Internship memoir in Kawsay Center, Puerto Maldonado, Perú.

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KAWSAY BIOLOGICAL STATION CONSERVATION CONCESSION

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INTRODUCTION

The Amazon Rainforest is the terrestrial extension with the largest concentration of biodiversity, both in flora and fauna. For the past 200 years, since the Industrial Revolution, anthropic activities have been demanding much of the resources that forests can give, especially from the Amazon Rainforest [1]. This constant and exponential perturbation, as the human population size increased, has diminished the species richness that primary forests comprised [2, 3]. Even though, at this point, the 12%, more or less, of the Earth's terrestrial surface is under some protected status [4], still the harvest continues and the loss of forest cover is increasing [5, 6]. Specifically, in Peru, the main activities that harvest the forest are illegal mining for gold extraction [7, 8], changes in the land use, wood extraction and hunting [9]. Puerto Maldonado city was established in 1902 [10], since then the city has grown and villagers have placed their farming areas on the riversides of Madre de Dios' river. The establishment of the Tambopata National Reserve (TNR) and the government's law to reduce the farming area (in 2000) [11], has allowed some parts of the forest to start to recover. Still, much has to be done to protect this area full of biodiversity.

Among all the species richness that Madre de Dios' Amazon Rainforest (Peru) holds, the Spider Monkey (*Ateles chamek*) is one of the species that is threatened by anthropogenic activities. *A. chamek* is exposed to unsustainable subsistence and commercial hunting. The development of cities, soy plantations, cattle ranching, illegal mining and selective logging increase habitat loss in the Peruvian Amazon. Moreover, Spider Monkeys appear to have little to no ability to adapt to human presence [12]. It is well known that climate change is having secondary effects all over the world's different ecosystems [13]; specially in primates, it is directly altering their time budget on different behaviors, disrupting the proportion of time they need for feeding and resting versus other behaviors [14, 15], and, indirectly, changing the seasonality and amount of their food supply and intensifying the reduction of their habitat [14]. It is seen that atelins' population size decreased within one year after an El Niño event due to a reduction in their food availability [14]. These threats led the *A. chamek* species from a Least Concern in 2003 to an Endangered status in 2008, listed in the International Union for the Conservation of Nature (IUCN) [16]; also considered as threatened by the Peruvian legislation [17]. In the outskirts of the TNR, *A. chamek* was locally extinct until 2011, when the first group of Spider Monkeys was reintroduced by the Taricaya Reserve; the release was coordinated by the biologist Raúl Federico Bello Santa Cruz [18]. Later, in 2013 and 2014, two other groups were released. This year, R. Bello decided to protect the area of use of this Spider Monkeys population. It is hoped that the new population of *Ateles chamek* helps to maintain the seed dispersal of the species they feed on (see *Table 1* in Annex II).

The present document is a summary of the job I performed from July 16th to September 7th in Kawsay Center, near Puerto Maldonado city, in the Madre de Dios Department, Peru. The initial filter I had to choose the placement of my summer internship was that it had to be in the Amazon Rainforest, which is still being harvest and not enough effort is on its protection and

management. The reason why I chose Kawsay Center was because I wanted to learn how proper field studies are done. Besides, this Station was just starting up which gave me the opportunity of learning how a conservation center is born and which are the steps, more or less, one can follow to construct one. My personal learning focus priority is on fauna, which is the reason why I was made responsible for all the data collection and processing related to fauna; in the activities related to flora, I worked as a helper to my coworker who was responsible for the botanical fraction. Different studies are hold since the start of Kawsay Center to determine fauna and flora composition and abundance. The aims I determined for this internship period was to learn: 1) how to install trap cameras and which is the use of it, 2) what methodologies are followed in a line transect and what are the differences between a flora and fauna study, 3) how are vegetation plots raised and used for continuous studies, 4) how is an ecological study done, what is the use of it and 5) how is data processed and analyzed in order to obtain final results.

The following sections will include a small description of the Kawsay Center entity and its main objectives, an extended explanation of the methodology followed while the internship lasted and the results that are or could be obtained from each study that was done.

KAWSAY CENTER

Kawsay Center is a small place that started up on March, 2018. The Station's infrastructure is placed at around 70 meters from the river, respecting the Peruvian law that says that no edification can be made in the first 50 meters, within the parcel belonging to R. Bello. It consists in a nine meter squared kitchen, two rooms with two bunk beds and two bathrooms each and a living room with tables where residents can eat or study. It also has a small, sealed storage room where all the material and books are saved from any meteorological condition. The house is powered with solar panels, but a generator is available to fill up the water tanks (see *Figure 1* in Annex II).

The main objective of Kawsay is the Spider Monkey's conservation and to increase the knowledge we have of this species by doing an ecological study for a long period of time. Furthermore, this Station is focused on a general conservation of the low altitude tropical rainforest, including the protection of those arboreal species that are exploited for their economic value and all the other plant/animal species that this concession captures. This becomes possible as the conservation of Spider Monkeys and other umbrella like species (charismatic and with a big area of use) allows, as well, the conservation and protection of naturally co-occurring species in that area [19, 20]. To do this, many side studies are done to determine the composition and structure of floristic and faunal communities and be able to estimate the relative abundance of species that this region captures.

STUDY SITE

Kawsay Center is located at 20 km from the city Puerto Maldonado, at the right river bank side from Bajo Madre de Dios, in the Tambopata province, Madre de Dios department, Perú (see *Figure 2* in Annex II). R. Bello has a small private parcel that is 80m wide per 1000m long. The

concession, which has a total area of 170.31 ha, starts at 1000m and limits with the TNR at 2000m (see *Figure 3* in Annex II). Kawsay's concession captures a North to South forest transition in its area; a majority of the area is covered by secondary forest, still recovering from past deforestations, to primary forest, which continues to the depths of the TNR (see *Figure 4* in Annex II). It includes many microhabitats, as are swamps, meadows, rivers, dense forest structure, etc.

Climate is mainly hot and humid with a slight season variation. Dry and wet seasons are in July-August and January-February, respectively, with the remaining months in between as a transitional mode. The period when I did the internship was the dry season, during which strong temperature decreases occur with frequency (every week or every two weeks).

CHRONOGRAM

In Kawsay Center we tried to follow a determined schedule which began from the start every two weeks. In green are the activities focused on flora and the blue ones, on fauna; light orange timelines could be used to either one, depending on the urge. We usually got up at 6:00 to start any activity around 7:30 h and at 12:00 h we arrived to the station. After lunch, the activities would start again around 14:30-15:00 h and it finished at 17:00-18:00 h depending on the day. Despite the schedule, there are always issues that are not easy to elude; one of the main problems was the few people we were at the station. Most of the time only a Forestry Student and I were at the station, we could not cover all the studies.

The principal activities were maintained or even prolonged: the installment and the collection of the camera-traps was mandatory as was the mammal transect, the phenology study could take more than one day to finish due to the difference on the number of species on a reproductive state depending on the season/ time period, localization and characterization of the commercial trees was made along with other activities while in the woods and the spider monkeys monitoring was always done, but if the monkeys were not found, the search was stretched until Friday. Habituation of the Dusky Titi Monkeys (*Plecturocebus aureipalatii*) and Bird observation was not done during the period I was at the station; it will not be included in methodologies. Instead, a side study was done to evaluate the structure and floral composition of the concession doing a Vegetation Plot (see *Table 2* and *Table 3* in Annex II).

MATERIALS & METHODS

As the methodology of every activity followed is explained with detail, if the reader is interested, *Annex II* includes pictures relating to each study to a better understanding of the method and an example of the evaluation sheet that was filled at the field for each of the studies.

Camera-traps

The study used two trap cameras Bushnell (trophy Cam HD Brown—Model 119874) (see Figure 5). The automatic photographic system consists, basically, in a common photographic camera with a 35 mm lens, a photometer, a flash shooter, focus and the capacity to take videos

automatically, it takes up to eight AA+ batteries in four-six months during 24 hours a day, depending on the times it gets activated. The photographic machine is coupled to a shooting system that can be: 1) an IR ray sensor, able to detect the irradiation of corporeal heat, 2) a radar sensor that detects moves against a relative fix background and 3) a mechanic system activated by pressure [21]. In this case, both cameras had 1) and 2), and the camera would only activate if both sensors detected a stimulus simultaneously. When activated, the camera was set to take two pictures in two seconds followed by a video of ten seconds, with sound included. When the camera is finished taking the video, it inactivated for five seconds before being able to be activated by an external stimulus again, resembling the absolute refractory period of a neuron. After this period, if the stimuli last or when a new one appears, the camera will get activated again. Night photographs and videos were possible due to the infrared light emitted by a Light Emitting Diodes (LEDs), which allows to take black and white pictures without scaring the animal away [22]. Pictures and videos could be set up to show time and date, besides the name of the Station (See *Figure 6*).

The batteries of the cameras would be checked and changed, if what was left was not enough for the next two weeks. The camera-traps were placed, one, in a Mineral Lick ("saladero" or "colpa", in Spanish) formed by past orogenic processes. The other one, captured similar conditions of soil feeding, but in this case, minerals and antitoxins in an enriched soil were exposed to the surface due to a tree that fell and with the roots, a block of soil was lifted. These places are important for their soil, rich in minerals and antitoxins, from which most animals seem to obtain nutritional benefits from its ingestion [23, 24]. The installation of these was on a Monday and collected the second Friday after that, obtaining a rough sampling effort of 22 nights/camera each month. The installment required a previous removal of the leaves in front of it to avoid an accidental activation when leaves heated by the sun, move at the same time due to some air current. Once collected, pictures and videos of the last 12 days were analyzed. Data was transcribed into an Excel sheet where the time, date, image/video code, name of the species, number of individuals and behavior were saved (See *Table 4*).

Spider Monkeys Evaluation

This study consists on a direct observation of the *Ateles chamek* population composed by three reintroduced groups, four to seven years ago. To do a direct observation kind of study, first there must be a period of habituation where the primates see that there is no harm from the observers that are going to do the evaluation [25]. Since this population results from a reintroduction program, these monkeys have already been in contact with humans, alongside of a long habituation period. They now know or assume they will not be hurt by us. Once this has been assured, any proper study needs its own detailed ethogram, which is a list of those behaviors that are going to be evaluated and a description of it [26]. The ethogram that was followed can be seen in *Figure 8*. To evaluate Spider Monkeys, a systematic study was followed, which is made to obtain quantitative data and allows to repeat the study again [27]. In this case, the study required 12 hours of evaluation for each category (Adult Female, Lacting Female,

Juvenile Female, Adult Male and Juvenile Male) in a two-month period. The year was divided according to the seasonality of tropic forests; the wet season includes months from November to April (three periods of two months) and the dry season, from May to October (idem). The evaluation did not need to be 12 hours of one category in one day; it could be divided in several days during those two months, but the evaluation had to start on a full hour and only complete hours of evaluation were counted as right (i.e. if the monkeys were found at 8:30h, the evaluation had to wait until 9:00h; and if the evaluation period from 9:00-11:00 was already done, the monkeys were followed until the hour when the evaluation had to start). The evaluation was based on a focal sampling, where an individual of the category being evaluated that day had to be followed throughout the time that lasted that evaluation collecting the data relevant to the study [26, 27].

The ecological study included three simultaneous evaluations: 1) behavior, 2) diet and 3) habitat use (home range and strata use). It required of binoculars (Nikon, Monarch3, 8x42, 63º) to be able to see what did the individual that was being studied at all times, any kind of photographic machine to record the fruits or leaves that were being eaten by the individual, a Global Position System (GPS) device (Garmin, GPSMAP 64sc) to mark the route or area they were using every time, a watch to track timings, a headlamp for nighttime returns and a machete to open paths when vegetation was too dense to go through (see *Figure 7*). In case the evaluation was going to take a whole day, including looking for them and monitoring them, breakfast or lunch had to be brought to the field.

1) The behavior evaluation was done to determine the behavior pattern of *A. chamek*/hour of activity, day or month. The activity was registered by intervals; it consisted on an instant sampling behavior [27] of the individual under study every five minutes during one or more complete hours. Accordingly, every five minutes the strata (Understory, Canopy or Overstory) and the behavior (Feeding, Traveling, Resting, Socializing, Others or Out of Sight) was recorded. Socializing was defined in observations as grooming with another individual, aggressive, socializing with the observer in any way, etc. Others would include an observation as vocalizing, attention or fear, etc. Out of Sight (os) was only recorded when the individual was not seen anymore; if more than three consecutive "os" were recorded, that hour of evaluation was cancelled.
2) The diet was registered in order to understand which resources *A. chamek* was using to survive each season. We followed an ad libitum sampling [27]; any time the individual consumed a plant, initial and ending time of the feeding period was recorded. Furthermore, the kind of item (Fruit, Flower, Mature or Immature Leaves, Bark, Seeds and others, mainly soil from mineral licks) and where (Understory, Canopy or Overstory) they were eating was written down. A photographic record from the food item was also taken, if possible, in order to be able to determine, afterwards, the species of that plant.
3) The habitat of use was already recorded in the behavior and diet evaluations. To determine the home-range, at least one year of study and tracking is needed [28]. During

the other two evaluations, a GPS was used to track the spots they were at. If the monkeys were traveling fast, we would record their position every 100 meters, if they were going slow, every 10 minutes, and if they were not moving at all, every 30 minutes. In this last condition, if they were not moving because they were resting, we would label the mark as a resting tree. In some evaluations, in order to find them early in the morning the next day, the monkeys had to be followed until 18:00 or later, time when they stop moving and sleep until the next day at around 6:00, when the sun rises. In those cases, the location would be marked as a sleeping tree.

