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# Evaluating a Primate Sanctuary: Population assessment of the Common Squirrel Monkey (*Saimiri sciureus*) on Sumak Allpa, Ecuador

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*Evaluating a Primate Sanctuary:*  
**Population assessment of the common squirrel monkey (*Saimiri sciureus*) on Sumak Allpa, Ecuador**

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*Abstract.* The common squirrel monkey (*Saimiri sciureus*) population on Sumak Allpa was assessed during 33 observation periods between November 5<sup>th</sup> and November 24<sup>th</sup> of 2012. Sumak Allpa is a 113.15-hectare island on the Napo River in the Orellana Province of Amazonian Ecuador that has been functioning as a primate sanctuary since 2005. Squirrel monkeys were surveyed during 1 to 3 hour observation walks in the mornings, afternoons, and evenings. During two occasions, the island was divided among multiple observers at the same time, including one observer in a canoe on the exterior of the island, to allow more coverage of the island and differentiation between multiple troops on the island. There was found to be one large troop, containing a maximum of 17 adults or juveniles and 3 infants (between 2 and 4 weeks of age), as well as an independent individual that likely separated from and joined the large troop frequently. A positive growth rate of 0.875 births/month in 2011 and 0.3075 births/month in 2012 was calculated using current and past data from the island (Latimer & Stout 2011). Sighting locations indicate a habitat preference for disturbed and island edge forest dominated by bamboo and heliconiaceae vegetation. The large troop was found to sleep in the same trees (two tall palms) in all but one observation evening, indicating high fidelity to sleeping sites. Behavioral recordings demonstrated significantly higher allocations to food-related activities (travel and forage, stationary forage) than other activities, accounting for 62% of all activity, and a high percentage of travel (travel, travel and forage), accounting for 72% of all activity. Very little aggression or social play was observed. This study demonstrates a positive growth and success of *S. sciureus* on Sumak Allpa, suggesting that the island functions effectively as a sanctuary for this species. Further research is needed to clarify and expand on results of this study, but the given results are significant in supporting sanctuaries such as Sumak Allpa in the protection and recuperation of the common squirrel monkey, as well as other exploited primate species.

ISP Topic Codes: 601, 614, 624

Key words: sanctuary; primate; squirrel monkey; *Saimiri sciureus*; Ecuador

## INTRODUCTION

The Amazon River Basin occupies 6.8 million km<sup>2</sup>, making it the largest river basin in the world and nearly twice the size of the second largest river basin, the Congo. About two thirds of the Amazon Basin is covered by the Amazon Rainforest, containing about one-sixth of all broadleaf forest in the world. This rainforest accounts for over 25,000 species of flowering plants and more than 5,000 species of vertebrates alone. One of the Amazon River's main tributaries is the Napo River, holding 109,915 km<sup>2</sup> and 1.9% of the Amazon Basin's water (Goulding et al. 2003). The Napo River drainage basin (between 00°10'N and 01°30's, 75°20' and 78°40'W) covers an area of 100,500 km<sup>2</sup>, 59.6% of which is located in Ecuador (27,000 km<sup>2</sup>), 40% in Peru, and 0.4% in Colombia (Laraque et al. 2011). The Napo rainforest is known to be among the most biologically diverse environments of the world and is considered one of the world's "hotspots," or areas with high human pressure and high biodiversity (Myers 1990).

This study focuses on Sumak Allpa, a 113.15-hectare island on the Napo River in the Orellana region of Ecuador. This area of Ecuador receives high precipitation averaging 2,900 mm per year and is quite sensitive to rain storms, often resulting in flash floods. Rain seasonality is low at the low altitudes of this region, with between 12 to 20 days with precipitation per month (Norwegian Meteorological Institute 2012). The Napo River is a white water river flowing at 6,300 m<sup>3</sup> per second, and is characterized by high quantities of suspended sediments, with an estimated sediment deposit of 4910<sup>6</sup> tons per year (Laraque et al. 2011).

The island of Sumak Allpa serves as a sanctuary for seven to nine species of monkeys in addition to a wide diversity of other species. A sanctuary is a facility that rescues, rehabilitates, and provides shelter for animals in need, often with the goal of

releasing them back into their natural environment. There are estimated to be 130 primate sanctuaries in the world, housing an estimated 10,000 native primates and 91 different species. In the Americas, there are 48 identified sanctuaries with an estimated total primate population of 1,776 individuals, 26% of which belong to a species that is vulnerable, endangered, or critically endangered (Trayford & Farmer 2012).

Sumak Allpa was established as a sanctuary in 2005 with a planned program to release selected primate populations into the wild. According to a survey by Trayford and Farmer (2012), 39 of a surveyed 71 sanctuaries have, or have had, a release program. Managing an effective sanctuary and release program can be challenging, as each monkey individual and species is of different conservation importance and requires varying degrees of care and monitoring (Trayford & Farmer 2012; Warner 2002). Due to the lack of regulation in sanctuary management and reintroduction practices, Trayford and Farmer (2012) recommend cooperation among sanctuaries, release professionals, and relevant external experts. While Sumak Allpa has presently not released any individuals from the island, the management practices seem to provide a near-wild experience for its primates. No alimention is provided for the monkeys after an introduction period and the forest is almost entirely untouched by human influence. Therefore, it seems likely that after proper reintroduction, monkeys from Sumak Allpa may thrive in a wild environment.

Sanctuaries such as Sumak Allpa have arisen due to the increasing pressure humans are putting on the livelihood of primates. Tropical deforestation is a widespread problem; however, it is highly concentrated in a relatively small number of regions. According to Myers (1993), the Napo region of Western Amazonia is one of the 14 largest deforestation fronts of the world, with around 200,000 hectares deforested annually. Human

population has been increasing rapidly around the world with a growth rate in Ecuador of 1.419% (CIA World Factbook 2012). Deforestation is largely due to this population growth, as it causes the dispersal of people, smallholdings, and ranches to previously untouched land. Livestock ranching, large-scale crop farming, and petroleum mining are responsible for much of the deforestation of the region. Unfortunately, deforestation and development is ranked as the primary cause of species extinction in the world (Pimm & Raven, 2000). Deforestation and development lead to habitat fragmentation, which have proven to be detrimental for many species (Simberloff & Abele 1982, Lomolino & Perault 2001, Lovejoy et al.). Additionally, hunting and poaching of animals represents a major threat to species. Primates particularly are hunted for their meat and captured for the pet trade, activities that continue despite national and international regulations for protected species (Trayford & Farmer 2012). Additionally, rising global temperatures are beginning to effect many regions of the world, increasing rates of fires, droughts, and flooding, causing further habitat destruction for primates. Sanctuaries such as Sumak Allpa help to combat the negative consequences of deforestation, human influence, and climate change by housing primates in protected and natural environments.

One of the species that Sumak Allpa functions to protect is *Saimiri sciureus*, or the common squirrel monkey. This study aims to describe the squirrel monkey population on the island of Sumak Allpa in order to evaluate their success, growth, behavior, and habitat use on the island in comparison to other surveys of wild and captive squirrel monkeys. According to Trayford and Farmer (2012), 29 common squirrel monkeys are present in two sanctuaries in the Americas, 18 of which have been identified for release. Common squirrel monkeys are the second most common primate genus used in laboratory research and

were formerly widely exploited in these practices (Emmons 1990). Despite extensive laboratory research, much less is known about the behavior, habitat use, and population compositions of *S. sciureus* in the wild (Baldwin & Baldwin 1971, Boinski 1987). While squirrel monkeys are generally considered too small for bush meat (480-1400 grams), they continue to be hunted and captured for medicinal traditions and ceremonies, as well as for the pet trade (Emmons 1990).

