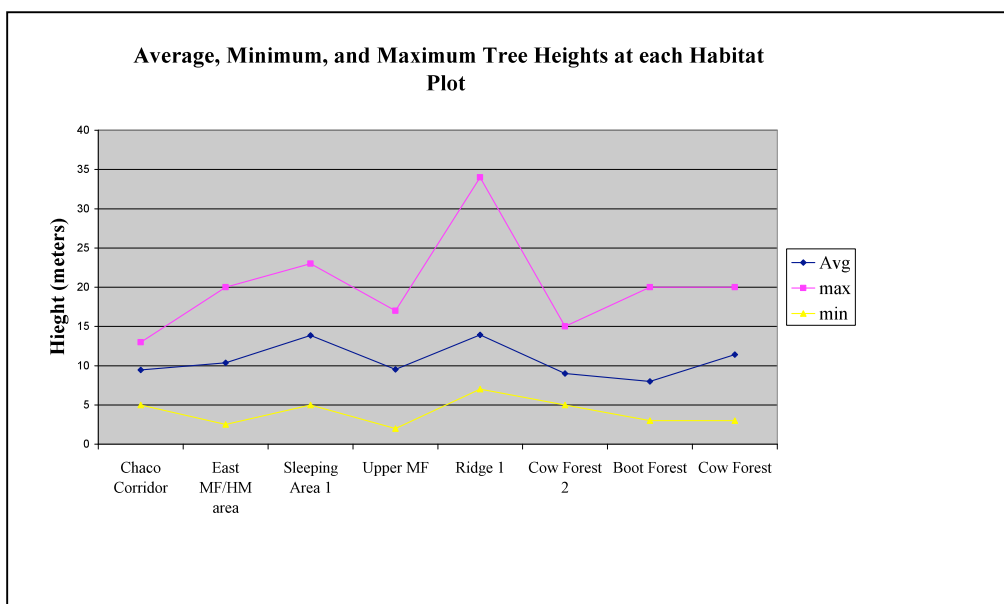


Figure 11: Minimum, maximum and average tree heights measured in each 10x10 habitat plot (m).

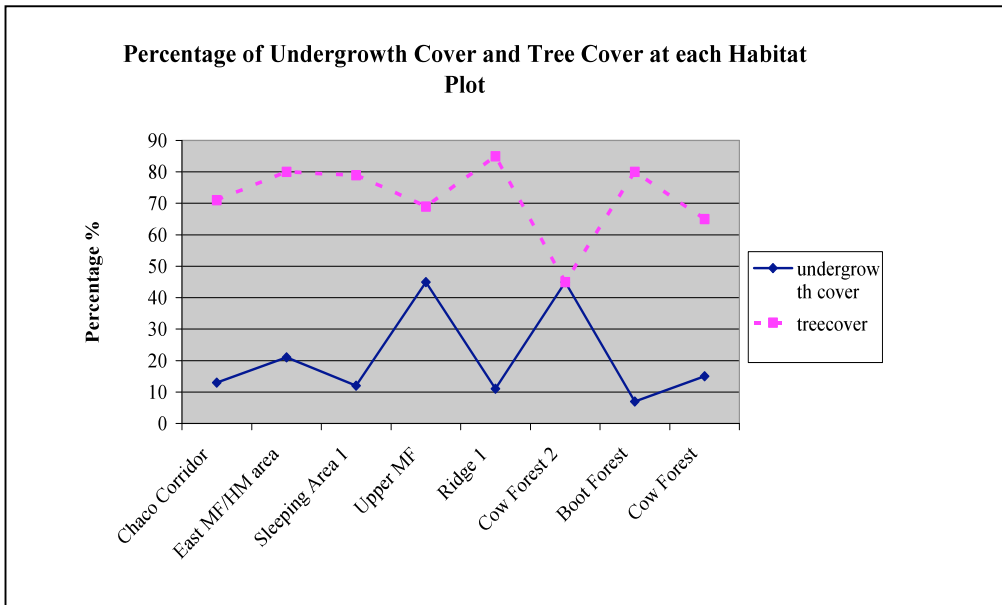


Figure 12 (to the left): Average percentage of undergrowth cover and tree cover at each of the 10x10 habitat plot sites.