If the 12 hours of evaluation for each category were finished for the correspondent two-month period, the activity remained ongoing to follow and mark the area the population was using.

Furthermore, an ad libitum sampling was taken for the whole population, recording all rare but note-worthy events as could be a fight, copulation, vocal interaction with another *A. chamek* subgroup, etc [27]. Time, date and a detailed description of the situation was written in a notebook [26].

All evaluation sheets (see *Figure 8*) were transcribed into an excel sheet and GPS waypoints organized by month in the MapSource program.

Mammal transect

The transect was made as linear as possible with the help of a compass and was labeled every 25 meters to be able to tell the exact location of the animal seen when the transect is traversed. The length was of two kilometers into the forest passing through most of the diversity of habitats as possible including primary and secondary forest formations, swamps, dry elevations, etc. [29]. The methodology consisted in walking the transect with a speed of 1km/h [29, 30], two times a day: the first one at dawn (5:30-7:30) and the second one at dusk (17:30-19:30). The aim of these timings is to see diurnal and nocturnal species [29]. In some cases, the morning transect was extended to three kilometers in hope to cover a greater area of the concession. Due to the lack of space and effort availability, it usually was maintained at a two kilometer transect.

The data collection was made following an evaluation sheet [29] seen in *Figure 10*. Time was known with a digital watch; location of the detection was marked according to the reference mark that labels the transect. The perpendicular distance from the troch to the animal seen was estimated; if the specie was in a group, the perpendicular distance from the troch to the first individual seen was measured. The species name, number and behavior of the individual/s seen was written down and if the species was not identified at the moment, any particular features or a family taxon classification was written in observations to attempt to certify the species with a taxonomic book. The strata (Ground, Understory, Canopy and Overstory) that the animal was using was also recorded. Any complementary information could be written down in observations. The observer could exit the transect in order to do the correct measurement of that distance or

the exact count of individuals in a group [29], binoculars (Nikon, Monarch3, 8x42, 63º) were used to see better those individuals far away (material seen in *Figure 9*). Data was transcribed into an excel sheet, which I modified to simplify future studies.

Four principal assumptions are made in line transects: 1) All animals in the transect must have been seen, 2) All the animals were detected on their initial point before it made any move in response to the observer's presence, 3) an accurate measurement of the perpendicular distance from the troch to the animal was taken and 4) the detections were independent events, assuring that the same individual was not count twice in the same sampling effort [29, 30, 31].

Phenology

The method used for the phenology report was a line transect of two kilometers, the same used for the mammal transect. Phenology was regularly done every two weeks [32], on a Monday, alternating with the mammal transect and, if necessary, more than one day was used to finish it. The analysis strategy consisted in identifying every tree, bush, herb, liana or epiphyte that was in any of the reproductive states, it did not follow any exclusion criteria [32]. Any flower, fruit or seed found on the floor or plant was collected and photographed, in case that fruits or flowers were in the canopy of a high tree, binoculars (Nikon, Monarch3, 8x42, 63º) were used in order to identify the fruit/flower's morphology [32, 33]. In addition, the state of the reproductive part had to be analyzed, meaning if fruits were mature or immature, if flowers were just opening or already starting to fall, etc [32]. Photo-specimens were taken over a black background (a black fabric) with a measuring reference that allowed to have a proportional sight of its size (see *Figure 11* and *Figure 12*). The individual found in some reproductive state was also photographed to determine through morphological traits which species it belonged to. If the species was not identified, a temporal code was assigned to that individual. Evaluation sheets (see *Figure 13*) were filled during the field detection, filling up the code or species of the individual in a reproductive state, the floristic classification (tree, bush, etc), what kind of evidence was found (fruit, flower and/or seed) and observations that can help to determine the species later. Photographs are then classified by species or code (if the species is not known) and date in a digital herbarium [32, 33]; data was transcribed into Excel sheets.

Vegetation Plot

To study the structure and composition of the concession area, a 50x50 meter plot was made. This plot is going to be measured annually to be able to visualize the volume increase. The following material was used: cord or string, measuring tape, compass, wood stakes and GPS device (Garmin, GPSMAP 64sc). 90º angles were measured following the Pythagoras Theorem with a relation of three and four meters at the sides and connected by a five-meter distance on the diagonal. This gave the direction to follow and was helped by the compass to maintain it while measuring the 50 m of that side of the plot [34]. Stakes were used to tie the cord and establish the vertices of the plot. The quadrant was then subdivided in blocks of 25x25 meters following the same steps above. Furthermore, the quadrant was labeled every 10 m in the X and

Y coordinates to localize the trees that were going to be measured [34]. Trees were also marked with a code (i.e. the 14th tree the 1st block was labeled as B1.14) which was unique to that tree [34]. The vertices of the plot were geolocalized with a GPS [34].

The measurements started once the plot was finished and labeled. To a better access to the trees that were going to be measured, a machete was used to clean up a path. The trees measured were those with a diameter >10 cm which can be translated into a 31.4 cm circumference. This limit is highly strict due to the higher probability of a tree survival when its diameter is >10 cm, besides other features of the tree that this determines [33, 34]. Diameter was measured at breast height (DBH) or at 1.3 m from the ground due to the variability of people's height [33, 34] with a measuring tape; if the tree had some irregularity, the measurement was done at the end of this deformation as well as above the root's ending [34]. The height was measured with a Tangent Height Gauge; by a tangent relationship, the sum of the distance from the person to the tree plus the height until the eyes of the person that was measuring gave us the final height of the tree (see *Figure 14* for a better understanding). In this case, as the measurement of the height of each tree in the plot could take up a lot of time, one tree was properly measured and the height of the next five trees was estimated from the reference (measured tree), following a 1 to 5 method [35]. The distance between trees was also measured using a measuring tape and each tree was assigned to specific coordinates according to the labels in X and Y of the plot. Binoculars (Nikon, Monarch3, 8x42, 63º) were used to see the leaves/flowers/fruits on the tree's canopy to a better recognition of the species measured (all material used in *Figure 15*). The data was recorded in an evaluation sheet (see *Figure 16*) and then transcribed into an Excel digital form.

Localization and characterization of commercial trees

In the Tambopata forest, the trees that have been harvested the most are the Shihuahaco (*Dipteryx micrantha*) and the Lupuna (*Ceiba pentandra*) due to their wood qualities that appear to be expensive when sold as furniture at the market [36]. First, all trees, cut or alive, belonging to these two species were geo-localized with a GPS device (Garmin, GPSMAP 64sc) (see *Figure 18)*.

The period I was in Kawsay characterization of the trees was not done, only geolocalization was started. However, in the future, this study will start with the measurements; there are two different methodologies depending on if it is alive or cut. To obtain the diameter of alive trees, first the circumference of the tree must be measured above the ending of the roots with a measuring tape and then the diameter can be calculated. If the tree is too thick or the roots end up to high as to measure it in a direct way, a projection of the limits of the trunk can be made as an indirect way of measurement. The height is measured using a clinometer, but can be estimated if there is lack of material. To do this the top of the tree must be seen, that is why binoculars are used in some cases. These measurements are used to calculate a volumetric value that can be translated into an economic value. To measure those that have already been cut by illegal extraction, the final diameter is reached by calculating the mean of two diameters

perpendicular to each other of the cut end of the trunk; the height of the tree before it was cut, is measured from the roots end of the trunk to the remaining branches of the canopy. The missing parts of the tree are estimated to obtain the economic value that illegal extractors got from it [35].

Temperature / Relative Humidity / Precipitation Monitoring

In order to ensure a weather relation to the data taken in all of the above activities, the Temperature (T), the Relative Humidity (RH) and Precipitation (pp) was measured and taken [37]. T and RH were taken by a monitor that also showed the maximum and minimum measured until the moment. The minimum, maximum and current T and RH were checked at 6:00 and 18:00, and only the current T and RH were taken at 12:00. The monitor was erased after the recording of 6:00 and 18:00. To measure pp, a pluviometer was used; in this case, it was checked once a day at 20:00h. See data sheets in *Figure 22* from which data was transcribed into an Excel sheet; mean and standard deviation were calculated.

Computer based methods

In order to have a data base, all of the evaluations above were transcribed to an Excel sheet. I organized the mammal transect data in order to make easier future studies. The MapSource program was used to organize the GPS waypoints and separate the localization related to Spider Monkeys and Commercial Trees. Waypoints were also classified by month, which enables us to see the different home-range area used by the Spider Monkeys population in different seasons. The Past statistical program (PAST version 2.17c) was used to analyze the data taken until now, related to the Spider Monkey monitoring.

Other jobs related to these studies

<u>Spontaneous Sightings:</u> every mammal above the 250g or bird/reptile of interest was written down in a common notebook. Time, date, scientific or common name of the species, location, strata and behavior of the animal seen were recorded.

<u>Opening and marking new trails:</u>

- Use of a compass to maintain the direction when opening the new trail. Use of a machete to open the trails with the aim of making the access into the woods easier when following the monkeys.
- Trail tracking with the use of a GPS.
- Marking those new trails with red plastic tags every 25 m (measured with a measuring tape) to know the position we are at in a certain point.

<u>Teaching</u>: during days 25 and 26 of July, my work-partner and I taught how to measure the trees in the vegetation plot and what was the purpose of it to a 14 people group that was divided in two subgroups, seven persons each.

RESULTS & DISCUSSION

To study fauna, three main methods were used: camera traps, line transects and spontaneous sightings. A list of mammals (see *Table 5* in Annex II) that are known to inhabit in the concession's area of the forest was made using different bibliography [38, 39]; it includes the kind of register by which sighted species were recorded and the IUCN status in which these species are classified. A 54% of the total mammal species that can be seen in this area was sighted by one, two or all three methods mentioned above. The fact that we did not see a 46% of them does not make that these species are not there. Some, as is *Chironectes minimus*, is a very shy animal that runs fast and can only be seen in places with water [38]; others, might have a very low population density making it harder to be seen by the methods that are used here, due to the small area that these capture. Furthermore, the study period has been of only four months, this impedes us to see maybe seasonal species or migratory ones [40]. However, one of the most probable explanation for the majority of those species that were not seen is that the area was, once, highly perturbed by anthropogenic activities, making this area less suitable for habitat use [41]. It is hoped that the recovery of the area that the concession captures, the direct contact with the protected area of the Tambopata National Reserve and a longer study period with an improvement of the methods used to the mammal study help to complete the total richness inventory of this small part of the Amazon Rainforest. Concerning the flora study, also three methods can be mentioned: phenology, localization and characterization of commercial trees and the vegetation plot. From these, also a list of species was obtained and the IUCN status was determined (see *Table 6* in Annex II). This cannot be considered a final result, as many other species might be still out of reach to us. Besides, the impressively high diversity of plant species in rainforests may difficult the total characterization of all of them [42].

As Kawsay Center is a young station, not much data has been taken. Still, the conservation station is working on different studies that will improve the knowledge we have from this remote region of the Madre de Dios tropical forest. Camera traps are thought to do indirect observations used to study the density and dynamics of different species' populations [21]; instead, Kawsay is just focused, for now, on knowing the frequency with which different species visit mineral licks [21], especially Spider Monkeys. In addition, data will be saved for future studies in behavior, if required. The mammal transect is meant to give us an estimate of population densities in a certain area; but, first, the methodology should be improved and dispose of more and longer transects to obtain a better representation of the area, as well as more people to do the job which requires of a considerable amount of time per transect [29]. Spontaneous sightings that are recorded help to determine the composition of species of the area that is used by Kawsay.

The phenology transect must be done during more than a year to be able to determine the reproductive seasonal patterns of different species and a quantitative and qualitative description of the fruit, flower and leaf availability of this region [32, 33]. It is a fundamental study to understand which will be the area of use of frugivorous species, as are the Spider Monkeys, besides the seasonal availability of food to them [33]. However, this activity cannot be called a

study but a report of those species in a reproductive state, as no proper method is being followed for a phenology study [33]. This should be based on, at least, five individuals from a same species. This rule allows to standardize differences between individuals, depending on age and health (different individuals might have a different growth pattern when under stress), besides different responses to a same or similar environment. Furthermore, it is recommended to report those individuals in a vegetative state, too [33]. Localization and characterization of commercial trees is needed to know which is the proportion of individuals remaining in this perturbed forest area to be able to make future evaluations of the recovery quality.