Squirrel monkeys on Sumak Allpa belong to the species *sciureus*, one of the five recognized species of primates in the genus *Saimiri*. Previously only two species, *S. sciureus* and *S. oerstedii*, were recognized, but recently genetic tools have clarified that there are indeed five species that fit into those two subgroups (Groves 2001) The common squirrel monkey (*S. sciureus*) has a wide range in South America of the Amazon Basin and Guianas up to an elevation of 1,500 meters (Emmons 1990). *S. sciureus* are arboreal and insectivorous-frugivorous, consuming both insects and fruits depending on their abundance (Cawthon 2006). Troops range in size from 5 to more than 100 (Emmons 1990, Pearson & Beletsky 2010). According to Baldwin & Baldwin (1971), under natural conditions and unaltered, continuous forests, troops can reach numbers of 150 to 300 individuals. Depending on troop size, common squirrel monkeys are generally seen to occupy a range of at least 2 square kilometers (Boinski 1987, Pearson & Beletsky 2010). Boinski (1987) estimates that *S. sciureus* generally have a density of 0.36 individuals per hectare. One objective of this study is to compare the population on the island to their estimated home range to evaluate the potential for growth of this population.

In addition to an overall count of the individuals of the population on Sumak Allpa, this study focuses on quantifying the number of new births and juveniles on the island to

discern the current growth rate of the population. Baldwin & Baldwin (1973) testified that a normal rate of reproductive success for common squirrel monkeys is characterized by about 85% of adult females carrying infants. Infants tend to cling to their mothers, or occasionally, between the third and seventh week, their “aunt” (Hunt et al. 1978), until they are about 1 year old (Emmons 1990). Females begin reproducing at about 3 years of age (Pearson & Beletsky 2010) and reproduce at highly predictable birth and breeding periods that rarely last more than two months each (Coe & Rosenblum 1978, DuMond & Hutchinson 1967); therefore, it is expected that the infants in the Sumak Allpa population will be of approximately the same age.

Squirrel monkeys are known to frequently form polyspecific groups with other primate species. In fact, Lehman (2000) showed that compared to other American primate species, squirrel monkeys were involved in polyspecific groups in 94.1% of observed polyspecific groups, most often with brown capuchins. According to Hall (1965) and Dunbar & Dunbar (1974), areas that are rich in food resources are more likely to tolerate polyspecific groups. It is hypothesized that interspecies interactions or polyspecific groups including the common squirrel monkeys will be likely on Sumak Allpa due to the small size of the island and density of monkeys (about 60 individuals in 113.15-hectares).

The habitat use of the squirrel monkey population of Sumak Allpa will also be evaluated and compared with general trends of habitat use of the species. Many studies have shown that *S. sciureus* tend to prefer disturbed forest with a dense underlayer, although they can be very flexible and are able to exploit a wide range of environments (Boinski 1987, Scollay 1981, Warner 2002, Terborge 1983). Additionally, among primates, *S. sciureus* have been noted to spend the most time in the

understory and rarely encountered above the lower part canopy (Boinski 1987, Warner 2002, Mittermeier & van Roosmalen, Boinski 1987). The island of Sumak Allpa contains a range of habitats from sandbar scrub to varzea forest, and some parts of transitional forest. Depending on rainfall, many parts of the island are frequently inundated. Riverine islands are constantly changing and progressing downstream through erosion, particularly in the fast flowing River Napo ( $6,300 \text{ m}^3 \text{ s}^{-1}$ ), so older developed forests tend to exist in the upstream side and more silty and inundated areas in the downstream end (Remsen & Parker 1983). This is consistent with Sumak Allpa, as the downstream Eastern end is frequently flooded and is dominated by bamboo and palms. It is hypothesized that the squirrel monkey population of Sumak Allpa will prefer the river edge habitats dominated by bamboo, but with the limited space on the island, they may take advantage of all habitats that the island offers.

Habitat of sleeping locations of squirrel monkeys will also be evaluated on Sumak Allpa. Many primate species, including *S. sciureus* tend to choose a single central sleeping location with specific preferred trees (Chapman et al. 1989, Boinski 1987, Fernandez-Duque 2008). Sleeping trees tend to be isolated from surrounding foliage to limit access routes of potential arboreal predators (Boinski 1987). Fernandez-Duque (2008) found that a studied group of nocturnal monkeys in Tiputini Biodiversity Station of Yasuní National Park tended to sleep in somewhat isolated, nearly dead, palm trees with diameters of around 15 cm. These types of sleeping trees allow the monkeys to avoid predation, so it is hypothesized that the squirrel monkeys on Sumak Allpa will behave similarly.

Finally, this study will focus on a general survey of the behavior of the Sumak Allpa *S. sciureus* population. Past studies have shown that squirrel monkeys spend between

43% and 64% of their time on food-related activities (searching for and eating food) (Boinski 1987). *S. sciureus* is unique among primates in that travel is more common than sedentary feeding or resting (Warner 2002). Squirrel monkeys tend to express little intertroop aggression except during the mating season (Boinski 1987, Wooley et al. 1978) while social interactions are known to vary among troops and habitat, ranging from 0 to 3 hours a day. In food-deprived habitats, food related activities tend to take precedence over play (Baldwin & Baldwin 1971, Baldwin & Baldwin 1973, Latta 1967).

The overarching goal of this study is to provide data regarding the population of *S. sciureus* on Sumak Allpa and to compare this population to other studied populations in captive and wild environments. Methodologies include individual daily observation walks in the mornings, afternoons, and evenings, sleeping site observations, group site division, where individuals covered different parts of the island at the same time, and canoe observations from the exterior of the island. Information regarding a) population composition, b) association with other species, c) habitat preferences and movement, d) sleeping trees and tendencies, and e) behavior will be examined in addition to an evaluation of the methodologies used. This study will serve to evaluate the success of the present population as an indication of the functionality of Sumak Allpa as a sanctuary for American primates.

## **MATERIALS AND METHODS**

### *Site Description:*

Research was conducted on the squirrel monkey population on Sumak Allpa, a 113.15-hectare island on the Napo River in the Orellana Province of Amazonian Ecuador. This island has been a recuperation habitat for Amazonian monkeys since 2005, housing

between seven and nine species of monkeys (black and golden-mantle tamarin, woolly, monk saki, squirrel, nocturnal, pygmy marmoset, and potentially dusky titi and capuchin) and about 60 individuals protected from the risk of hunters and trappers. Many of the monkeys were taken out of the pet trade and brought to live on the island to recuperate and reproduce naturally. Following an introduction period between zero and nine months, the monkeys are not given alimentation or support and live naturally on the island. *S. sciureus* was introduced to the island in 2007 from the Madero River and received no alimentation introduction period. The island houses two permanent families, student researchers, and visiting tourists who come for day visits to see the monkeys. Sumak Allpa contains six trails allowing tourists and researchers to walk to most parts of the island (Figure 1). Nearly the entirety of the island is primary forest, with cleared land at the port and camp, and bamboo cane forest on the exteriors. The island is occasionally flooded due to riparian effects and the surrounding Napo River varies in size due to rainfall between 12 and 20 days each month.