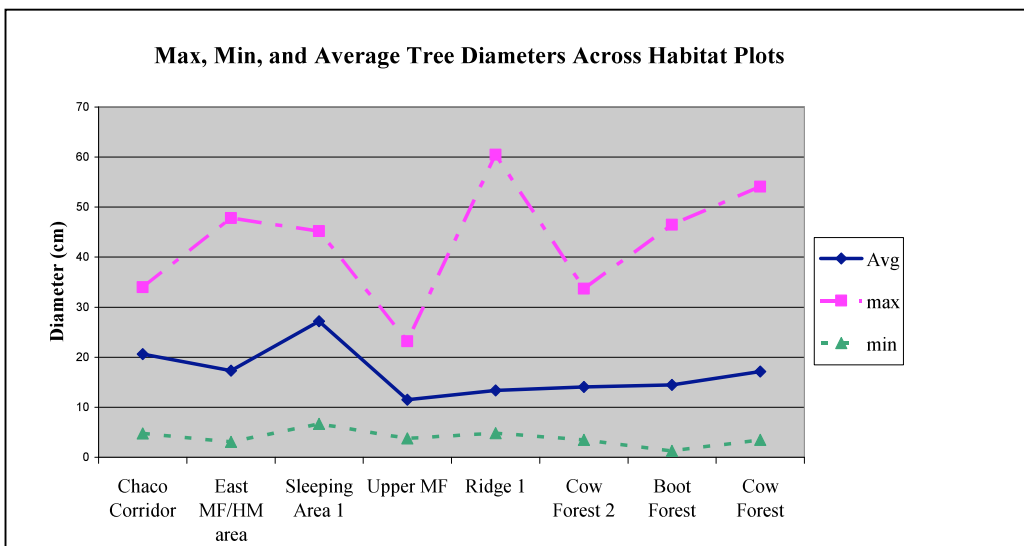
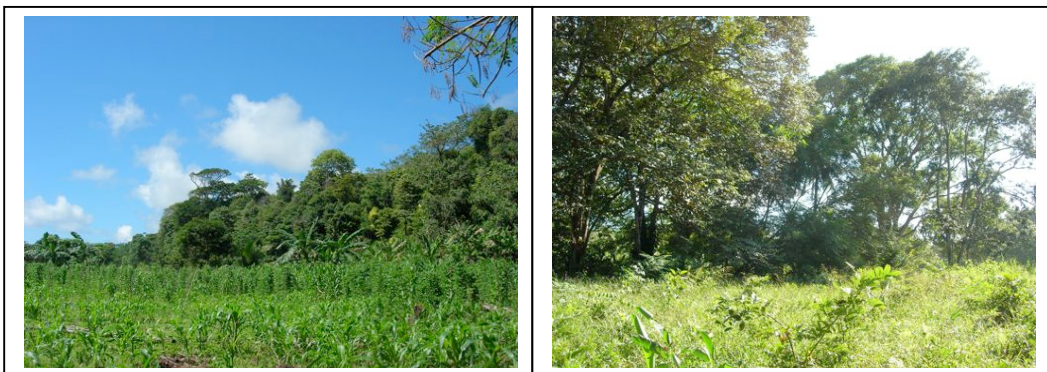


Figure 13: Average, maximum and minimum tree diameters in each of the habitat plots



Picture 1 and 2: (1) Late secondary forest ridge that lies to the west of Mono Feliz (2) extent of gallery forest across many creeks in the area. This picture is of Quebrada Burica and its plethora of tree growth.