A structural description of the forest was obtained from the 50x50 m vegetation plot that was evaluated. In Annex II, *Figure 23* shows a dominance of thinner trees, ranging between 10 and 20 cm of diameter, and *Figure 24*, a more abundant population of short trees that measure between 5 and 15 meters tall. *Figure 25* shows a positive relationship between these two measurements; a high concentration of short and thin trees in comparison to a low and dispersed distribution of tall, thick trees, which are closer related to mature primary forests [43]. These results show a clear structure of a secondary forest, as the plot was made in a relatively recent perturbed forest. However, more vegetation plots will be done in a near future to obtain a better representation of the forest structure that is captured by the whole area of study and plots will be used to compare the structures obtained of different parts of the forest within the concession's area. Furthermore, the first plot is meant to be measured once a year to obtain an annual volumetric growth rate of a secondary forest sample [43]. In addition, a plot will be done in a primary forest area to describe the natural composition and structure of mature and unperturbed areas.

As for the Spider Monkey ecological study, a statistical analysis was made with the data that has been taken until now. Still, no final results can be obtained until the evaluation completes, at least, a one-year period. Firstly, the use of strata by *Ateles chamek* was analyzed; as seen in *Figure 26* in Annex II, it spends more time on the canopy and the overstory of the forest than in the understory (Kruskal-Wallis, $p<0.05$, $H= 11.89$, $H'= 11.9$). Furthermore, there have not been seen any differences between males and females (Mann-Whitney, $p>0.05$), and between juveniles and adults in the use of the forest strata (Mann-Whitney, $p>0.05$) (see *Figure 27* and *Figure 28*). Meaning that, more or less, all categories in a Spider Monkey group make a similar use of the habitat available. As can be seen in Bello, R. (2018) the use of higher strata instead of the understory is a more similar use to what natural populations of *A. chamek* have been seen to use [18]. *A. chamek* is propitiously adapted to feed in the canopy by the presence of a prehensile tail, among other features [12, 44]; we can, therefore, relate the specialization on canopy and overstory use to a low ability to adapt to perturbed forest [12], where the overstory is almost absent versus a dominant understory [43].

Secondly, focusing on the behavioral fraction of the study, Black Spider Monkeys seem to spent more time resting and traveling than any other behavior, closely followed by feeding (Kruskal-Wallis, $p<0.05$, $H= 39.22$, $H'= 39.4$) (see *Figure 29*). As seen in *Figure 30*, resting appears to

be steady along the day (6:00 h to 18:00 h) with a small decay from 8:00 h to 10:00 h, when traveling seems to be the main activity. Feeding takes less time from the monkey's day than traveling and resting, but still is an important proportion in their time budget. It is possible to see an apparent pattern in *Ateles chamek*'s day; right after they wake up (around 6:00 h) they, feed on whatever is available in their surroundings. Around 8:00 h, they start traveling in search of an area with more food availability. Usually, resting time is between 11:00 h and 13:00 h, due to the heat. In the afternoons, traveling gets less frequent as monkeys start resting or eating alternatively with more frequency. Most of them, at 18:00 h, are already resting in, what is going to be a sleeping tree, where the group is going to spend the night. As seen in Bello, R. (2018), *A. chamek* prefers big trees with a thick trunk to rest or sleep on [18].

On one side, males and females do not seem to have a different behavioral daytime budget as seen in *Figure 31* (Mann-Whitney, p value>0.05). More or less, they seem to use a similar proportion of the day in the different behaviors mentioned. On the other side, juveniles and adults do differ in the time budget. Even if they spent a similar part of the day on feeding (Mann-Whitney, p value>0.05), they differ in resting, traveling and socializing. As seen in *Figure 32*, juveniles seem to use a greater part of the day traveling and socializing than adults (Mann-Whitney, p value<0.05), but less time resting (Mann-Whitney, p value<0.05). In part, an explanation may be that juveniles are more energetic, like kids, and often play with other juveniles while adults are resting. It can be related to *Alouatta caraya* monkeys [45], where resting increased proportionally to age, compared to bridging and hanging, behavior closer related to young individuals. Furthermore, in the Prates and Bicca-Marques (2008) study, no differences were seen between age and sex categories on the feeding behavior [45].

Paying attention to the Spider Monkey's diet, we have been able to see that they slightly differ between the two periods evaluated until now. During the May-June period, *Ateles chamek* had a significant preference for Fruit (49.5%) over the rest (Kruskal-Wallis, p value<0.05, H= 21.06, H'= 22.45). This was followed by a consumption of Mature Leaves (21.4%) and Immature Leaves (20.9%) (See *Figure 33*). While during the July-August period, *A. chamek* fed more on Immature Leaves (63.7%), followed by some fruit ingestion (27.8%) and others (6.4%), in this case, referring to soil from mineral licks (Kruskal-Wallis, p value<0.05, H= 18.49, H'= 21.84) (See *Figure 34*). As it is well known, *Ateles chamek* is a ripe fruit specialist [12, 44], spending 70-85% of the feeding time eating fruit [44, 46]. They show a dietary flexibility, which is constraint by their physiological specialization. During the dry season fruit is more scarce forcing Spider Monkeys to change their feeding behavior. Especially during July, *A. chamek* feeds more on immature leaves, compelling them to rest during more time in order to be able to digest better the foliage. Even if they may shift their diet during the dry season, they may be only able to survive temporally. A longer period of fruit scarcity may lead to a population depletion [46].

The home-range is studied in order to understand how this varies with the seasons, what is the frequency with which they visit a certain area, which areas are they avoiding and why, etc. As the evaluation period that has been done until now does not complete a whole year, no results

were obtained from these fraction of the study of *Ateles chamek*. Even so, natural Spider Monkey populations usually use around a 95-390 ha, whereas this population at the beginning of its reintroduction used from 20-40 ha [18]. At the end of a year-round evaluation period, we may be able to see if some changes in their area of use have occurred.

SUMMARY & CONCLUSIONS

During the four months that Kawsay Center has been active, much data has been taken with the activities followed every week. It was possible to report a 54% of the mammalian fauna that is thought that inhabits the area where Kawsay is established and to make an inventory of those plant species seen and identified until now. The vegetation plot showed that part of the area of the concession has a typical structure of secondary forests. With regard to the Spider Monkey monitoring, it is seen that the canopy and the overstory are particularly important to them as they carry out all of their behaviors on it. Juvenile Spider Monkeys rest less and travel and socialize more than adults, in spite of using the same amount of time on feeding. Their diet consists mainly on fruits, even though they have a somewhat plastic feeding behavior, being able to shift temporally to a diet based on leaves during fruit scarcity periods.

To conclude, it is prudent to say that much more effort and time has to be invested in each of the mentioned studies, and improvements of the methodology need to be made in order to obtain strong data for future analysis. As for the Spider Monkey monitoring, many hours are spent in the field just to find them compared to the hours dedicated to the proper evaluation; reason why more people that are passionate about fieldwork are needed to do this rough job. This kind of studies are required to improve conservation programs and preserve the rainforest's biodiversity.

Duties of a Conservation Concession Titular in Peru

R. Bello was given a Conservation Concession by the Regional Government (RG), which was previously approved by Tambopata National Reserve (TNR); the region was part of the buffer zone surrounding the TNR, which is important to the conservation of Natural Protected Area (NPA) [47].

A conservation concession is given under certain conditions; the aim is to contribute in a direct way to the conservation of flora and fauna species and eco-systemic services through investigation and education. Reason why timber harvesting is not allowed. In addition, as a license ("Título habilitante" in Spanish) was given to R. Bello, a DEMA (Declaración de Manejo) document has to be made, which includes a plan for the next five years. Every year an annual execution form (AEF) must be delivered to the RG group within MINAGRI and every five years a final execution form (FEF). The DEMA form includes information of the general description of the area (geographic location, climate, physical aspects…). It requires a current picture of the state of the forest as it was given to R. Bello. This is done by elaborating a flora and fauna species inventory of the area which will include a IUCN red list classification for each species, an evaluation of the forest structure by doing a 50x50 m vegetation plot and must geolocalize those

trees, cut or alive, of high economic value. In addition, a five-year management plan must be described with a detailed chronogram, the evaluation methods and area that will be used. The AEF will include a detailed description of what was accomplished during the year with the activities that were done, and the FEF is a summary of the five years.

As the concession is limiting with the TNR, some studies, as the spider monkey monitoring, invade this area. Nevertheless, to make use of an NPA, a special permission must be given to those that cross the limits which is usually given by the MINAM. This kind of process includes too much effort for now, so Kawsay has established an inter-institutional agreement with the Asociación para la Investigación y el Desarrollo Integral (AIDER). AIDER has a partial administration contract with the TNR for investigation and monitoring; thanks to this contract, Kawsay may work with them in activities of investigation, monitoring and surveillance in a sector of the TNR, which grants us permission to use the area limiting with the concession.

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ANEX II

INTRODUCTION

Table 1:Ecological description sheet of A. chamek. Information taken from Rowe et al., 2016 [12]; own photograph.

Order	*Primates*
Suborder	*Haplorhini*
Infraorder	*Platyrhini*
Family	*Atelidae*
Genus	*Ateles*
Scientific name	*Ateles chamek*
Common name	Black spider monkey or mono araña negro
Characteristic morphological traits	Black pelage, without hair around their eyes, nose and mouth. They have a reduced thumb, almost absent, as the rest of *Ateles sp.*, which allows them to move rapidly through the forest using below-branch suspensory locomotion. Longer arms than legs, with prehensile tail. 
Physical characteristics	Head plus body lengths ranges between 0.45 to 0.6 meters, noticing a slight sexual dimorphism in which the female mean is around 10 cm smaller; the tail length is 0.8-0.88 meters. Adult male monkeys weigh around 7kg, females around 5.
Social organization	Fission-fusion, where large groups of 30-40 individuals divide in subgroups of 2-9 individuals. Groups are usually formed by females and their offspring, accompanied by one or more males.
Life history	Females are sexually mature at age of five to eight years and the birth interval is of 34.5 months (about three years).
Habitat	Tropical, primary, rain forest; but also, flooded, subtropical, transitional forest to savanna.
Diet	Fruits (85.8%), leaves (10.7%), flowers (2.9%); they also eat the seeds of unripe fruit, which may be an important source of protein. The most eaten fruit species seen: *Pseudolmedia laevis, Brosimum lactesciens, Pouteria sp, Ficus sp, Clarisa racemosa, Spondias monbin, Inga sp* and *Virola sp.*
Ecological importance	Medium-sized frugivorous monkeys with a more or less large home range. They are important seed dispersers of trees that produce big fruits, some of which are also listed as threatened in the IUCN red list.

KAWSAY CENTER

Figure 1: Images of Kawsay's Station. From: own photographs.

STUDY SITE

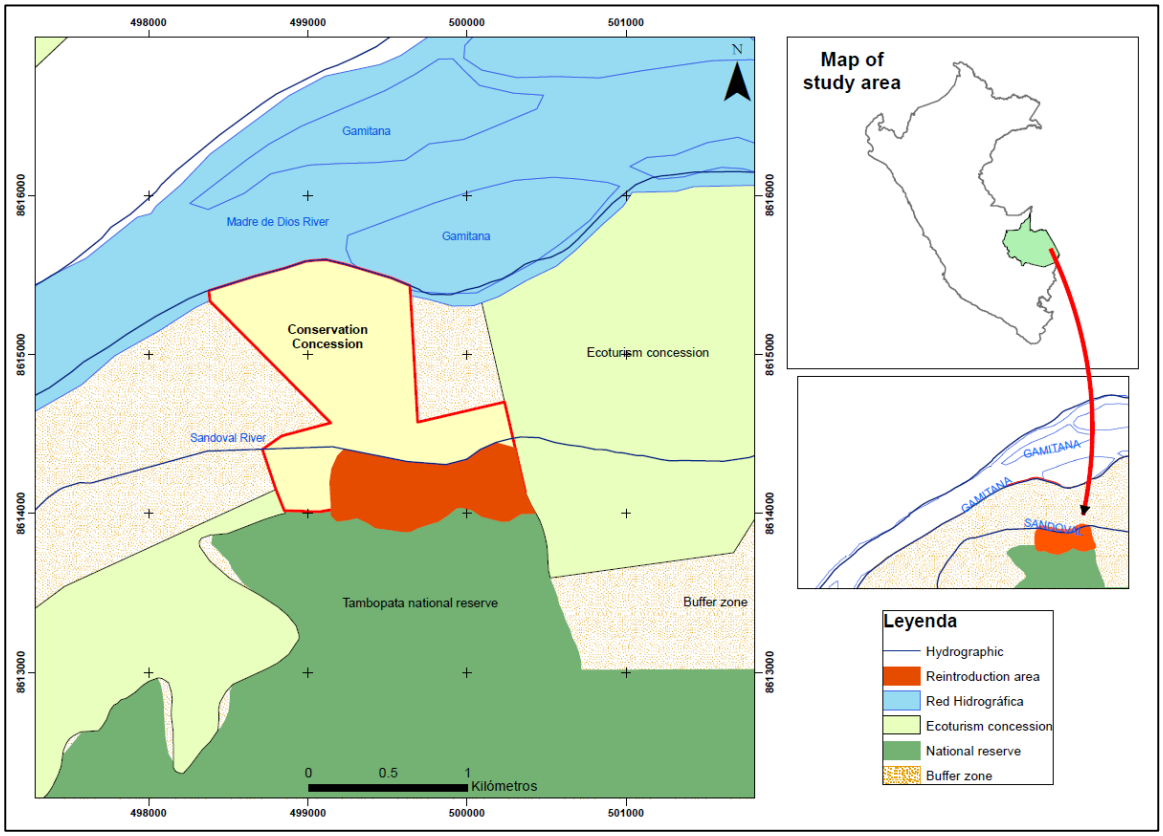


Figure 2: Location map of Kawsay's Conservation Concession. From: Bello, R.