### *Observation Period:*

Observations were conducted during the month of November in 2012 (November 5<sup>th</sup> through November 24<sup>th</sup>). During this period, rain was frequent, particularly in the final two weeks of the study month. Overall, temperatures varied from 21°C to 31°C with strong sunlight and little wind. This period is characterized by a high abundance of fruit on the forest trees (Ecotour Expeditions 2011). On Sumak Allpa, particularly along Eastern Jatun, there was a high abundance of guava fruits during this month (Figure 1). Observations were taken six days a week (excluding every Thursday morning and afternoon, as well as Friday morning). Morning observations generally began between 5:30 am (sunrise) and 7:30 am.

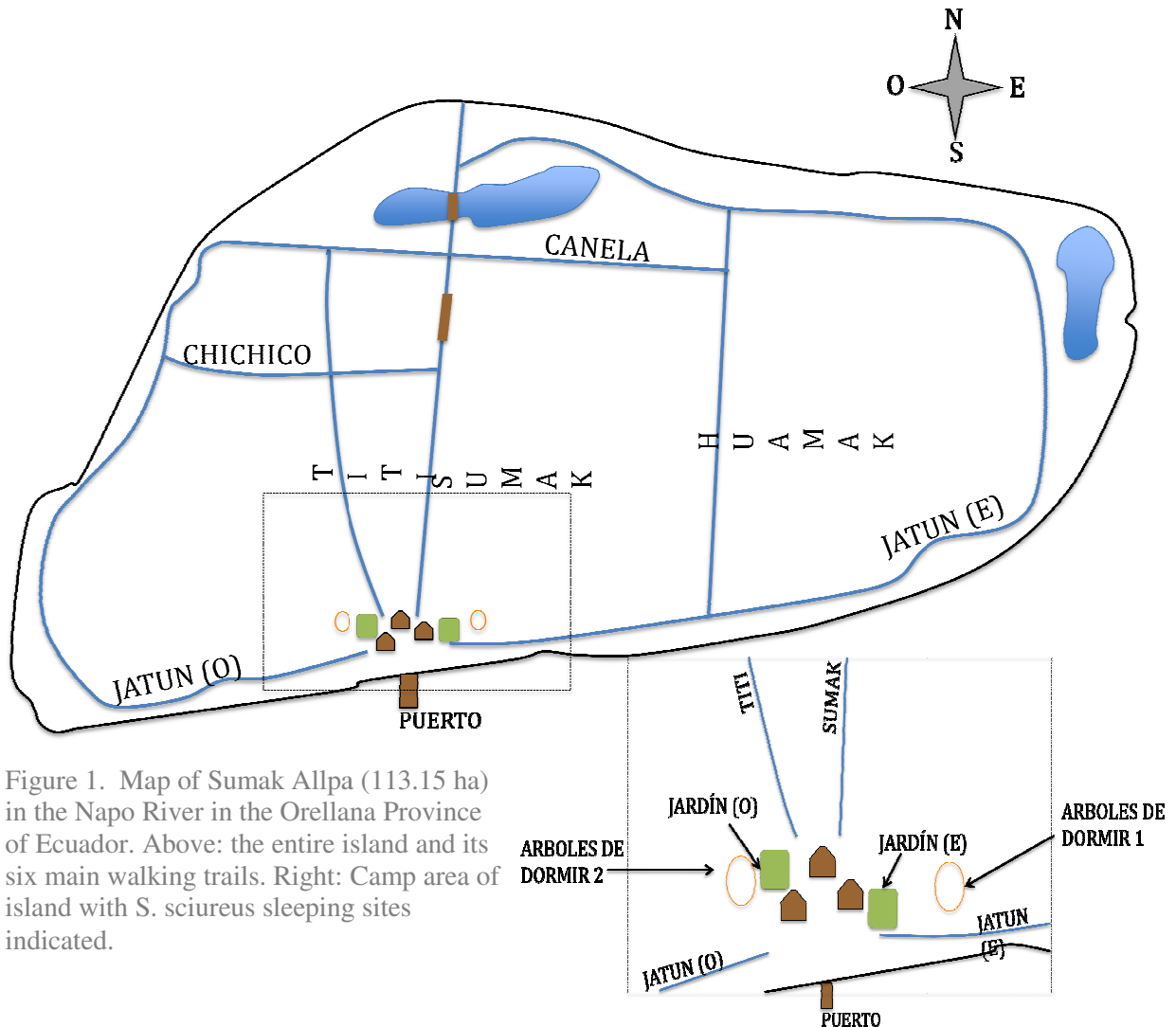


Figure 1. Map of Sumak Allpa (113.15 ha) in the Napo River in the Orellana Province of Ecuador. Above: the entire island and its six main walking trails. Right: Camp area of island with *S. sciureus* sleeping sites indicated.

Afternoon observations took place at varying times starting between 2 pm and 5:30 pm. Observation start times were varied in order to observe the squirrel monkeys at different times in their daily routines. Duration of each observation period varied based on if and when the squirrel monkeys were encountered. Generally, observation periods lasted between 1 hour and 3 hours.

*Field Methods:*

During each observation period, the forest surrounding the port and camp was first scanned to see if the squirrel monkeys were in the surrounding area. Each period consisted of walking transects of the trails on the island. At the start of the month of November, transects covered all trails on the island, but later, transect trails were selected based on past

sightings of squirrel monkey populations. However, in the final week of the study, an additional effort was made to find and survey potential smaller troops living on the island, so all trails and off-trail transects were covered. During this final period, additional help from experts, Hector Vargas and Miguel Ualinga, allowed a greater coverage of the island during observation periods. One group of observers would cover one area of the island as the other group covered another part of the island. This allowed greater area coverage and the potential to view and identify distinctly different troops. Finally, a motorized canoe was used to travel around the exterior of the island to search for squirrel monkeys while another group searched the interior of the island by foot. These additional methodologies provided a more extensive

view of the squirrel monkey population on the island. Appendix A details the observation periods and trails taken during each period.

Walking slowly and quietly on trails permitted hearing and viewing of the monkeys. A recorder and speaker (iPhone 4S) were used on trail in order to record squirrel monkey calls and to play them in order to attract the monkeys. Additionally, a compass was used both to indicate the direction of travel of the monkeys and to remain oriented when off trail. A map of the island trails was carried to remain oriented and to mark down viewing points of the squirrel monkeys. A machete was also used to facilitate travel through areas off-trail. Finally, binoculars (DESCRIBE) were used to make more precise observations and a camera (Canon Powershot S95, 6.00 x 22.5mm) was used to document sightings when possible (Appendix B).