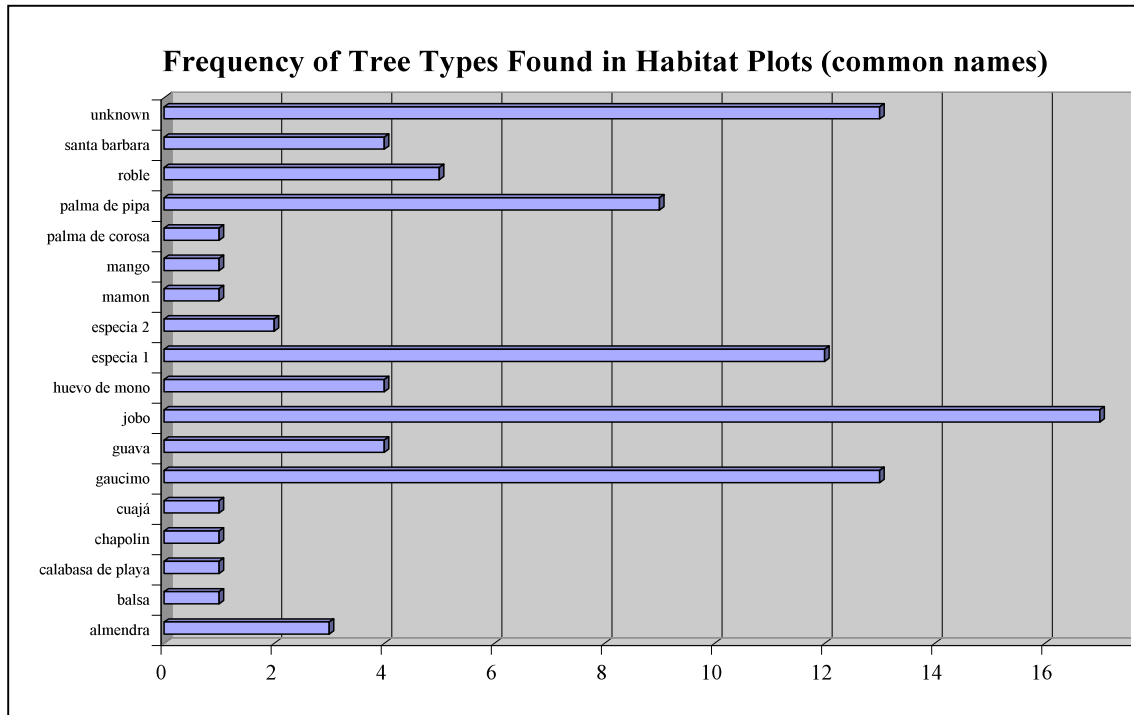


Figure 14 (below): Distribution of all tree types by common name found within the 10x10 plots.

Common names were used for this section due to lack of time to positively identify with a high level of certainty the plants of the area. Some latin names were determined for the trees of the area which are listed below (Table 3).

Common name	Family	Genus	Species
almendra	Combretaceae	Terminaba	catappa
balsa	Bombacaceae	Ochroma	
guava	Myrtaceae	psidium	guajava
jobo	Anacardacium	Spondias	
mango	Anacardiaceae	Mangifera	
palma de pipa	Plamea	Cocus	
roble	Bignoniaceae	tabebuia	
guaruma	Moraceae	Cecropia	

How do the patterns, habitats, attitudes, and behavior of a troop that is being fed artificially differ from that of troops that do not have additional food sources?

Feeding stations have been advocated as possible conservation tools to maintain Squirrel monkey populations in the future that do not have enough habitat left to survive without supplementary food (Wong and Carillo 1996). While the methods of feeding that the owners of Mono Feliz employ to feed the monkeys are not scientifically initiated, they are fulfilling principally the same role of providing sustenance for the monkeys that a feeding station would. The monkeys are fed approximately 12 bunches of bananas a week, but the white face capuchins steal quite a portion of this food. Normally squirrel monkeys do not prefer to eat bananas and will choose many other types of fruits before it (Boinski et al. 1998). A diet high in bananas does not contain the high protein content of insects, and it is hard to know how good a high banana diet is for

a squirrel monkey. On the other hand it is hard to argue with the obvious relish that the MF troop ate their bananas. Numerous locals told me that the monkeys that come past their house every few mornings feed on their ripe bananas from time to time.