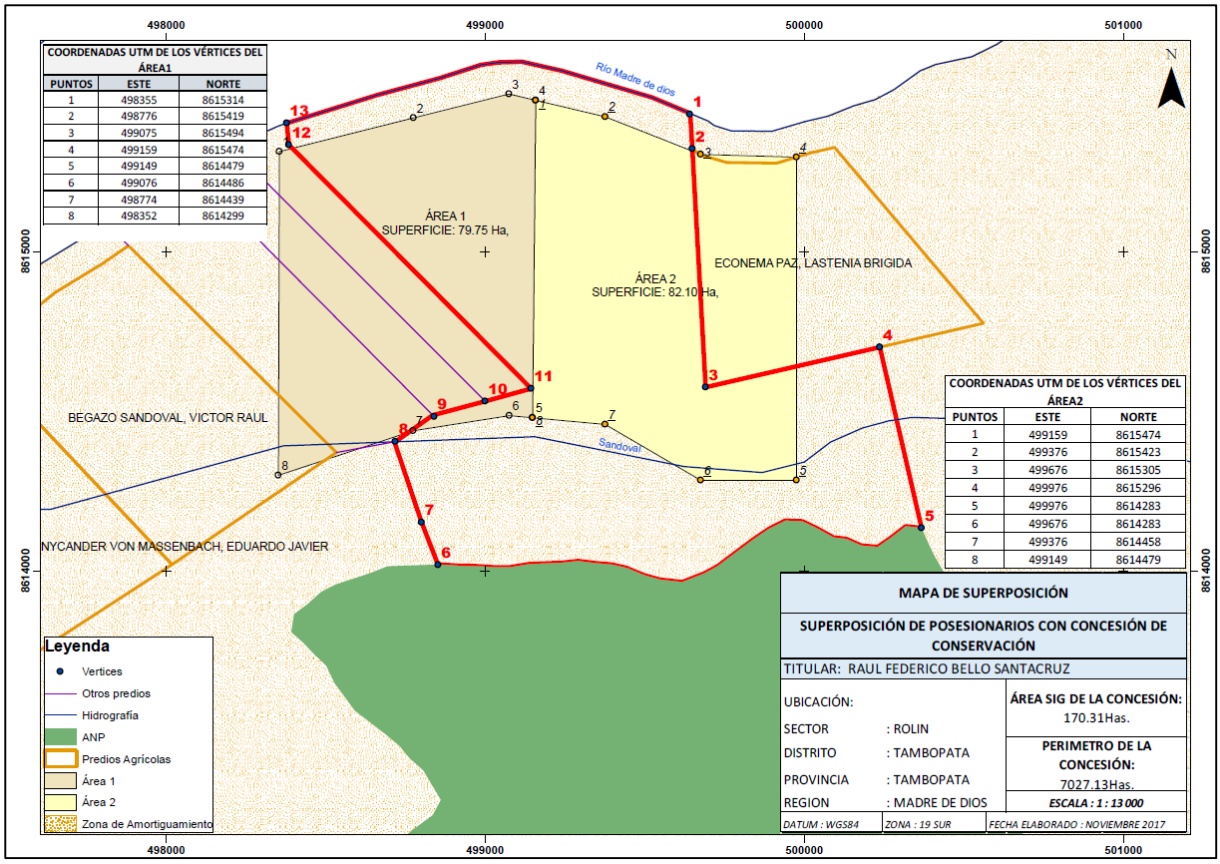


Figure 3: Descriptive map of the Conservation Concession given to Kawsay Center. From: Bello, R.

Figure 4: Example of Secondary Forest (left), Transitional (middle) and Primary Forest (right). As it can be seen, a secondary forest has a higher density of understory vegetation where palms are predominant. A transitional forest has a more arboreal structure, but trunks are still thin and big dominant emergent trees are scarce. The primary forest has higher and thicker trees, as are the Ceiba pentandra and Dipteryx micrantha, closer together allowing a fewer percentage of sun light pass through to the ground. From: own photographs.

CHRONOGRAM

Table 2: Programmed schedule seen at the web site. From: self-made.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Installing cameras	Monitoring Spider Monkeys	Monitoring Spider Monkeys	Birds observation	Habituation of Dusky Titi Monkeys	Patrol the reserve	Resting and free time
Phenology			Habituation of Dusky Titi Monkeys	Localization and characterization of commercial trees	Resting and free time	
Phenology data processing	Data processing	Data processing				
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Mammal transect	Monitoring Spider Monkeys	Monitoring Spider Monkeys	Birds observation	Habituation of Dusky Titi Monkeys	Go to the city	Resting and free time
			Habituation of Dusky Titi Monkeys	Collecting cameras	Resting and free time	Return to the Station
Mammal transect data processing	Data processing	Data processing		Trap cameras data processing		

Table 3: Schedule followed the period I was at the Station. From: self-made.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Installing cameras	Monitoring Spider Monkeys	Monitoring Spider Monkeys	Spider monkeys monitoring or Vegetation plot	Spider monkeys monitoring or Vegetation plot	Patrol the reserve	Resting and free time
Phenology				Localization and characterization of commercial trees	Resting and free time	
Phenology data processing	Data processing	Data processing				
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Mammal transect	Monitoring Spider Monkeys	Monitoring Spider Monkeys	Spider monkeys monitoring or Vegetation plot	Collecting cameras	Go to the city	Resting and free time
				Trap cameras data processing	Resting and free time	Return to the Station
Mammal transect data processing	Data processing	Data processing				

MATERIALS AND METHODS

Camera traps or trail cameras

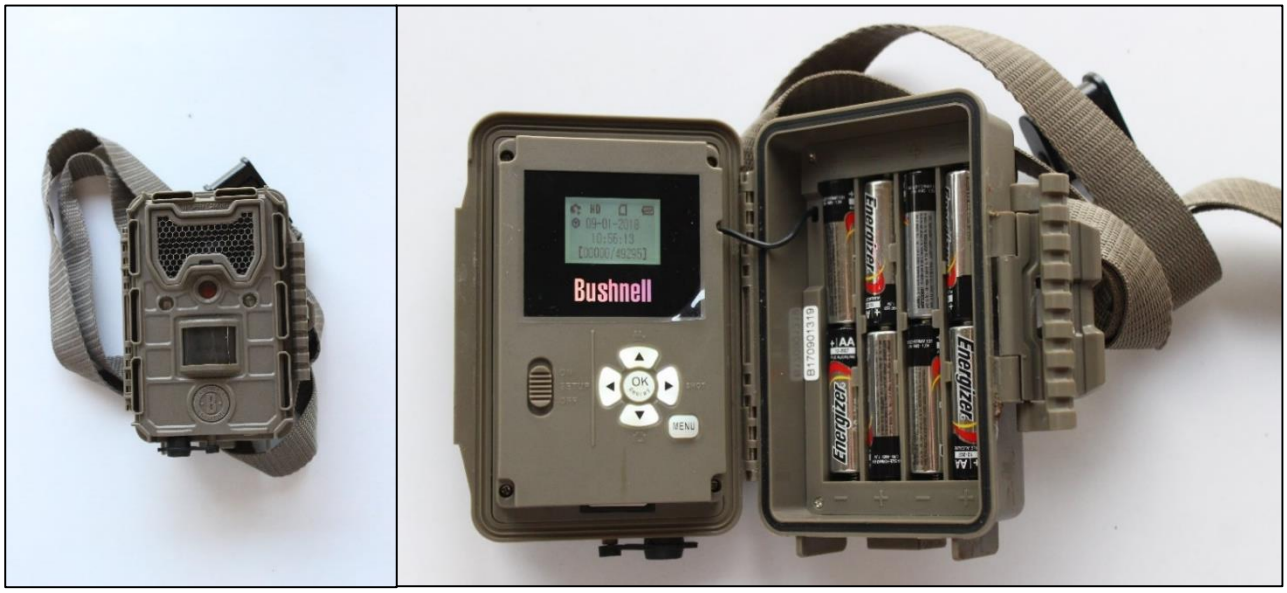


Figure 5: Trap camera used, brand Bushnell, trophy Cam HD Brown—Model 119874. From: own photographs.

Figure 6: Examples of pictures taken in a Mineral Lick. Every picture is labeled with the name of the camera, temperature, date and time. Image on the left shows a Puma concolor at daylight and the one on the right, a Tapirus terrestris at nighttime. From: Kawsay's Camera Traps.

Table 4: Filled excel sheet example; same parameters are filled for photographs and videos. From: Kawsay's Data Base.

Registro de cámaras trampa										
No. De foto	Fecha	Ubicación	Cámara	*Especie*	Nombre común	No-individuos	Hora	Código de la fotografía	Actividad	Observaciones

Spider Monkeys Evaluation

Figure 7: Material used for the Spider Monkey monitoring: binoculars, watch, writing material, headlamp, GPS and machete. From: own photgraph.

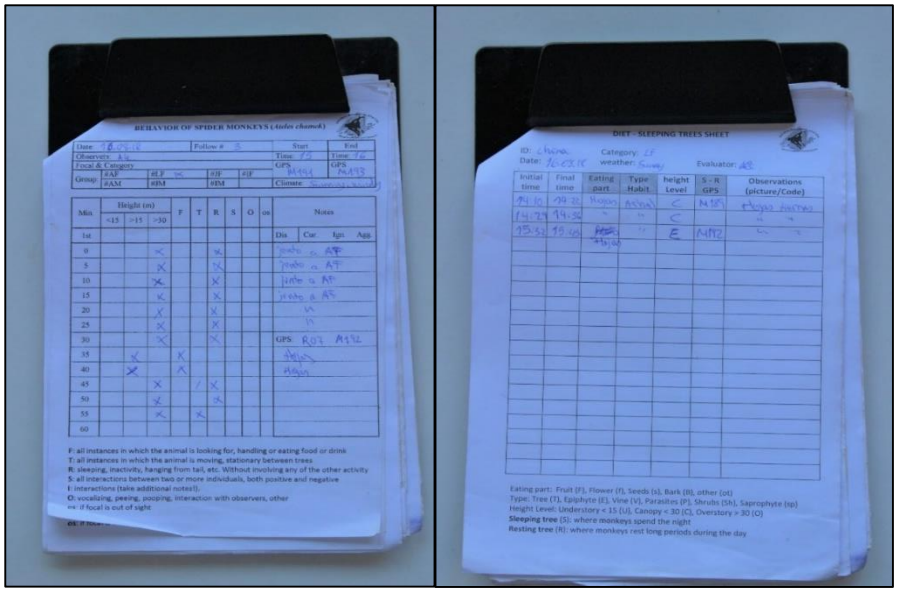


Figure 8: Evaluation sheets used in Spider Monkey monitoring: Behavior sheet on the left, Diet sheet on the right.

Ethogram can be read at the bottom of the behavior evaluation sheet (left): (F) all instances in which the animal is looking for, handling or eating food or drink, (T) all instances in which the animal is moving, stationary between trees, (R) sleeping, inactivity, hanging from tail, etc. Without involving any of the other activity, (S) all interactions between two or more individuals, both positive and negative, (I) interactions (take additional notes!), (O): vocalizing, peeing, pooping, interaction with observers, others, and (os) if focal is out of sight.

Diet sheet legend (right). Eating part: Fruit (F), Flower (f), Seeds (s), Bark (B), other (ot). Type Habit: Tree (T), Epiphyte (E), Vine (V), Parasites (P), Shrubs (Sh), Saprophyte (sp). Height Level: Understory < 15 (U), Canopy < 30 (C), Overstory > 30 (O). Sleeping tree (S): where monkeys spend the night. Resting tree (R): where monkeys rest long periods during the day.

From: own photographs.

Mammal transect

Figure 9: Material used during the mammal transects: binoculars, watch,, headlamp, writing material. From: own photograph.