At the start of each observation period, the date, time, weather (temperature, cloud cover, rain presence, and sun strength) was noted. After returning, the trails covered were noted. When the squirrel monkeys were seen, the time and estimated location and trail, and the direction of travel were recorded. Using the trails, and occasionally off-trail with the help of a machete, the monkeys were followed for as long as possible. The number of individual monkeys seen was recorded; if more monkeys were heard than seen, an estimate of total monkeys in the troop was noted as well. Additionally, if possible, the size of the monkeys was noted corresponding to age range (infant with estimated age, juvenile, and adult). Behavior (travel-foraging, stationary-foraging, resting, traveling, and play) was noted for the individuals in view and extrapolated to be the general behavior of the troop during that time period. Observations of other species of monkeys and animals were noted as well to supplement information regarding the environmental conditions of squirrel monkey sightings and potential intraspecies associations. Habitat in

which squirrel monkeys were seen was noted as well.

## RESULTS

During 33 observation periods, squirrel monkeys were seen 21 times. Within the first week of observations (11 observations), the monkeys were only seen 4 times, but in the later observation periods, viewings increased, with 80% of observation periods including squirrel monkey sightings during the third week (Figure 2). In addition to a variance in squirrel monkey observation frequency across the month of November, success rate, or percentage of observations including views of *S. sciureus* varied according to the time of day observations took place. Successful observations of squirrel monkeys was much more common between 5:00 and 8:00 am (88%) and 5:00 and 7:00 pm (86%) (Figure 3).

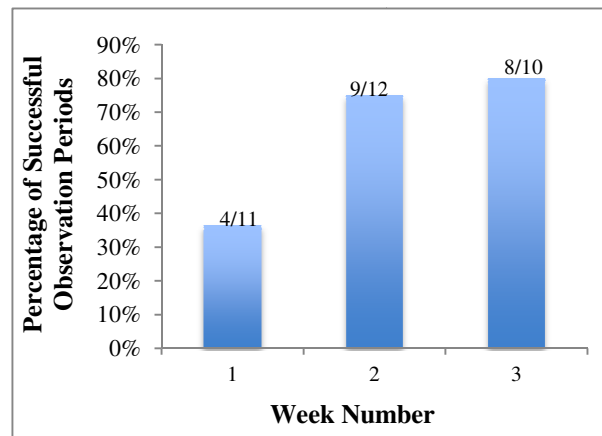


Figure 2. Percentage of successful observation periods in which squirrel monkeys were seen on Sumak Allpa during each week of observations in the month of November. The number of successful observations over the total number of observations is shown for each week.

Not all factors in question (population composition, association with other species, habitat preferences, sleeping trees and tendencies, and behavior) could be



documented during each observation period, as views were often fleeting and from a distance. During 21 successful observation periods, six did not yield observations other than general troop location.

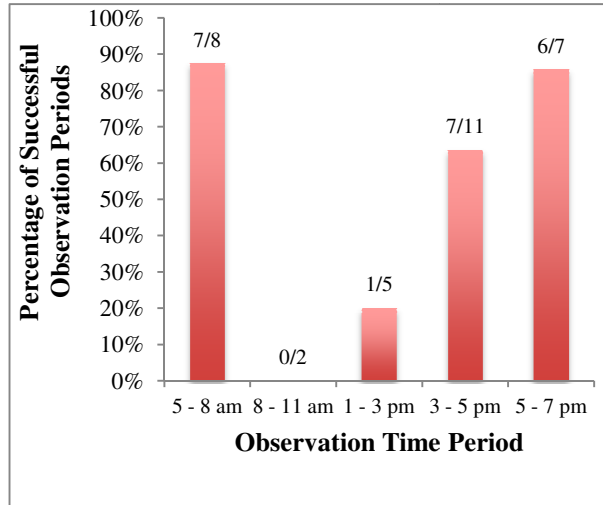


Figure 3. Percentage of successful observation periods in which squirrel monkeys were seen on Sumak Allpa at varying times of day. Each time period contains varying numbers of observations, with 8 am - 11 am and 1 pm - 3 pm only accounting for 7 of the 33 total observations.

**Population Composition:**

The monkeys were not always able to be counted and counts varied greatly from 1 to 17 adults and juveniles, 4 to 6 juveniles, and 0 to 3 infants. One large troop was clearly identified. This troop was estimated to have between 13 (including one baby on back) and 20 (including three babies on backs) (Figure 4). An independent individual was also observed, but is hypothesized to separate and merge with the larger troop.

Data from previous research on Sumak Allpa's *S. sciureus* population was also collected and analyzed (Latimer & Stout 2011) These data from January through February and October through November of 2011 demonstrate an increase in population from an average of 9 individuals seen (including up to 3 infants) in January-February of 2011 to an average of 15

individuals seen (including up to 4 infants) in October-November of 2011 (Figure 5).

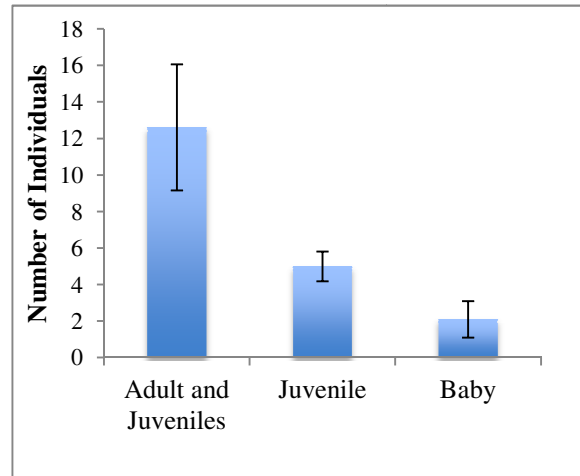


Figure 4. Population composition of large troop of squirrel monkeys (*Saimiri sciureus*) on Sumak Allpa in November 2012. Number of adults, juveniles, and babies was estimated based on 21 observations. Individuals carried on the backs of adults were considered to be babies (<1yr), smaller individuals were considered juveniles (1-3yrs), and all others were considered adults. Averages are shown with the standard deviation to display the potential range in the population structure.

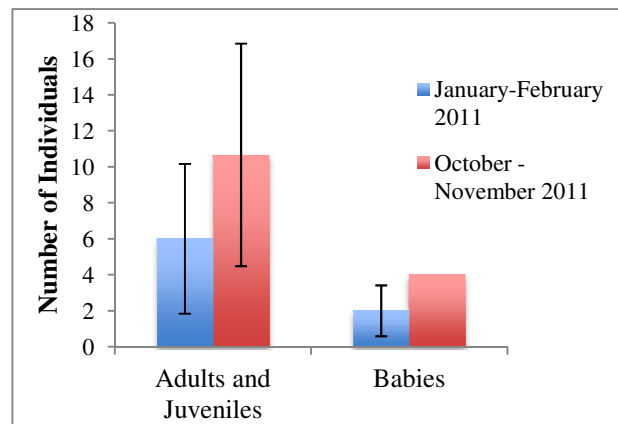


Figure 5. Population composition of large troop of squirrel monkeys (*Saimiri sciureus*) on Sumak Allpa in Jan-Feb 2011 and Oct-Nov 2011. Jan-Feb babies were born in 2010, and Oct-Nov in 2011.