While at Mono Feliz feeding, the troop displayed many instances of aggression, chasing and resource stealing. This aggression pattern was also observed in 2 other areas of the MF troop range but never in the other troops of the area that were monitored. The pattern of food-based aggression of the MF troop more closely mimics the behavior of the *Saimiri sciureus* troops than those of the *Saimiri oerstedii* troops as reported by Mitchell et al. (1991). They report that *Saimiri oerstedii* engage in resource-based aggression .004 times per hour and 100% of the aggression occurred over insects while the *Saimiri sciureus* troops engage in resource based aggression with a frequency of .286 events per hour with 95% of the aggression occurring over fruit resources. These *Saimiri sciureus* troops spend more time utilizing larger patches of fruit resources than do the *Saimiri oerstedii*. It is possible that the feeding of the monkeys at Mono Feliz has introduced a different behavioral structure than has not developed in other *S. oerstedii* troops. It is impossible to tell this from such a limited initial investigation. What can be said definitely is that the MF population demonstrates a high level of aggression in and around areas where the monkeys are fed.

Obviously the Mono Feliz troop has become very accustomed to being fed as they return to Mono Feliz multiple times per day and eat bananas from human hands. This troop is distinguished by the locals as having less fear of humans than others. The troop became familiarized to the presence of an observer in less than 3 days and had no problem passing over an observer on branches 2-3 meters overhead. The troop did become slightly more wary of humans as they got farther and farther from Mono Feliz. This lack of fear towards humans is in direct contradiction to the other three *Saimiri oerstedii* troops that were seen or followed over the course of the study. These monkeys gave loud distress vocalizations immediately upon seeing me and would bounce side to side in concern before heading in the other direction quickly. In other studies responses such as these are described of squirrel monkey troops before habituation occurs (Seiter 2005, Boinski 1987, Baldwin and Baldwin 1971). Baldwin and Baldwin also note troops who lose a member to hunters or traps become extremely wary of humans (1971). The Mono Feliz troop is more habituated to humans than the other troops in the area due to feeding at Mono Feliz

Additionally the Mono Feliz troop uses as a home range less than 27 hectares of land and frequently uses only 7 hectares. Their range could be limited to a smaller area than normal because the troop returns so many times to Mono Feliz over the course of the day, but habitats for squirrel monkeys seem to vary dramatically in size across the literature. The troop of 23 monkeys used for one of Baldwin and Baldwin's study (1972) used a home range of 43.5 ha over the 10 week study period and in another study site in Panama the monkeys used approximately 17.5 ha as a home range (1976). This is in contrast to the troop of 38-45 monkeys studied by Boinski (1987) which used a range of 176 ha. over an 11 month study period although most of their time was spent in 24 ha. In 1997 Boinski and Sirot recommended that squirrel monkeys not even be looked for in forest smaller than 30 ha because this was considered too small to support a troop. There is no evidence to indicate that the MF troops range is being compressed by the presence of the feeding area except for the frequency of the troop returning to Mono Feliz

In past literature squirrel monkeys were documented to expand their ranges by up to 50 % in the late wet season (Boinski 1988 and Boinski & Sirot 1997). A study by Boinski documented the troop using 176 hectares in total with only moderate overlap in

habitat use between the four seasons. One hundred and ten ha. were used by the troop in the wet season. If this troop is considered to demonstrate the normal movements of a troop in more pristine environment, then the Mono Feliz troop is demonstrating the exact opposite response to food stress than Boinski's troop. The MF troop is constricting its range by returning an average of 5 times a day to Mono Feliz where it is assured to get food. It would be interesting to investigate the effect of increased monkey presence on insect populations to see if the increased time the *Saimiri oersted* spend foraging around MF is affecting arthropod populations. This centrality of troop location would also limit the distance the troop could travel to utilize large fruiting trees as a food source. Lastly the fragmented structure of the habitat available to the MF troop could be affecting the troop's response to a central feeding location. Unlike in a large forest, the troop cannot set out in any direction radiating from the feeding area to forage. It is confined to two pathways to the east and west.