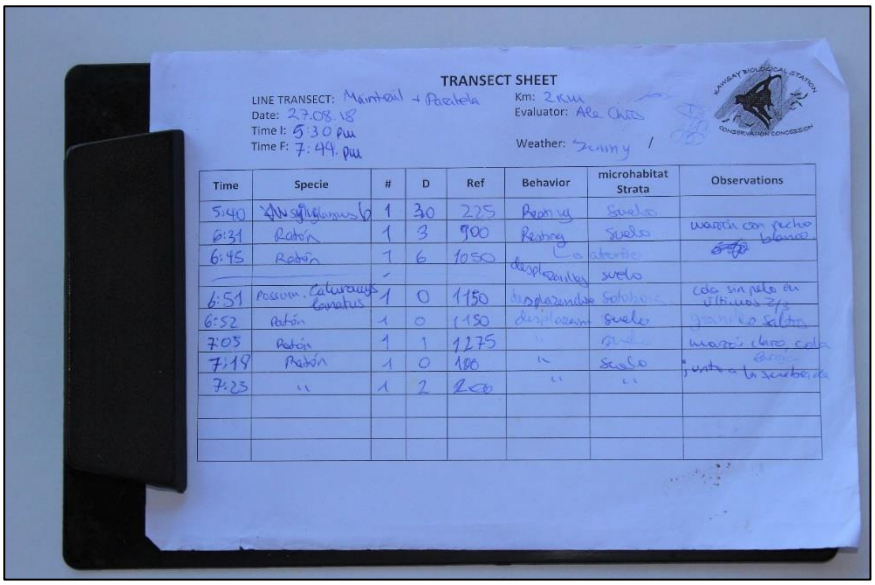
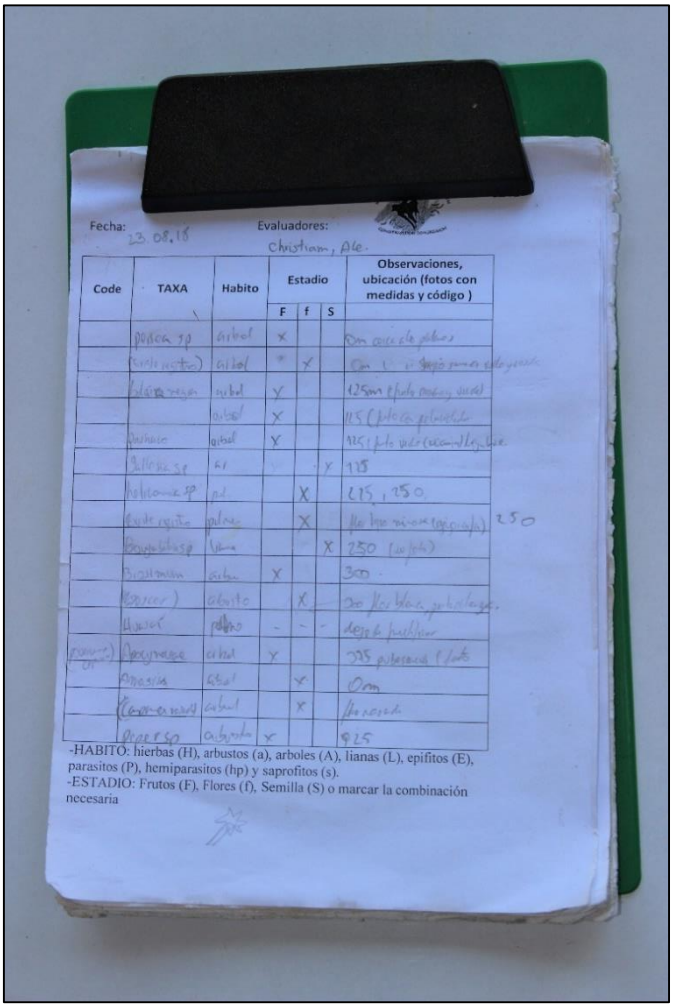


Figure 10: Evaluation sheet used in mammal transects: Time and Species seen, number of individuals seen (#), perpendicular distance from the troch to the animal (D), meter of the transect at where it was seen (Ref), activity at the moment (Behavior), strata that it was using (microhabitat strata) and any observations that could be made. From: own photograph.

Phenology

Figure 11: Material used in Phenology: "tela de color negro", "regla", binoculars, writing material. From: own photograph.

Figure 12: Example of photographs taken for the Phenology study with date and temporary code. From: own photographs.



Fecha: 23.08.18 Evaluadores: Christian, Ale.

Code	TAXA	Habito	Estadio			Observaciones, ubicación (fotos con medidas y código)
			F	f	S	

-HABITO: hierbas (H), arbustos (a), arboles (A), lianas (L), epifitos (E), parasitos (P), hemiparasitos (hp) y saprofitos (s).
-ESTADIO: Frutos (F), Flores (f), Semilla (S) o marcar la combinación necesaria

Figure 13: Evaluation sheet used in Phenology. Habitat can be described as herbs (H), bushes (a), trees (A), lianas (L), epiphytes (E), parasites (P), hemiparasites (hp) and saprophytes (s). Phenophases are described as fruit (F), flower (f) or seed (S), which can be labeled in the needed combination. From: own photograph.

Vegetation Plot

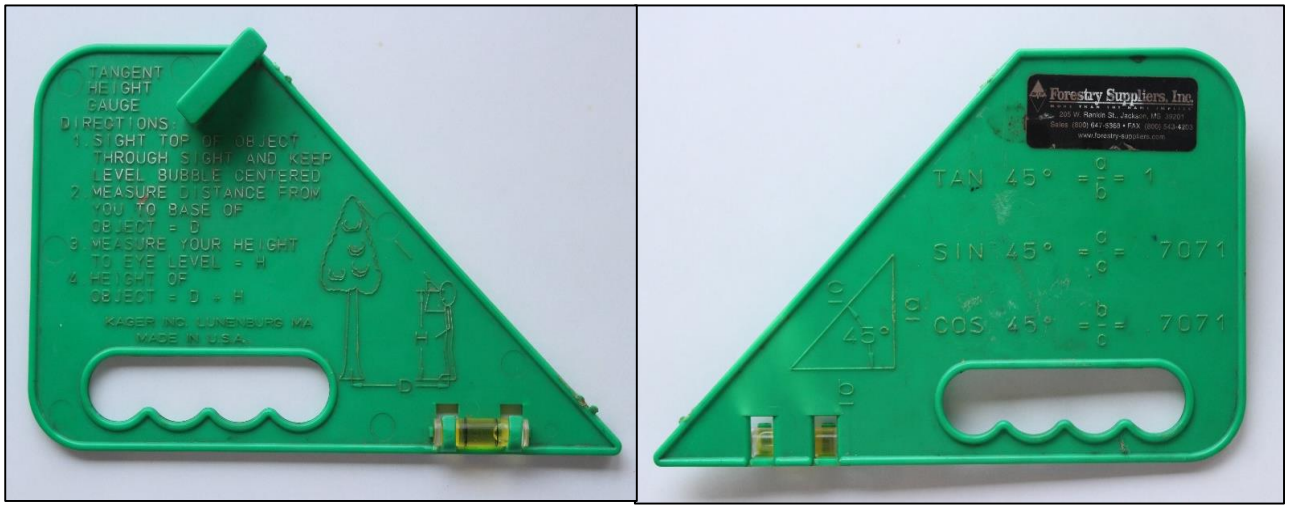
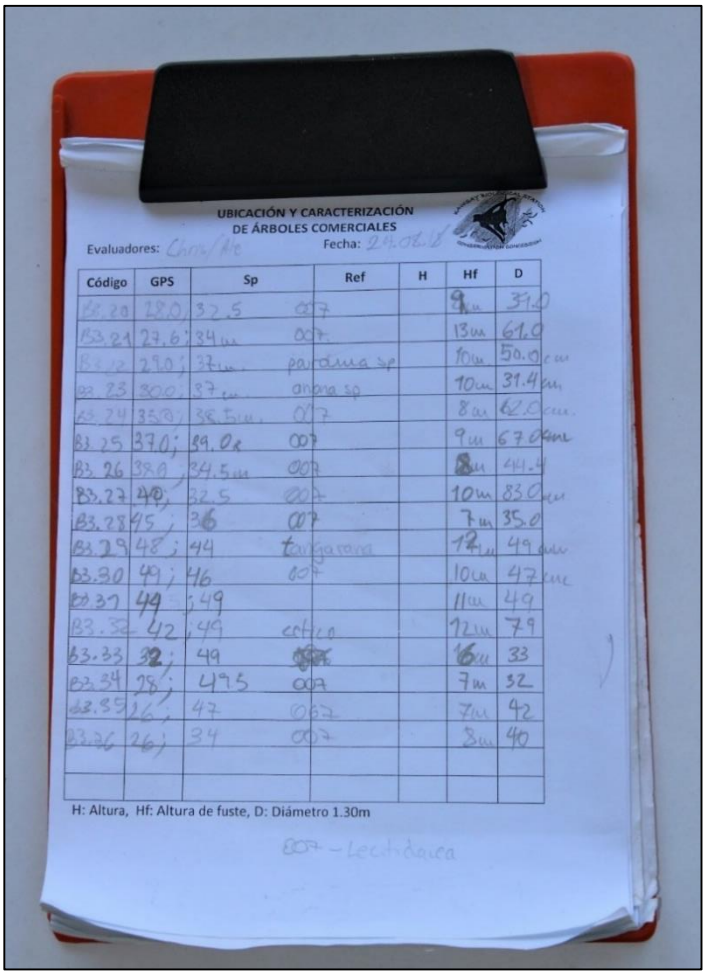


Figure 14: Tangent Height Gauge used to measure the height of the reference trees at the vegetation plot. Directions (left):

1. *Sight top of object through sight and keep level bubble centered*
2. *Measure distance from you to base of object = D*
3. *Measure your height to eye level = H*
4. *Height of object = D + H*

From: own photographs.

Figure 15: Material used to create and evaluate the plot: binoculars, writing material, "metro", labelling material, cordel, GPS, compass and machete. From: own photograph.



UBICACIÓN Y CARACTERIZACIÓN DE ÁRBOLES COMERCIALES

Evaluadores: Chris/Ale Fecha: 24.01.18

Código	GPS	Sp	Ref	H	Hf	D
B3.20	28.0;	32.5	007		9m	31.0
B3.21	27.6;	34m	007		13m	61.0
B3.22	29.0;	37m	paraduna sp		10m	50.0 cm
B3.23	30.0;	37cm	anona sp		10m	31.4 cm
B3.24	35.0;	35.5m	007		8m	62.0 cm
B3.25	37.0;	39.0m	007		9m	67.0 cm
B3.26	38.0;	34.5m	007		8m	44.4
B3.27	40;	32.5	007		10m	83.0 cm
B3.28	45;	36	007		7m	35.0
B3.29	48;	44	tangarana		12m	49 cm
B3.30	49;	46	007		10m	47 cm
B3.31	49;	49			11m	49
B3.32	42;	49	cetico		12m	79
B3.33	32;	49	[illegible]		16m	33
B3.34	28;	49.5	007		7m	32
B3.35	26;	47	007		7m	42
B3.36	26;	34	007		3m	40

H: Altura, Hf: Altura de fuste, D: Diámetro 1.30m

007 – Lecithidaceae

Figure 16: Evaluation sheet used for the evaluation of the vegetation plot. Data included the code of the tree (Código), the location related to the X,Y "coordenadas" (GPS), the species name if known (Sp), the total height of the tree (Hf) and the circumference of the tree (D). From: own photograph.

Figure 17: Photograph of the center of the plot, where all the blocks converge. See labeled tree on the right. From: own photograph.

Localization and characterization of commercial trees

Figure 18: GPS device used for geolocalization of alive and cut trees. From: own photograph.

Figure 19: Two of the biggest trees in the region: Lupuna, Ceiba pentandra (left) and Shihuahuaco, Dipteryx micrantha (right). From: own photographs.

Figure 20: Profited D. micrantha found within the vegetation plot limits. From: own photographs.

Temperature / Relative Humidity / Precipitation Monitoring

Figure 21: Temperature and Relative Humidity Monitor (left) and Pluviometer (right) used to take daily measurements. From: own photographs.