**Association With Other Species:**

Association of *S. sciureus* with other species occurred in 6 of 22 successful

observation periods. They were most frequently seen to associate with tamarin troops (*Saguinus graellsii* and *Saguinus tripartitus*) on the island and could often be found within 100 meters of these troops. Squirrel monkeys on Sumak Allpa were also seen to associate with the baby wooly monkey (*Lagothrix poeppigii*) troop on the island that generally spends its time in the areas surrounding the camp (Figure 6). Associations between the squirrel monkeys and the wooly monkeys were only observed when the wooly monkeys were foraging and preparing to sleep in the same area that the squirrel monkeys sleep. Neither the tamarins nor the woolys were ever seen to make physical contact with the squirrel monkeys and no aggression between the species was ever observed.

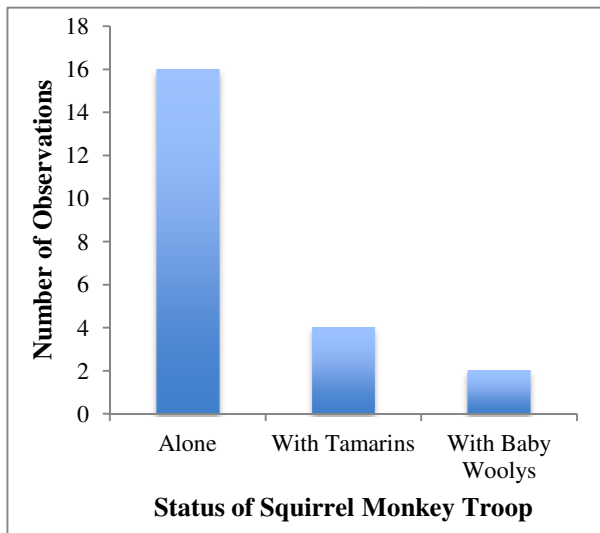


Figure 6. Association of squirrel monkey (*S. sciureus*) with other primate species on Sumak Allpa. Number of observations in which squirrel monkeys were seen alone or in close proximity (100 meters) to tamarin or baby wooly troops is shown.

**Habitat Preferences and Movement:**

Squirrel monkeys were seen most often on the edges of the island, particularly on the Southeastern border, which are dominated by bamboo and heliconiaceae vegetation. They were also frequently seen on the forest edge near the cleared camp land.

Most successful observations occurred in the morning and the evening as the monkeys were leaving from or arriving at their sleeping location, which was on the border of cleared land and the island edge (Figure 7).

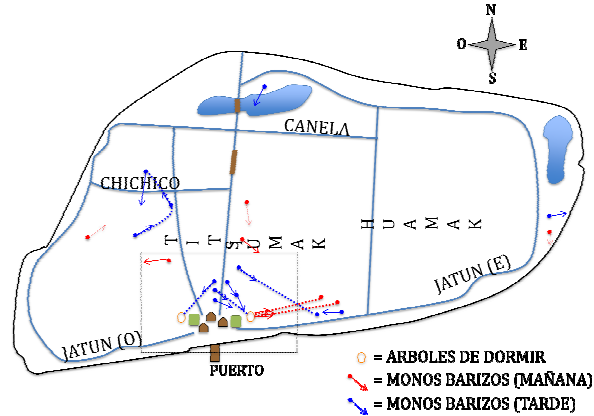


Figure 7. Sightings and direction of travel of squirrel monkeys on Sumak Allpa during the month of November 2012. Morning (5:30 - 11 am) sightings are shown in red and afternoon (1 pm - 6 pm) sightings are shown in blue.

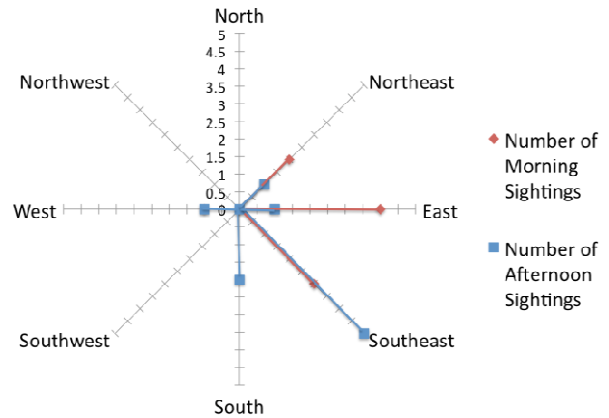


Figure 8. Direction of travel of squirrel monkeys in morning and afternoon sightings. Number of sightings during each time period and in each direction is displayed, indicating that the general movement tended to be Southeast.

During the morning, the large squirrel monkey troop tended to travel southeast and east along the southern island edge and circle around to the Northwestern side of the island in the afternoon, to eventually travel southeast to their sleeping location between 5:30 and 6 pm. Figure 8 demonstrates that observed travel of the squirrel monkeys tended towards

East and Southeast, with very little travel North, Northwest, West, or Southwest. Data from past research on the squirrel monkeys of Sumak Allpa (Latimer & Stout 2011) showed similar patterns of travel and encountering locations (Figure 9).

Rate of travel was calculated during four observation periods (two morning, two afternoon/evening) and averaged to be 310 meters per hour in the morning observations and 142 meters per hour in the afternoon and evening observations (Figure 10).

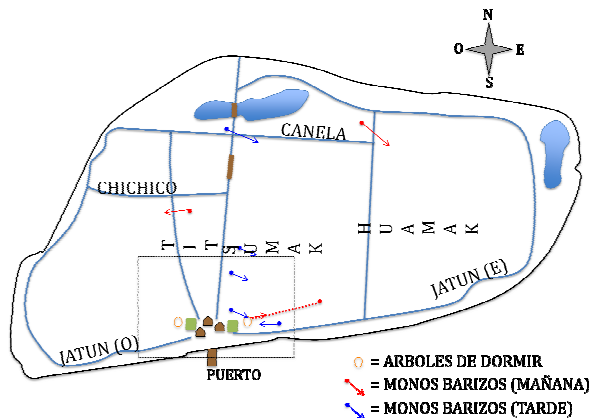


Figure 9. Sightings and direction of travel of *S. sciureus* on Sumak Allpa during Jan-Feb 2011 and Oct-Nov 2011. Morning (5:30 - 11 am) sightings are in red and afternoon (1 pm - 6 pm) are in blue.

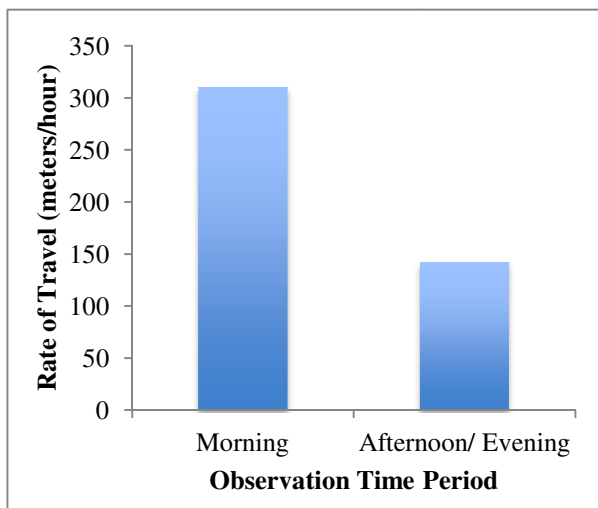


Figure 10. Rate of travel of squirrel monkey troop on Sumak Allpa during the morning (5:30-7 am) and the afternoon/evening (3-6pm) during the month of Nov 2012.