Despite this smaller, confined habitat, the MF troop spent substantially more time in stationary rest forage and stationary rest (41%) than in Boinski's troop in the late wet season (1.8%), indicating that perhaps the MF troop is getting enough to eat. However the MF troop did exhibit some of the signs of lack of food abundance listed by Boinski and Sirot (1997). The troop was seen unfurling leaves, descending to the ground, and scraping bark and twigs with teeth for tiny arthropods. These behaviors were seen mostly in and around Mono Feliz and could indicate a lack of resources in the area due to the increased time spent around Mono Feliz.

It was heartening to see the MF troop set off for almost three days and utilize other forested areas that can sadly be guessed at because there are so few. One of the largest drawbacks of feeding stations is the creation of troop dependence on the station for food so any demonstration of continued independence is positive.

This study only encompassed 13 days so one cannot draw conclusions about how the troop uses their habitat and responds to a feeding station over the other seasons of the year when more trees are fruiting and arthropod abundance increases. However, at least a loose conclusion can be drawn about troop range in other seasons because proprietors of MF say that it is highly unusual when the monkeys do not come for bananas for a day and almost unheard of for the *Saimiri oersted* to stay away for two. There is only a limited amount a troop can travel in one day. Additionally, according to multiple local sources, the other squirrel monkey populations of the area retreat completely into the gallery forests along rivers during the dry season, but the MF population remains in the same area all year.

What are the conservation status of and largest threats to *Saimiri oersted* in the Bella Vista area?

While threats to squirrel monkeys in general are numerous, this section will focus more specifically only on those threats which pose, in my opinion, the largest danger to the populations in the Bella Vista area: further habitat fragmentation, uneven sex distribution, and hunting. Additionally the possible risks and benefits of the current tourism situation in the area will be discussed. Despite all the problems and challenges facing these monkey, it is positive to note that in 7 km², about 67 squirrel monkeys were confirmed to be in the area and it is very possible that as many as 157 squirrel monkeys live in the area, making the squirrel monkeys up to this point survivors.

Habitat loss/fragmentation and is always cited as a large problem for species and is discussed over and over in conservation. This is not because conservationists like to wear out the subject, just that it is true. Especially with arboreal species like the

squirrel monkey, an hour with a chainsaw can cut their habitat in half. The structure of the remaining forest in the area besides the reforested pastures on the coast is small strips, most of them narrowly following creeks (Picture 2). Almost everyday of the study I could hear chainsaws in the distance working. Even now the monkeys walk on bamboo and barbed wire fences of the area to connect forested areas. These bottle neck crossings make the monkeys vulnerable to any number of predators from birds to humans. If what the locals say is true and there are half as many squirrel monkeys now as 10 years ago, then it is likely that the squirrel monkey populations are still getting smaller due to their smaller habitat area.

Hunting of squirrel monkeys poses a huge threat to area troops. Capturing, selling, and buying squirrel monkeys is illegal in Panama and carries with it fairly harsh punishments, but in extremely isolated rural locations such as this Peninsula, there is little enforcement of the law. There are only two police officers that man the check point and are in charge of enforcing the law in a substantial section of the area in between Limones and Bella Vista. It is therefore fairly easy for a person to smuggle out a baby squirrel monkey. These monkeys are generally taken to David and Panama as pets, but are very hard to keep alive in an artificial environment. Price quotes of the locals ranged from 5-25 dollars and perhaps more if the purchaser did not know the going rates. Sadly I was told that the rates are so low because it was so easy to catch them. It was difficult to determine exactly how many babies are taken a year especially because what troops babies are taken from could not be specified. Numbers were given to me that ranged from 5 to 20 babies sold per year, but these are pure local speculation, and I suspect not even the trappers really know.