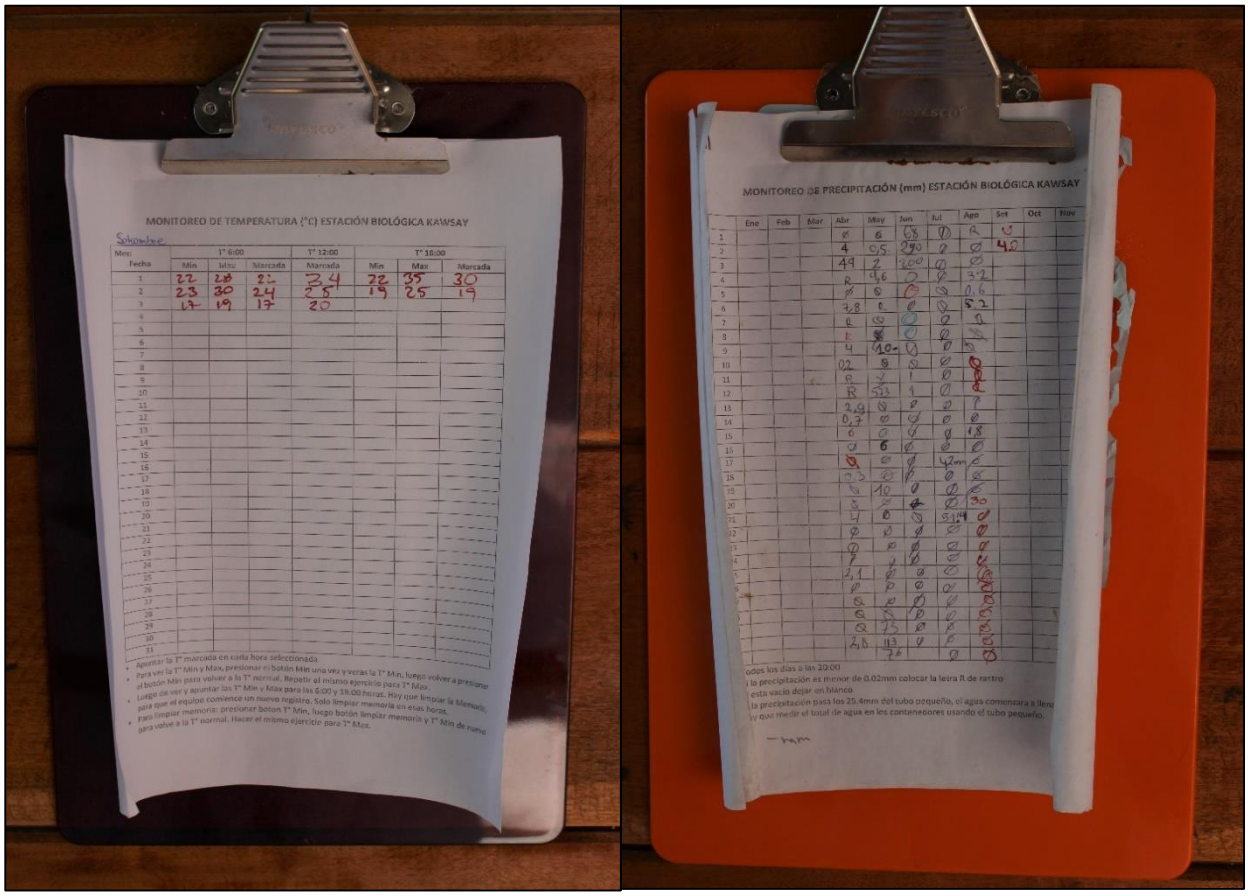


Figure 22: Evaluation sheets to take Temperature and Relative Humidity (left) at 6:00, 12:00 and 18:00, and Precipitation (right) at 20:00h. From: own photographs.

RESULTS

Table 5: List of mammals that can be found in Kawsay's Concession area with the kind of register and a IUCN status classification.

Taxonomic classification of mammals found in Kawsay's Concession area						
Order	**Family**	**Genus**	**Species**	**Common Name**	**Kind of register**	**IUCN status**
Didelphimorphia	*Didelphidae*	*Caluromys*	*Caluromys lanatus*	Brown-eared Woolly Opossum	LT	LC
		Didelphis	*Didelphis marsupialis*	Common Opossum	LT, TC	LC
		Philander	*Philander opossum*	Gray Four-eyed Opossum	NR	LC
		Chironectes	*Chironectes minimus*	Water Opossum	NR	LC
		Lutreolina	*Lutreolina crassicaudata*	Little Water Opossum	NR	LC
		Metachirus	*Metachirus nudicaudatus*	Brown Four-eyed Opossum	NR	LC
Cingulata	*Dasypodidae*	*Priodontes*	*Priodontes maximus*	Giant Armadillo	NR	VU
		Dasypus	*Dasypus novemcinctus*	Nine-banded Armadillo	SS	LC
Pilosa	*Myrmecophagidae*	*Myrmecophaga*	*Myrmecophaga tridactyla*	Giant Anteater	TC	VU
		Tamandua	*Tamandua tetradactyla*	Southern Tamandua	LT, SS	LC
	Cyclopedidae	*Cyclopes*	*Cyclopes didactylus*	Pygmy anteater	NR	NL
	Bradypodidae	*Bradypus*	*Bradypus variegatus*	Brown-throated Sloth	NR	LC
	Megalonychidae	*Choloepus*	*Choloepus hoffmani*	Hoffmann's two-toed sloth	NR	NL
Primates	*Callitrichidae*	*Leontocebus*	*Leontocebus weddelli*	Weddell's Saddle-back Tamarin	LT, SS	LC
		Saguinus	*Saguinus imperator*	Emperor Tamarin	NR	LC
			Saguinus mystax	Moustached Tamarin	NR	LC
		Callimico	*Callimico goeldi*	Goeldi's monkey	NR	VU
	Cebidae	*Saimiri*	*Saimiri boliviensis*	Bolivian/peruvian Squirrel Monkey	LT, SS, TC	LC
		Sapajus	*Sapajus macrocephalus*	Large-headed Capuchin	SS	LC
		Cebus	*Cebus cuscinus*	Shock-headed Capuchin	NR	NT
		Aotus	*Aotus nigriceps*	Black-headed Night Monkey	LT, SS	LC
	Pitheciidae	*Plecturocebus*	*Plecturocebus aureipalatii*	Madidi Titi Monkey	LT, SS	LC
	Atelidae	*Alouatta*	*Alouatta sara*	Bolivian Red Howler Monkey	LT, SS, TC	LC
		Ateles	*Ateles chamek*	Black-faced Black Spider Monkey	LT, SS, TC	EN
Carnivora	*Canidae*	*Atelocynus*	*Atelocynus microtis*	Short-eared Dog	NR	NT
		Speothos	*Speothos venaticus*	Bush Dog	NR	NT
	Procyonidae	*Procyon*	*Procyon crancrivorous*	Crab-eating racoon	NR	NL
		Nasua	*Nasua nasua*	South American Coati	SS, TC	LC
		Brassaricyon	*Brassaricyon alleni*		NR	NL
		Potos	*Potos flavus*	Kinkajou	NR	LC
	Mustelidae	*Mustela*	*Mustela africana*	Amazon Weasel	NR	LC
		Galictis	*Galictis vittata*	Greater Grison	NR	LC
		Eira	*Eira barbara*	Tayra	LT, SS, TC	LC
		Lontra	*Lontra longicaudis*	Neotropical Otter	NR	NT
		Pteronura	*Pteronura brasiliensis*	Giant Otter	NR	EN
	Felidae	*Leopardus*	*Leopardus pardalis*	Ocelot	SS, TC	LC
			Leopardus tigrinus	Northern Tiger Cat	NR	VU
			Leopardus wiedii	Margay	SS	NT
		Herpailurus	*Herpailurus yaguarundi*	Jaguarundi	NR	NL
		Puma	*Puma concolor*	Puma	SS, TC	LC
		Panthera	*Panthera onca*	Jaguar	SS, TC	NT

Lejend for Kind of Register	
LT	Linear transect
SS	Spontaneous sighting
TC	Trap camera
NR	Not Registered
Legend for IUCN status	
CR	Critical
EN	Endangered
VU	Vulnerable
NT	Near Threatened
LC	Least Concern
DD	Data Deficiency
NL	Not Listed

Order	Family	Genus	Species	Common Name	Kind of register	IUCN status
Perissodactyla	*Tapiridae*	*Tapirus*	*Tapirus terrestris*	Lowland Tapir	LT, SS, TC	VU
Artiodactyla	*Cervidae*	*Mazama*	*Mazama americana*	Red Brocket	SS, TC	DD
			Mazama gouazoubira	Gray Brocket	NR	LC
	Tayassuidae	*Tayassu*	*Tayassu pecari*	White-lipped Peccary	SS, TC	VU
		Pecari	*Pecari tajacu*	Collared Peccary	SS, TC	LC
Rodentia	*Erethizontidae*	*Coendou*	*Coendou prehensilis*	Brazilian Porcupine	SS, TC	LC
			Coendou bicolor	Bicolor-spined Porcupine	SS	LC
	Cuniculidae	*Cuniculus*	*Cuniculus paca*	Agouti	SS, TC	LC
	Dinomyidae	*Dinomys*	*Dinomys branickii*	Pacarana	SS	LC
	Caviidae	*Hydrochoerus*	*Hydrochoerus hydrochoerus*	Capybara	NR	NL
	Dasyproctidae	*Dasyprocta*	*Dasyprocta variegata*	Brown agouti	LT, SS	DD
			Dasyprocta fulginosa	Black agouti	NR	NL
		Myoprocta	*Myoprocta pratti*	Green Acouchi	LT, SS, TC	LC
	Sciuridae	*Sciurus*	*Sciurus spadiceus*	Southern Amazon Red Squirrel	LT, SS, TC	LC
			Sciurus ignitus	Bolivian Squirrel	LT, SS, TC	DD
Lagomorpha	*Leporidae*	*Sylvilagus*	*Sylvilagus brasiliensis*	Tapeti	SS	LC

Table 6: List of plant species that can be found in Kawsay's Concession area with a IUCN status classification.

Taxonomic classification of plant species found in Kawsay's Concession area				
General Features	**Family**	**Genus**	**Species**	**IUCN status**
Tree	*Anacardiaceae*	*Spondias*	*monbin*	LC
Tree	*Annonaceae*	*Cremastosperma*	*sp*	-
Tree	*Annonaceae*	*Guatteria*	*sp*	-
Tree	*Annonaceae*	*Oxandra*	*sp*	-
Tree	*Annonaceae*	*Ruizodendron*	*ovale*	LC
Tree	*Apocynaceae*	*Tabernaemontana*	*heterophylla*	LC
Tree	*Bignoniaceae*	*Tabebubia*	*sp*	-
Tree	*Bixaceae*	*Bixa*	*urucurana*	LC
Tree	*Boraginaceae*	*Cordia*	*nodosa*	LC
Tree	*Burseraceae*	*Protium*	*sp*	-
Tree	*Capparidaceae*	*Capparis*	*sp*	-
Tree	*Cecropiaceae*	*Pourouma*	*sp*	LC
Tree	*Cecropiaceae*	*Pourouma*	*cecropiifolia*	LC
Tree	*Celastraceae*	*Salacia*	*sp*	-
Tree	*Chrysobalanaceae*	*Hirtella*	*racemosa*	LC
Tree	*Combretaceae*	*Combretum*	*assimile*	LC
Tree	*Combretaceae*	*Terminalia*	*oblonga*	LC
Tree	*Ebenaceae*	*Diospyros*	*sp*	-
Tree	*Elaeocarpaceae*	*Sloanea*	*sp*	-
Tree	*Euphorbiaceae*	*Acalypha*	*sp*	LC

Legend for IUCN status	
CR	Critical
EN	Endangered
VU	Vulnerable
NT	Near Threatened
LC	Least Concern

General Features	Family	Genus	Species	IUCN status
Tree	*Fabaceae*	*Inga*	*umbellifera*	LC
Tree	*Fabaceae*	*Inga*	*sp*	-
Tree	*Fabaceae*	*Lecointea*	*peruviana*	LC
Tree	*Fabaceae*	*Pterocarpus*	*sp*	-
Tree	*Flacourtiaceae*	*Carpotroche*	*longifolia*	LC
Tree	*Guttiferae*	*Chyrsochlamys*	*ulei*	LC
Tree	*Guttiferae*	*Garcinia*	*madruno*	LC
Tree	*Guttiferae*	*Garcinia*	*sp*	-
Tree	*Guttiferae*	*Symphonia*	*globulifera*	LC
Tree	*Guttiferae*	*Symphonia*	*globulifera*	LC
Tree	*Lauraceae*	*Ocotea*	*sp*	LC
Tree	*Lauraceae*	*Aniba*	*sp*	-
Tree	*Lauraceae*	*Nectandra*	*sp*	-
Tree	*Lecythidaceae*	*Gustavia*	*hexapetala*	LC
Tree	*Malpighiaceae*	*Bunchosia*	*sp*	LC
Tree	*Malvaceae*	*Ceiba*	*speciosa*	NT
Tree	*Malvaceae*	*Theobroma*	*speciosum*	LC
Tree	*Malvaceae*	*Ceiba*	*pentandra*	NT
Tree	*Malvaceae*	*Ceiba*	*sp*	-
Tree	*Malvaceae*	*Pachira*	*acuatica*	VU
Tree	*Malvaceae*	*Quararibea*	*amazonica*	LC
Tree	*Malvaceae*	*Quararibea*	*wittii*	LC
Tree	*Melaiceae*	*Guarea*	*guidonia*	LC
Tree	*Meliaceae*	*Trichilia*	*maynasiana*	LC
Tree	*Moraceae*	*Ficus*	*maxima*	LC
Tree	*Moraceae*	*Ficus*	*insipida*	LC
Tree	*Moraceae*	*Brosimum*	*lactescens*	LC
Tree	*Moraceae*	*Brosimum*	*alicastrum*	LC
Tree	*Moraceae*	*Brosimum*	*sp*	-
Tree	*Moraceae*	*Clarisia*	*biflora*	NT
Tree	*Moraceae*	*Clarisia*	*racemosa*	NT
Tree	*Moraceae*	*Ficus*	*americana*	LC
Tree	*Moraceae*	*Ficus*	*coerulescens*	LC
Tree	*Moraceae*	*Ficus*	*insipida*	LC
Tree	*Moraceae*	*Ficus*	*pertursa*	LC
Tree	*Moraceae*	*Ficus*	*sp*	-
Tree	*Moraceae*	*Pseudolmedia*	*laevis*	LC
Tree	*Moraceae*	*Sorocea*	*pileata*	LC
Tree	*Myrisiticaceae*	*Virola*	*sp*	-
Tree	*Myristicaceae*	*Iryanthera*	*juruensis*	LC