### Sleeping Trees and Tendencies:

The large troop of *S. sciureus* was seen to sleep at two locations during the month of November 2012. All but one observation evening, the monkeys arrived and slept about 15 meters east of the eastern camp garden. One night, they were seen to sleep on the opposite side of camp, about 10 meters west of the western camp garden (Figures 1, 7, and 9). The squirrel monkeys were seen to sleep in two tall palms. The two trees are relatively isolated from the surrounding trees, requiring the squirrel monkeys to climb up them from the low understory or jump a few meters from nearby trees. The monkeys tended to arrive at their chosen sleeping trees between 5:30 and 6 pm, settle down to sleep by 6:25 pm as the sun set, and depart between 5:15 and 5:45 am as the sun rose.

### Behavior:

During the 21 successful observation periods, the behavior of visible *S. sciureus* troop individuals was noted. Troops were seen most often to be foraging while traveling 48% of observations. They were seen to be traveling without notable foraging behavior during 24% of observations. Stationary rest and foraging accounted for 24% of observations (14% and 10% respectively). Play was only noted during one observation (5% of all observations) (Figure 11). During this play, the observed individuals were seen to be pulling each other's tails, lying down and twisting on the branches, and chasing each other on the branches at the large troop's sleeping site.

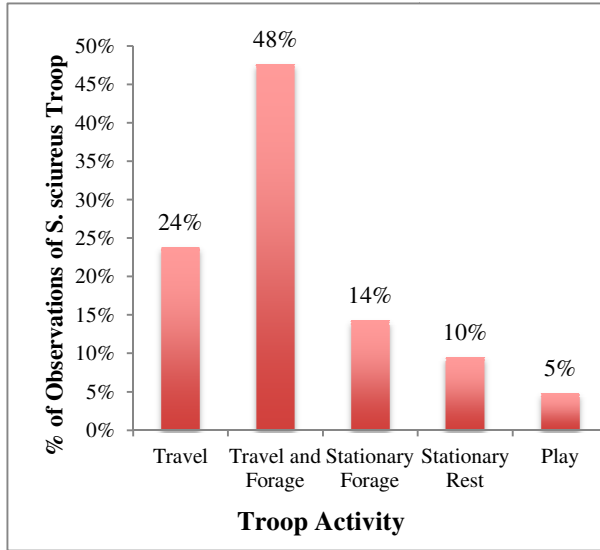


Figure 11. Troop activity of *S. sciureus* on Sumak Allpa during 21 observations in Nov 2012. Behavior of visible individuals was assumed to represent the entire troop during the given observation period.

## DISCUSSION

### *Population Composition:*

In a total of 33 observation periods, squirrel monkeys were seen 21 times and counted 13 times. Data presented on numbers of adults, juveniles, and infants (Figures 4 and 5) demonstrate a growth in population size on the island. According to Latimer & Stout's (2011) data from January through February of 2011 and from October through November of 2011, the *S. sciureus* population saw a growth rate of 3 individuals from 2010 to 2011 (0.25 births/month) and 4 individuals from 2011 to 2012 (0.33 births/month).

The data collected during the present study in the month of November 2012 indicate one large troop of squirrel monkeys, with occasional separation, notably of one independent individual. According to the data recorded during this study, there are currently an average of 13.62 adult and juvenile individuals (large troop and solo individual), with an average of 2.1 infants (Figure 4). These data are determined from an average of

counts from many observations of squirrel monkeys. It is more likely that the populations are better represented by the highest counts obtained (18 adults and juveniles, 3 infants) as it is probable that not all individuals were visible during most counting observations. Using the averaged data, a growth rate of 0.0877 individuals per month (1.05 births per year) from November of 2011 to November of 2012 is observed. However, if the maximum counts for the present data are used, a growth rate of 0.538 births per month (6.33 births per year). We might assume the growth rate to be an average of the two estimates and therefore, 0.3075 births per month (3.69 births per year).

Based on a size estimation using binoculars, the three identified infants were assumed to be about 2 to 4 weeks old. The largest infant was seen twice to display actions of further maturity. It was seen once to climb off its mother's back and try to walk for a few seconds only to be quickly picked back up by the mother. A subsequent time, the same individual was seen to try to crawl off its mother's back again, but this time it was pushed back on immediately. Similar behavior of infant exploration has been noted by Baldwin & Baldwin (1971).

While it was often difficult to identify the number of juveniles in the viewable population, the present data suggest an average of 5 juveniles (between 1 and 3 years old). More are expected to be present as those closer to an adult age of 3 years (Cawthon 2006) were likely nearly indistinguishable from adults, especially in during fleeting views. Depending on the age of the infants viewed during the previous studies by Latimer and Stout (2011), there would be expected to be at least between 3 and 7 juveniles, given no infant mortalities.

Data on population composition is highly uncertain as counts varied greatly (Standard Deviation: 3.45 for adult and juvenile count and 0.99 for infant count). Scollay (1981) and Klein (1971) testify to the

difficulty in obtaining accurate counts of squirrel monkey troops, as the rainforest environment provides natural camouflage and the monkeys travel quickly through the understory. Additionally, the death rate of the squirrel monkeys on the island is uncertain, so births do not necessarily equate to growth of the population. Further observation periods are necessary to obtain a more accurate count of the present population of *S. sciureus* on Sumak Allpa; however, these data suggest a positive growth rate. The population seems to be thriving on the island with between 1 and 4 new births each year. As the island is a limited size, the squirrel monkey population cannot be expected to grow continuously at a high rate. The growth rate will likely decrease until the island has reached carrying capacity, which according to Boinski (1987) will be when the population reaches a density of 0.36 individuals per hectare, or 77 individuals on this island. However, this will likely be less for this island, as there are about 60 total monkey individuals inhabiting the same area.

#### *Association With Other Species:*

*S. sciureus* is known to frequently associate with other species for greater foraging efficiency and predator avoidance (Lehman 2000, Klein and Klein 1973), especially in habitats with high food abundance and thus infrequent competition for food (Dunbar & Dunbar 1974). Squirrel monkeys most often associate with brown capuchins (*Cebus albifrons*) (Lehman 2000, Terborgh 1983); however, in the present study, there were no sightings of capuchins. However, past data on Sumak Allpa have recorded the presence of *Cebus albifrons* with the large squirrel monkey troop (Latimer & Stout 2011). It is hypothesized that the capuchin individuals on the island may have been subject to hawk predation before the initiation of the present study.

In this study, squirrel monkeys on Sumak Allpa were seen to most often

associate with tamarin troops (*Saguinus graellsii* and *Saguinus tripartitus*). While no physical interactions were noted, the tamarin troops could often be located within 100 meters of the squirrel monkeys (Figure 6). It is presumed that the benefit of this intraspecies interaction is to improve foraging efficiency. Additionally, while there is no risk of hunters and trappers on Sumak Allpa, raptors, hawks, snakes, and felids are known to be predation threats for squirrel monkeys as well (Mitchell et al. 1991). Traveling with other species in a larger group yields more eyes for potential threats and new patches of unexploited food.