There are two methods according to the locals of capturing squirrel monkeys: one which kills the mother and another one which does not. Which one is used is determined by the knowledge of the trapper and the environment the squirrel monkeys are using. In large forest patches, squirrel monkeys do not descend to the ground for any extended period of time. Therefore the only way to obtain the baby is to shoot the mother either with a gun or with a slingshot. The mother falls to the ground and the baby is taken off the mothers' carcass (with a slingshot the mother is not always killed). The second way involves more detailed knowledge of squirrel monkey habits and travel pathways. When the monkeys are walking along a fence or negotiating a ground crossing to connect habitats, one person scares the mother off the fence and she drops the baby and flees. A second person grabs the baby. This process was described as fairly easy and almost comical. It is possible to catch the mother and baby together with both alive because once a local tried to sell a live mother and baby together at Mono Feliz. It could not be determined which of these two methods was used more in the area. All but one source told me that babies were captured, but mothers were not killed, but sex distribution evidence points to the opposite conclusion—that the mothers are being killed. This situation is an interesting one because when the monkeys are living in a difficult environment where they must make exposed crossings, the mother does not have to be killed to collect the baby. In a denser and larger area, poachers must kill the mother to collect the baby making the richer environment for the monkey a less safe environment for the mother.

The apparently skewed sex distributions of the troops in the area are a large cause for worry, and this situation should be monitored closely in the future. It would be very helpful for an assessment to be made after the females give birth this year to ascertain the true proportions of individuals in the squirrel monkey troops. It is impossible to determine exactly what the causes of the apparent higher number of males in the area populations. The obvious answer is that hunting for the babies by killing the

mothers has decimated female populations over the last 15 years, but I am not convinced that this outside predation explains all of the apparent lack of females in the area. This question is worth investigating further in the future because a healthy proportion of adult females (>3 years old) within a troop, Boinski and Sirot suggest 40%, is vital to the genetic health and viability of squirrel monkey populations (1997).

While the hunting situation a little depressing, there is some local conservation attention being paid to these monkeys mostly from outsiders who come into the area as well as a few local citizens. There are two conservation/ eco-tourism projects that are developed and in the process of being developed in the area. These two establishments have taken and are taking completely divergent paths to the conservation of *Saimiri oerstedii* in the area. An entire paper could easily be written comparing, contrasting and describing the two different projects but a short description will have to suffice for this paper.

Eco-tourism development is a double-edged sword. It can provide the local area money, education, and employment as well as educating outsiders and preserving land for species to use. On the other hand, it brings, increased environmental impacts, opens the door for new development, and sometimes is not eco-friendly at all. In planning eco-tourist projects, it is important to keep in mind all of these impacts and balance out the worth of the project versus possible environmental harms. It is even more critical in eco-tourist projects than in others that everything be well researched, well planned, and well executed with sufficient capital and will-power to see the project through to the end. This is because the initial development phases carry the preponderance of the environmental impact (construction/ disturbance) so if projects are abandoned or sold in the initial stages of creation no positive impacts have yet been realized on the environmental side.

Mono Feliz is a small reserve/ eco-lodge of 7 hectares on the southeastern coast of Punta Burica (N 8.03701, W 82.86859 to N 8.03178, W82.87611). The reserve also includes another forested property of about 10 hectares about a kilometer to the east of the first property which is utilized mainly by a different troop of squirrel monkeys. The project was started about 5 years ago but only this year is beginning to receive good numbers of guests. The goal of the area is to create a haven for wildlife, especially the monkeys, amongst the sprawling cattle ranches of the area. In addition to the natural wildlife the lodge has many pets. The development of the lodge on the property is confined to less than a hectare although paths bisect the rest of the reserve. All the water used is taken from the spring and there is no electricity at the property. The lodge only consists of 3 cabanas but can accommodate more people by providing them camping equipment for the beach. The establishment has is in good standing with the local population of the area and employs and works with the local community.

The regular feeding of the monkeys is done with genuine intentions of conservation probably have had interesting and unknowable consequences on the squirrel monkey populations of the area, as discussed earlier. Lastly the possession by the owners of Mono Feliz of several pet squirrel monkeys over the years creates interesting moral questions, as well as, a close study subject for the scientist. The monkeys over the years are brought to the lodge by locals and children—some are hurt and others are without mothers. The current pet monkey is an almost 2 year old male named Mickey. He is a volatile pet and goes from being cute to biting quite hard very easily. He seems to have limited interaction with the squirrel monkey troop that comes to Mono Feliz, but sometimes forages with the troop. There were many times when I was monitoring the troop near Mono Feliz that a squirrel monkey that I thought was part of the troop jumped right onto my shoulder. As a scientist, it would be nice to see all

squirrel monkeys in the wild, but as a realist one has to consider that these monkeys, after being estranged from their troops, will probably not survive for very long. The pets at Mono Feliz are free to go at anytime and other pet monkeys at the lodge have left.