General Features	Family	Genus	Species	IUCN status
Tree	*Myrtaceae*	*Eugenia*	*uniflora*	LC
Tree	*Myrtaceae*	*Eugenia*	*sp*	-
Tree	*Olacaceae*	*Minquartia*	*guianensis*	LC
Tree	*Papilionideae*	*Dipteryx*	*micrantha*	-
Tree	*Phytolaccaeae*	*Gallesia*	*integrifolia*	LC
Tree	*Polygonaceae*	*Coccoloba*	*lepidota*	LC
Tree	*Polygonaceae*	*Coccoloba*	*sp*	-
Tree	*Rubiacea*	*Palicourea*	*punicea*	LC
Tree	*Rubiacea*	*Psychotria*	*santaremica*	LC
Tree	*Rubiacea*	*Psychotria*	*viridis*	LC
Tree	*Rubiaceae*	*Genipa*	*americana*	LC
Tree	*Rubiaceae*	*Psychotria*	*sp*	-
Tree	*Rubiaceae*	*Uncaria*	*tomentosa*	LC
Tree	*Salicaceae*	*Casearia*	*obovalis*	LC
Tree	*Salicaceae*	*Casearia*	*sp*	-
Tree	*Salicaceae*	*Hasseltia*	*floribunda*	LC
Tree	*Sapotaceae*	*Manilkara*	*bidentata*	VU
Tree	*Sapotaceae*	*Pouteria*	*bilocularis*	LC
Tree	*Sapotaceae*	*Pouteria*	*sp*	-
Tree	*sapotaceae*	*Manilkara*	*inundata*	LC
Tree	*Sterculiaceae*	*Theobroma*	*cacao*	LC
Tree	*Sterculiaceae*	*Guazuma*	*crinita*	LC
Tree	*Sterculiaceae*	*Theobroma*	*speciosum*	LC
Tree	*Tilaceae*	*Apeiba*	*menbranasea*	LC
Bush	*Flacourtiaceae*	*Mayna*	*parviflora*	LC
Bush	*Loranthaceae*	*Psittacanthus*	*cucularis*	LC
Bush	*Piperaceae*	*Piper*	*sp*	-
Epiphyte	*Commelinaceae*	*Dichorisandra*	*sp*	-
Hemiepiphyte	*Cyclanthaceae*	*Asplundia*	*ecuadoriensis*	LC
Hemiepiphyte	*Cyclanthaceae*	*Evodianthus*	*funifer*	LC
Hemiepiphyte	*Solanaceae*	*Lycianthes*	*coffeifolia*	LC
Herbs	*Araceae*	*Philodendron*	*sp*	-
Herbs	*Cannaceae*	*Heliconia*	*sp*	LC
Herbs	*Commelinaceae*	*Dichorisandra*	*hexandra*	LC
Herbs	*Euphorbiaceae*	*Croton*	*grandulosus*	LC
Herbs	*Euphorbiaceae*	*Margarita*	*nobilis*	LC
Herbs	*Poaceae*	*Pharus*	*latifolius*	LC
Herbs	*Solanaceae*	*Solanum*	*robustifrons*	LC
Herbs	*Violaceae*	*Leonia*	*racemosa*	LC
Herbs	*Violaceae*	*Leonia*	*crassa*	LC

General Features	Family	Genus	Species	IUCN status
Liana	*Bignoniaceae*	*Clytostoma*	*uleanum*	LC
Liana	*Bignoniaceae*	*Handroanthus*	*chrysanthus*	LC
Liana	*Bingoniaceae*	*Biognonia*	*aequinoctialis*	LC
Liana	*Dichapetalaceae*	*Tapura*	*peruviana*	LC
Liana	*Malpighiaceae*	*Branisteriopsis*	*muricata*	LC
Liana	*Menispermaceae*	*Anomospermun*	*grandifolium*	LC
Liana	*Nyctaginaceae*	*Bougainvillea*	*sp*	LC
Liana	*Nyctaginaceae*	*Neea*	*sp*	LC
Liana	*Theophrastaceae*	*Clavija*	*parapotona*	LC
Palm	*Aracaceae*	*Anthurium*	*sp*	LC
Palm	*Aracaceae*	*Astrocaryum*	*murumuru*	LC
Palm	*Aracaceae*	*Astrocaryum*	*huicungo*	NT
Palm	*Aracaceae*	*Attalea*	*phalerata*	LC
Palm	*Aracaceae*	*Bactris*	*maraja*	LC
Palm	*Aracaceae*	*Euterpe*	*precatoria*	LC
Palm	*Aracaceae*	*Euterpe*	*sp*	LC
Palm	*Arecaceae*	*Anthurium*	*clavigerum*	LC
Palm	*Arecaceae*	*Bactris*	*concinna*	LC
Palm	*Arecaceae*	*Geonoma*	*macrostachys*	LC
Palm	*Arecaceae*	*Geonoma*	*aspidifolia*	LC
Palm	*Arecaceae*	*Geonoma*	*sp*	-
Palm	*Arecaceae*	*Mauritia*	*flexuosa*	LC
Palm	*Arecaceae*	*Oenocarpus*	*mapora*	LC
Palm	*Arecaceae*	*Socratea*	*exorrhiza*	LC

Vegetation plot

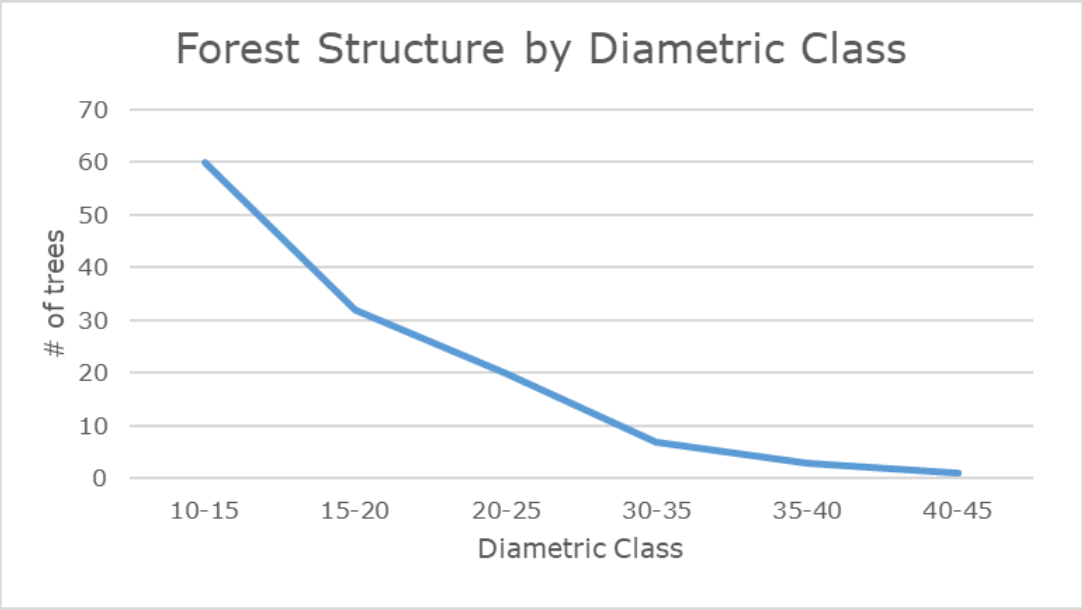


Figure 23: Trees measured at the vegetation plot are classified by diametric class. As the tendency shows, thinner trees are more abundant, signature of Secondary Forests' structure. Excel2016.

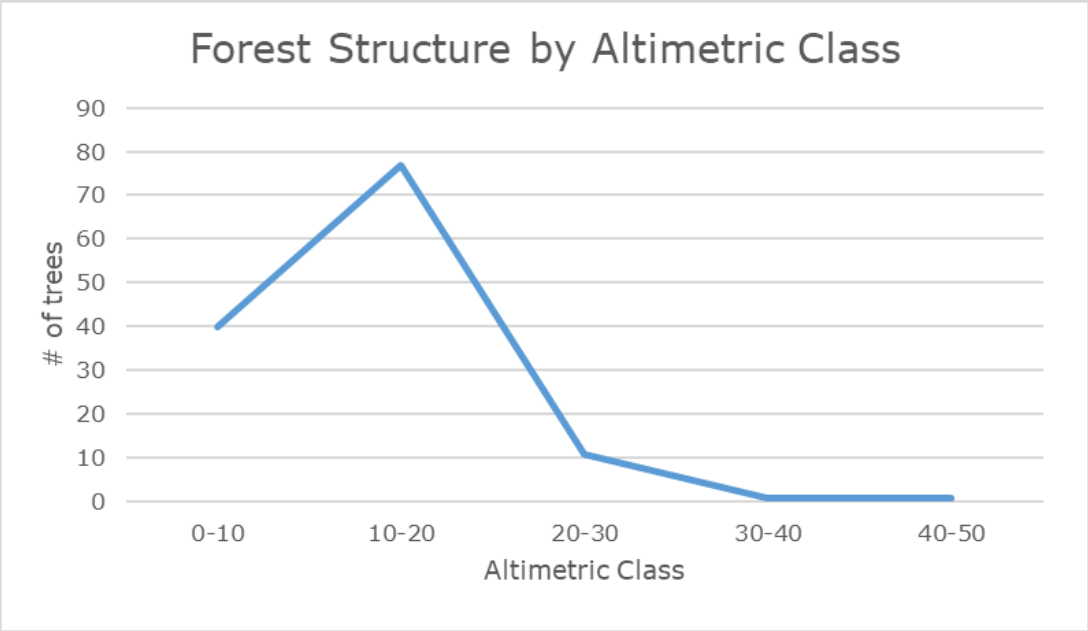


Figure 24: Trees measured at the vegetation plot are classified by altimetric class. As the tendency shows, shorter trees are more abundant, related to Secondary Forests' structure. Excel2016.

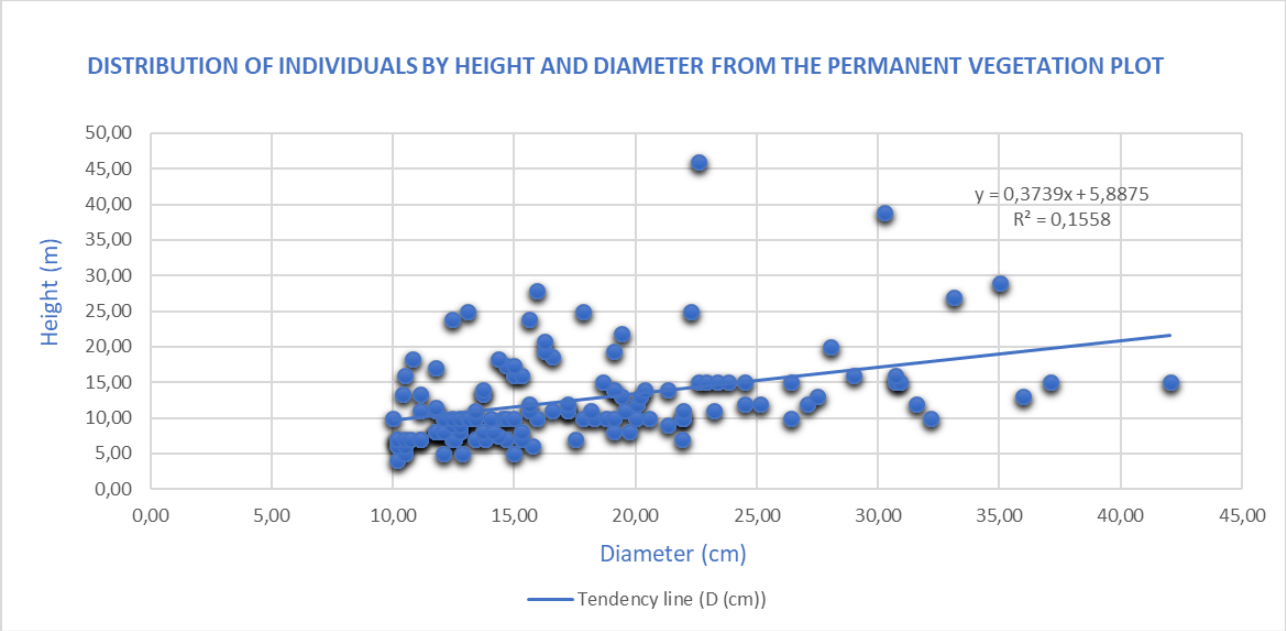


Figure 25: Showing the dispersion of trees based on height and diameter of the trees. It can be seen that a larger proportion of the trees are about 5 to 25 meters high and 10 to20 centimeters thick; big trees are highly scarce. Excel2016.