Squirrel monkeys were also twice seen to associate with the baby woolly monkey (*Lagothrix poeppigii*) troop on Sumak Allpa (Figure 6). This troop was introduced two months prior to the study period and still remains close to camp. Therefore, their current habitat range coincides with the large squirrel monkey troop's sleeping sites. Twice, the squirrel monkeys were seen to arrive to their sleeping site between 5:30 and 6:00 pm while the baby woolly monkeys were there as well. The monkeys were seen to sleep in the same area as the woollys without any noticeable interactions. The following mornings, the squirrel monkey troop left the area and the woolly monkeys remained there. As interactions between *L. poeppigii* and *S. sciureus* are uncommon (Lehman 2000), it is likely that these noted associations were purely coincidental due to range overlap.

#### *Habitat Preferences and Movement:*

The *S. sciureus* population on Sumak Allpa was most commonly found on the island edges and on borders between forest and cleared land (Figure 7). Squirrel monkeys are known to prefer disturbed forest with a dense underlayer, often dominated by bamboo (Boinski 1987, Warner 2002). The forest edges of Sumak Allpa are dominated by bamboo and heliconiaceae vegetation, so it is logical that the squirrel monkeys were often

encountered in these regions. These areas also tended to be areas with guava and other fruiting trees with high fruit abundance (Appendix B). Additionally, the central trail, Huamak, in which the monkeys were occasionally seen, also has a high abundance of cane vegetation.

As the island of Sumak Allpa is the minimal size range of *S. sciureus*, the monkeys could not be limited to just this vegetation and therefore were seen throughout the island. Based on the recorded sighting locations and paths of the squirrel monkeys, a sketch of a proposed daily track of the large troop was created (Figure 12). There is likely additional activity on the eastern end of the island where the often-independent individual meets and separates from the large troop.

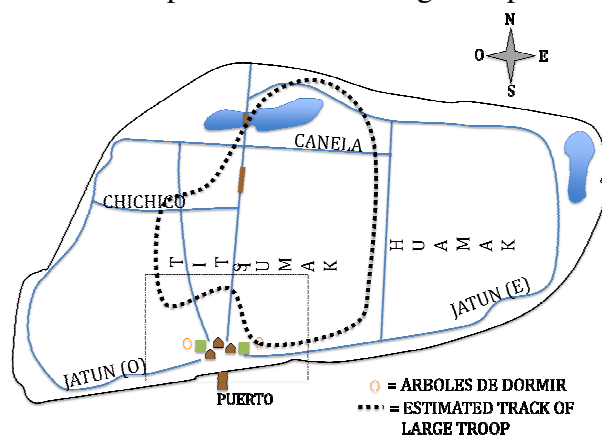


Figure 12. Proposed daily track of large troop of squirrel monkeys on Sumak Allpa based on observations during Nov 2012. Movement is presumed to be clockwise along this track.

Additionally, studies have shown that *S. sciureus* is consistently found lower in the forest strata, with more sightings in the forest underlayer and shrub layer than any other American primate (Mittermeier & van Roosmalen 1981, Warner 2002). This pattern was also observed in the population on Sumak Allpa. Accurate population composition counts were very difficult to obtain, as individuals were often too low down to see from a distance. Individuals were most often seen in the middle understory, running and

jumping from tree to tree, but they could often also be heard lower down in the shrub layer. According to Stone (2007), a tendency to reside lower in the forest strata is a predation avoidance tactic, as being lower in the trees provides more protection from aerial predators, a threat that squirrel monkeys face due to their small size (Terborgh 1983).

Overall, squirrel monkeys are known to be quite flexible and able to exploit different environments (Scollay 1981), so they are able to thrive and travel through the entirety of the island of Sumak Allpa, yet still demonstrating preference for disturbed forest edge vegetation.

Squirrel monkeys were seen to travel faster in the mornings than the afternoons (310 meters/hour and 142 meters/hour respectively) (Figure 10). A faster rate of travel is consistent with data collected by Boinski (1987), who found travel, without foraging, to be more common in the mornings than the afternoons and evenings.

#### *Sleeping Trees and Tendencies:*

Many species of monkeys including *S. sciureus* tend to have high fidelity to few sleeping sites (Fernandez-Duque et al. 2008, Boinski 1987). In the case of the Sumak Allpa population, the large troop of squirrel monkeys was seen to use only two sleeping sites in the month of November with a strong preference for one of the sites (91.6% of observation nights at that site). This main sleeping site of the large troop was on the eastern side of camp, just past the camp's eastern garden (Figure 1). They were seen to sleep on two tall, somewhat isolated palms. These trees were likely favorable as the crowns of the trees are isolated from surrounding foliage, preventing easy access for arboreal predators. Nocturnal monkeys (*Aotus vociferans*) in a study by Fernandez-Duque et al. (2008) were also found to select small diameter palms as sleeping sites. Since palms do not have any extending branches and

extending fronds cannot hold very much weight, access routes for predators are limited.

Many ecologists have hypothesized that fidelity to sleeping sites can decrease foraging efficiency and range size of primates, as they are limited in how far they can travel to allow them to return each evening before sunset (Boinski 1987, Chapman et al. 1989). However, in the case of the *S. sciureus* population on Sumak Allpa, their range is already limited (113.15 ha) and fidelity to the central sleeping site near camp does not likely limit where they are able to travel or forage on the island.

#### *Behavior:*

Behavior of *S. sciureus* has been widely studied in laboratories; however, less data is present regarding behavior in natural, wild settings (Baldwin & Baldwin 1971, Boinski 1987). In the present study, troop activity (travel, travel and forage, stationary forage, stationary rest, and play) was recorded when the troop was seen and when viewing period permitted a behavioral observation. Occasionally, squirrel monkey individuals were seen so briefly that only an indication of general location and direction of travel was possible.

Warner (2002) found that *S. sciureus* was the only American primate species where traveling was more common than sedentary activities of feeding or resting. In the present study, the common squirrel monkeys were found to spend 72% of their time traveling (travel, travel and forage). The percentage of time spent just traveling (without foraging) is exceptionally high compared to most studies of common squirrel monkeys, which could likely be due to the limited viewing time of the populations. Movement of individuals greatly facilitated sightings of the troop, as moving branches were much easier to locate. Much of the time marked as just travel was likely accompanied by periods of forage, rest, or play, but these activities were more difficult

to see due to the lack of movement. Additionally, Boinski (1987) notes that travel is most common during the early morning, between 5:00 and 6:30 am and 33.3% of all successful observations took place between 5 am and 8 am, making travel observations more likely.

Consistent with previous studies (Boinski 1987, Warner 2002), the common squirrel monkey population on Sumak Allpa was found to spend the majority of their time in food-related activities, with 62% of time spent in travel and forage and stationary forage activities (Figure 11).

Play was only observed once during the month of November, which according to Baldwin and Baldwin (1971) is typical of *Saimiri*. They found the monkeys to exhibit social play between 0 and 3 hours a day depending on troop size and habitat. The play that was observed in the present study was in the form of chasing, lying on their backs on branches and twisting, and pulling each other's tails. Latta et al. (1967) describes these activities as common and as potential indicators of sexual play. They noted that laying on his back and twisting by a male is often an attempt to attract a sexual partner. Additionally, pulling tails and chasing can be dominance actions in sexual situations. No intertroop aggression was seen, as it is generally only seen during the breeding season (Boinski 1987).