In stark contrast to Mono Feliz, Tigre Salvestre, is a larger scale eco-tourism project sanctioned by the Panamanian government. The papers are almost through to create a project of tourism and reforestation on 25-29 hectares along 14 km of largely deforested coastline from the road (N 8.03559, W 82.8875) to the coast of Costa Rica. The overarching goal of the project is to create a sanctuary and rehabilitation center for wildlife which will attract students, scientists, and eco-tourists to the area. At this moment only 7% of the 29 hectares are forested, the rest, including the older growth bank, was completely deforested for cows. The plan is to reforest the deforested areas with food sources for the monkeys and other wildlife. The environmental impact assessment of the area cites the following plans for land use of the area (the low impact usage area has the option of being reforested in the future also):

Uso de Tierra: Espanol	Land-Use: English tran.	Percentage of 29 ha
Protección	Protection	35%
Uso intensive total	High impact usage	29%
Extensivo o muy extensivo	Low impact usage	21%
Produccion	Production (agriculture)	5%
Manglares	Mangroves	10%

The development plans of the area which are well on their way to completion included a main two story building of 500m², 2 cabanas about 88.00m², One cabana 30.45m². The establishment will be able to accommodate about 26 guests at a time with electricity. Electricity was brought in from the town of Bella Vista to the project, in the process the wires had to cross the creek Resbolosa fragmenting one of the main pathways that the monkeys use to travel between habitats. While this effect was not intended and attempts were made to string up ropes (which keep disappearing) for the monkeys to cross on, it is occurrences like this that make eco-tourist projects a potential environmental risk.

Reforestation is a difficult and complicated process and requires expertise and experience to do correctly. It is very important that the area not just be reforested by fruit trees for the squirrel and white face monkeys and favorite leaf trees of the howlers. Attention should be paid to native vs. non-native species, soil preferences, natural pest control, and other issues.

Both Mono Feliz and Tigre Salvestre have great potential to be a good thing for the squirrel monkeys, but only in the long-run and with careful, informed management. It is also possible that a tourist attraction of the scale of Tigre Salvestre paired with the attraction of Mono Feliz will pave the way for more development and access to this rural area. On the other hand, they may very well raise local awareness and income levels enough that monkey trapping is not used as a source of income. The wheels of development are already turning in this area and one must wait and see what the future brings.

In conclusion the prognosis for the squirrel monkey populations in the area is neither promising nor dire in the near future. The low habitat availability and uneven sex distributions, no matter the cause, are justification for a fairly high level of worry especially concerning genetic viability of the population and ability of young females to migrate between troops. However there is a greater attention being paid to the squirrel

monkeys and their habitat in the area now; and two very different eco-tourism projects lend some hope to the conservation status of the monkey.

Conclusions and Recommendations:

S. oerstedii present an interesting conservation problem. They have a small overall range, they compete with humans for lowland areas, they are cute and therefore exploited, and they like secondary forests and disturbed areas instead of the pristine areas that are valued for preservation. Yet despite all these obstacles they are adapting and surviving in small forest patches and creek beds in Punta Burica in Panama. They are not abundant, but they appear so because of the lack of habitat and their proximity to humans. The ultimate hope of doing an intensive case study of one troop was to be able to draw conclusions about the squirrel monkey populations of the area as a whole, but because the model Mono Feliz troop was being fed, one cannot necessarily make any generalizations about the other troops in the area based off of these data. Despite these difficulties, it seems likely that there are between 100-150 monkeys living in the study area that utilize river corridors and are visible to humans on a regular basis.