Finally, behavior towards human observers was characteristic of primates with little interaction with hunters or trappers (Baldwin & Baldwin 1971). *S. sciureus* individuals, particularly males and juveniles, demonstrated curiosity towards human observers, often approaching slowly and watching the observer for an extended period of time (usually a few minutes) (Figure 13). Monkeys with exposure to hunters and trappers would have been expected to flee quickly.



Figure 13. Common squirrel monkey (*S. sciureus*) on Sumak Allpa, November 2012, displaying curiosity and defense in the presence of a human observer.

#### *Evaluation of Methodology:*

Methodologies performed in this study were basic and replicable with very little funding. Necessary materials included binoculars, a compass, and a notebook, while a camera and a recording and speaker device were useful. Many studies have used radio collars to locate and follow the paths of primate troops (Fernandez-Duque 2008); however, the small size of the Sumak Allpa sanctuary allowed consistent location of the species without expensive technology and interference with the individuals. The duration of this study, 3 observation weeks, was short and additional observation periods are necessary for more definite conclusions. With further repetition, success rate (Figure 2) would surely continue to increase, as more information is gained regarding the troop locations at different times of day with more observation time.

Data is likely skewed due to the facility of encountering the squirrel monkey troops at different times of day, during different activities, and in different forest layers. For example, as previously discussed a greater percentage of successful observations occurred in the early mornings (88%) and the

evenings (86%), as these were the times when the troop arrived at and left from the sleeping site. Also, more observations were likely made while the monkeys were traveling as the movement made it easier to locate them in the forest. Lastly, it was easier to locate the monkeys when they were higher up in the forest strata, so the data is likely skewed towards activities performed in the higher levels and individuals were likely not counted if they were lower in the understory. Overall, more observation time is required to clarify number of individuals, troop dispersion and travel, association with other species, and activity, but the data obtained during this study coincide well with past research of *S. sciureus*, indicating successful methodologies and data collection.

## CONCLUSIONS

This study, conducted between November 5<sup>th</sup> and November 24<sup>th</sup> on the primate sanctuary island of Sumak Allpa in the Orellana Province of Ecuador, served to assess the current status of the common squirrel monkey (*Saimiri sciureus*) population on this island. Results demonstrated a population maximum of 21 individuals, including 3 infants between 2 and 4 weeks of age and an estimated 4 to 6 juveniles. The population has been seen to have a positive growth rate in the past two years (between 0.3075 and 0.875 births/month). One large troop (up to 20 individuals and 3 infants) and one frequently independent individual were identified. The large troop was often seen to associate with tamarin (*S. graellsii* and *S. tripartitus*) troops while traveling and foraging on the island. They were also seen to share a sleeping site with a small troop of four juvenile woolly monkeys (*L. peppigii*). Sighting locations indicated a preference for disturbed, island edge forests that were often dominated by bamboo and heliconiaceae



vegetation. The large troop tended to travel southeast in the morning from their sleeping site and return in the evening. All except one observation evening, the squirrel monkey troop elected to sleep in two tall, isolated palms probably in order to minimize risk of arboreal predators while sleeping. Behavior of squirrel monkeys demonstrated a high allocation to traveling (travel, travel and forage) and to food related activities (travel and forage, stationary forage). Very little play, aggression, or social interactions were observed.

According to this study, the population of common squirrel monkeys on Sumak Allpa is continuing to grow and flourish in this nearly completely natural environment. Despite the limit to their range, the population is increasing in size, indicating that Sumak Allpa is a successful recuperation facility for this species. Despite a claim by Zimblér-DeLorenzo (2009) that captive environments alter the behavior of *S. sciureus*, this study did not imply any variance in the population on Sumak Allpa compared to observed populations in the wild. It can be presumed that members of this population will thrive once released into a wild environment due to their natural behavior on the island. Findings of this study are significant as common squirrel monkeys remain at risk due to hunters and trappers (Emmons 1990) and a successful sanctuary can help to combat the negative impact these forces have had on the world's squirrel monkey population. Sumak Allpa is one of two sanctuaries in the Americas housing squirrel monkeys (Trayford & Farmer 2012). This study documents the success of Sumak Allpa's *Saimiri sciureus* population and the sanctuary should thus be supported in its conservation efforts.

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## APPENDIX A

DAY	TIME	TRAILS	<i>Saimiri</i> Seen?
5/11/12	4:15 PM	Titi, Chichico, Jatun (W)	NO
5/11/12	5:00 PM	Titi, Canela, Huamak, Jatun (E)	NO
6/11/12	6:40 AM	Titi, Sumak, Jatun, beach	NO
6/11/12	1:45 PM	Sumak, Canela, Titi	NO
7/11/12	6:25 AM	Titi, Chichico, Jatun (W)	YES
7/11/12	3:30 PM	Jatun (W)	NO
9/11/12	3:50 PM	Sumak - Jatun (East)	YES
10/11/12	6:35 AM	Sumak - Canela - Huamak - Jatun/ Sumak - Chichico - Titi	YES
10/11/12	3:15 PM	Sumak - Jatun (East) - exit to beach to East point of island	YES
11/11/12	6:30 AM	Jatun (E), Huamak, Canela, Sumak	NO
11/11/12	2:15 PM	Jatun (East) - Chichico - Titi	NO
12/11/12	10:00 AM	Sumak - Canela - Huamak - Jatun (E)	NO
12/11/12	5:30 PM	Camp garden - Jatun (East)	YES
13/11/12	5:45 AM	Camp garden	YES
13/11/12	3:30 PM	Sumak - Canela - Huamak - Jatun (E)	NO
13/11/12	5:45 PM	Camp garden - Jatun (East)	YES
14/11/12	5:45 AM	Jatun (E), Huamak, Canela, Huamak, Jatun (E), beach	YES
14/11/12	1:30 PM	Titi - Canela - Huamak - Jatun (East)	NO
15/11/12	5:00 PM	Jatun (East)	YES
16/11/12	4:30 PM	Jatun (E), Huamak transect, Canela, Sumak, garden, Start of Jatun	YES

17/11/12	5:00 PM	Jatun (E) - Huamak and back; Sumak (50 meters)	YES
18/11/12	5:15 AM	Jatun - beach	YES
18/11/12	4:32 PM	Titi - Transect to Sumak – S. Sumak - Titi - Sumak – Garden (W)	YES
19/11/12	4:50 PM	Titi - Chichico - Sumak	YES
20/11/12	1:00 PM	Jatun (East) to end - Huamak - Canela - Sumak//500 m of Jatun (W)	NO
20/11/12	5:00 PM	Titi, Chichico, Sumak, both gardens	YES
21/11/12	5:35 AM	Jatun (E) - Chichico - Canela - Sumak	YES
21/11/12	8:35 AM	All of Jatun - off trail on E side of island	NO
21/11/12	5:50 PM	Garden (east)	YES
22/11/12	1:00 PM	Titi - Canela - Huamak - Jatun (East)	YES
22/11/12	4:10 PM	All of East side of island, garden (E)	YES
23/11/12	7:55 AM	All of Jatun, off trail East side of island; canoe around island	YES
23/11/12	3:45 PM	Western side of island	YES

## APPENDIX B

Common squirrel monkey (*S. sciureus*) seen in large troop during November 2012 on Sumak Allpa.



Ripe guava fruits that were commonly eaten by the *S. sciureus* population on Sumak Allpa