These gallery forests contain a mixture of trees and vary in density and are the last resort for these hardy monkeys. The tenuous connections created by the sparse trees on the creeks cannot be removed if the monkeys are going to continue to survive. Already the monkeys are using fence lines of trees along roads and fences themselves to move between the end of one creek and the beginning of another. The troops also utilize the available overgrown pastures of the southern edge of the Peninsula. It would be interesting in a conservation and scientific context to undertake a longer term study of one or more of the other troops of the area that is not relying on Mono Feliz for food. A study such as this would provide a context for how much overlap these 4-7 troops have in terms of sharing the 100 ha. of habitat available, and would provide a good framework to examine the interactions of troops living in close proximity to each other. Additionally it would be interesting to determine if habitat type has a substantial effect on troop distribution in these highly modified environments.

The Mono Feliz troop, which was more intensively studied than the others and is being fed daily with bananas, has provided a good, preliminary case-study of the effects of a feeding station on a squirrel monkey troop. It seems by comparison with other studies that this troop is more rooted in place and centralized around the feeding location than other troops that have been studied. The troop rested more than troops in during the late wet season, as well as, demonstrated resource-based aggression when competing for bananas. Besides the aggression, the MF troop was behaviorally comparable to other squirrel monkey studies. None of the troop changes except habituation to humans appears to create a problem if the feeding station is continually available and stable. Luckily, there were also some indications of troop independence from the food source demonstrated by the troop disappearing for a few days. It would be interesting to explore further how the Mono Feliz troop exploits its habitat areas in different seasons and compare it to the 1987 Boinski habitat study to examine further the effects of a feeding area on a squirrel monkey troop.

The troops in the area face many challenges in terms of habitat and sex distributions. Without females in the area there cannot be normal reproduction or gene flow between troops. The troops in the area besides the MF troop tend to fear humans and rightly so because there is a healthy hunting trade in the area. It was not determined exactly which of the two methods for capturing babies are being used in the Bella Vista area although my pure speculative guess would be that most of the hunters scare the mothers to catch the babies and that maybe one or two are still killing the mothers. This

would be interesting to explore further as no amount of conservation will help these monkeys if poachers are easily targeting the babies and perhaps the females.

Lastly, the eco-tourism projects directly related to these monkeys in the area have the potential to create and preserve good patches of habitat for squirrel monkey use in the future, but individual owners in areas like this cannot preserve this monkey alone. Due to the large range needs of the monkey combined with the extreme fragmentation that characterizes landscape of Punta Burica, the conservation of the monkeys depends on habitat owned by a wide variety of owners. It is essential that any conservation project in the area maintain a good rapport with local community members and local landowners to prevent trees and habitat from being destroyed. Additionally eco-tourist projects need to be carefully managed and well-planned because a single misstep can create more harmful environmental impact in the in the short-term than environmental help in the long-term. However the presence of these projects and this level of concern in the area is a welcome and wonderful indication that perhaps the tides are turning for this little monkey.

In summary these steps should be taken to help the squirrel monkeys of the area:

- Stop the loss of trees in general. All habitats are not created equal for squirrel monkeys and high priority should be given to the tenuous network of gallery forests that connects other habitat areas together. As well as to the ridge of secondary forest that the troops use to connect habitats.
- Creeks and other habitats used as connections by the squirrel monkeys should be analyzed for gaps and high stress areas so isolated reforestation can occur where it is needed.
- Many of the landowners of the remaining forested land in the area live in David, Panama, or outside the country. It is important to gain the support of these people to preserve the current squirrel monkey population of the area
- Further analysis should be made of the sex distributions within the populations here because there is a good indication that the troops in the area are heavily dominated by females which would have striking consequences on the genetic viability of area populations
- Hunting should be decreased in a manner that works through community education and alternatives rather than simply by increasing the vigilance of authorities (although that could help too).
- Planting and reforestation of areas with fruit trees that the squirrel monkeys use in accessible areas would do a lot to augment the troop's diet although there is no evidence that the area populations are resource-stressed
- Continue with the development of eco-tourism projects in the area but with a careful eye for environmental consequences.
- Continue with the feeding of the monkeys at Mono Feliz, and perhaps study seasonal effects of this feeding on the troop.

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