Spider Monkey Evaluation

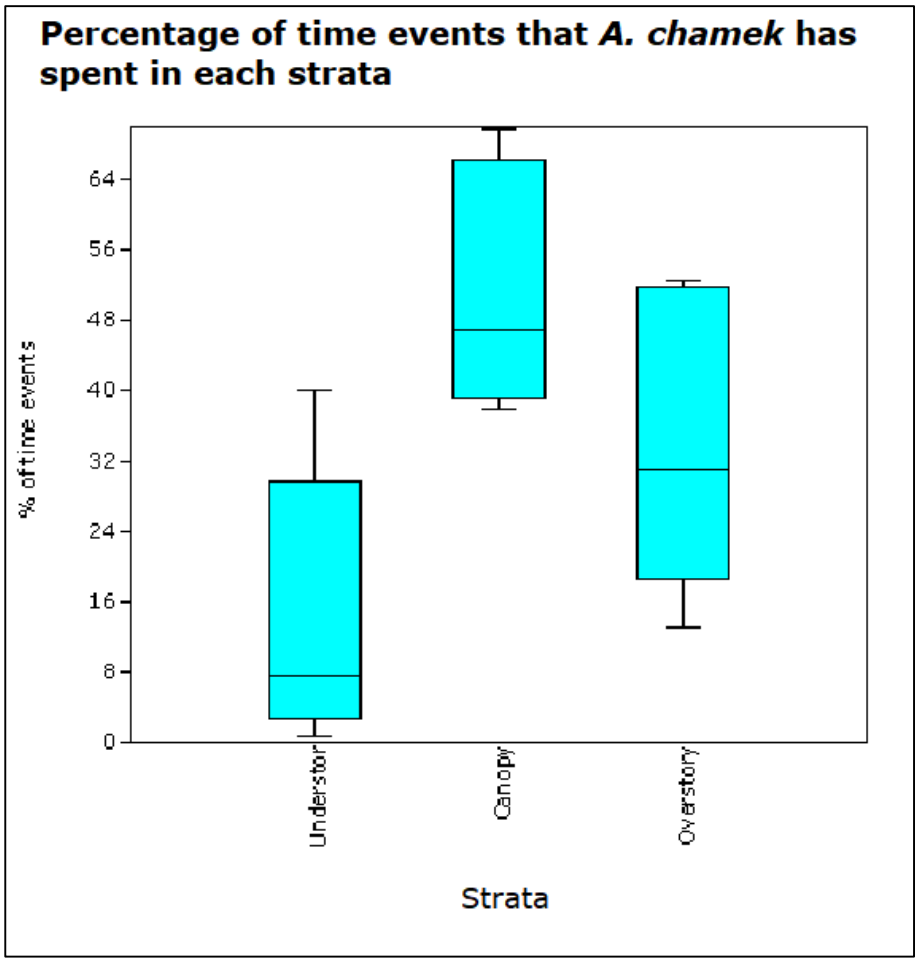


Figure 26: Percentage of time events that A. chamek has spent in each strata including months from May to August and all categories. It is seen that it spends more time on the canopy and the overstory of the forest than in the understory (Kruskal-Wallis, $p<0.05$, $H= 11.89$, $H'= 11.9$). PASTprogram.

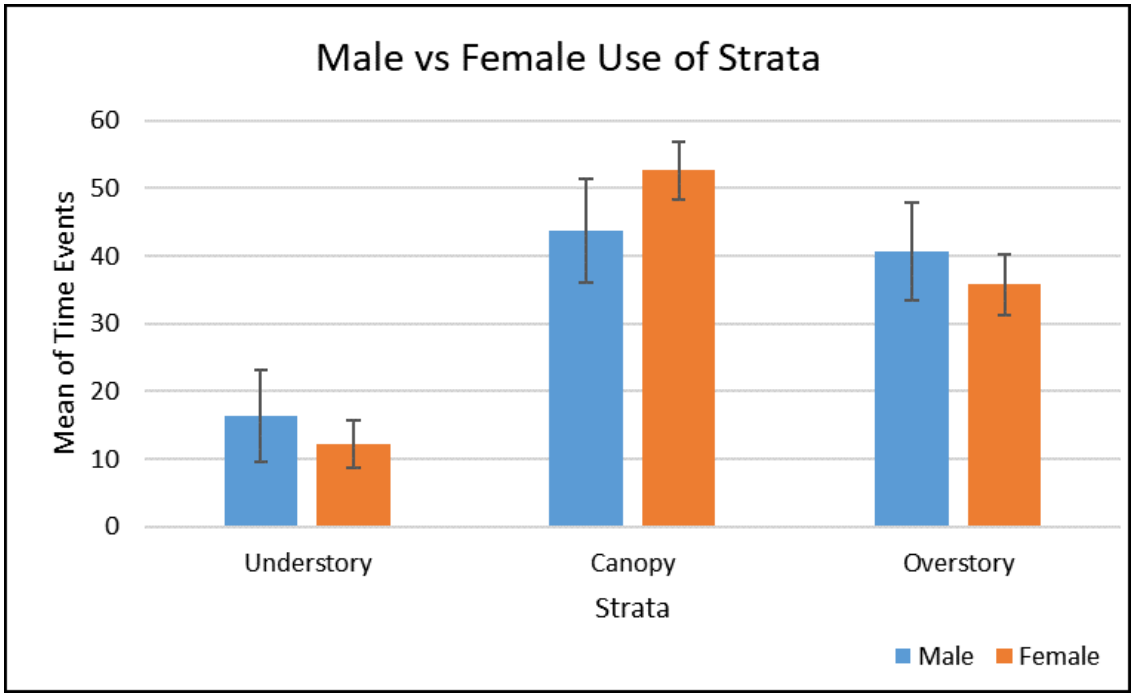


Figure 27: Mean of time events that the Male/Female A.chamek spends in each strata; standard error bars are shown. It is seen that there is no significant difference between male and female in the use of the forest strata (Mann-Whitney, p>0.05). Excel2016.

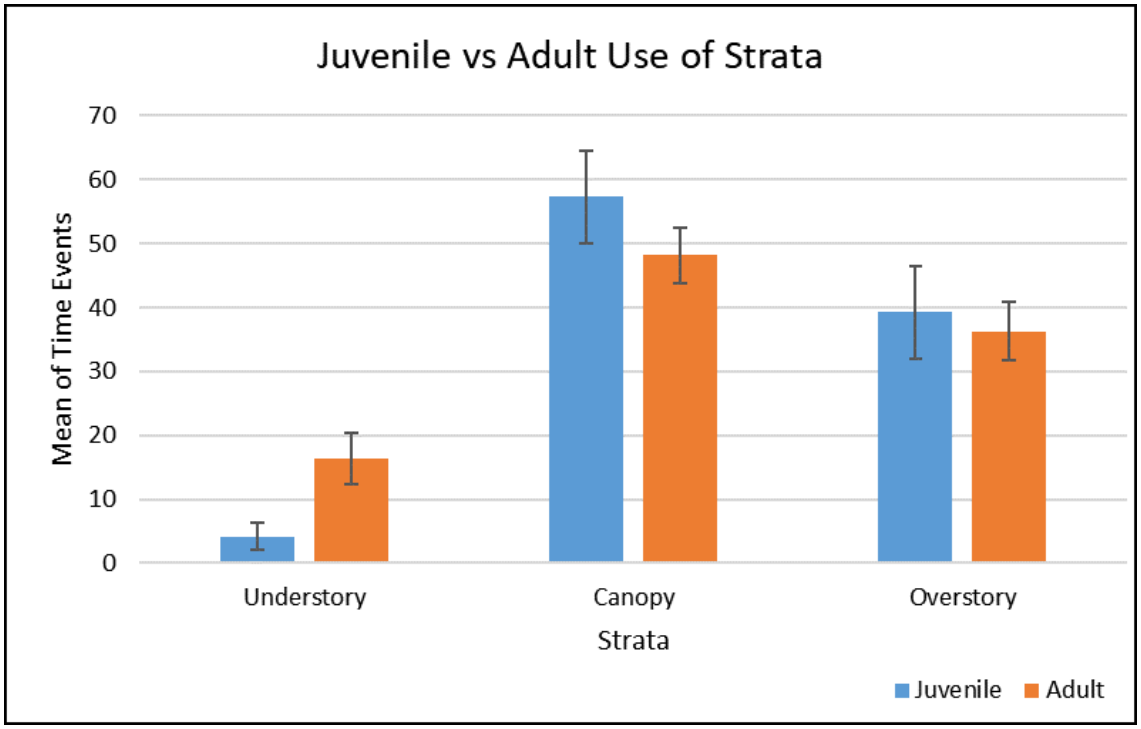


Figure 28: Mean of time events that the Juvenile/Adult A. chamek spends in each strata; standard error bars are shown. It is seen that there is no significant difference between male and female in the use of the forest strata (Mann-Whitney, p>0.05). Excel2016.

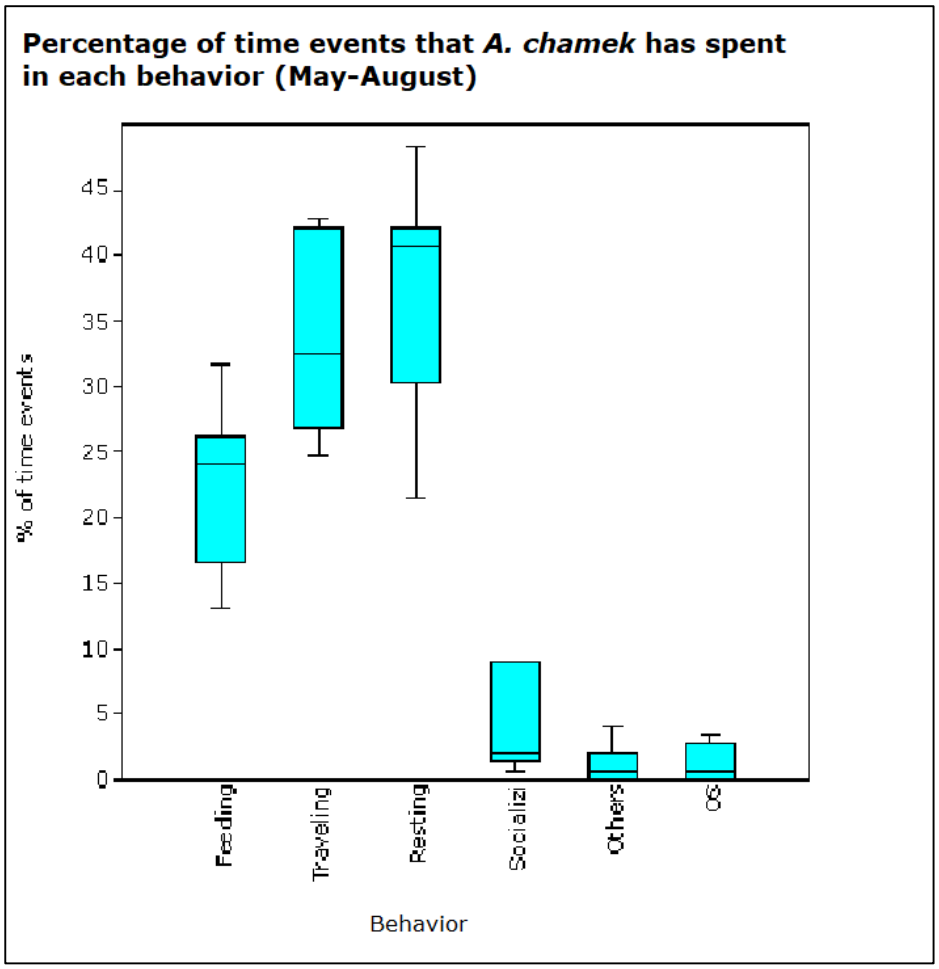


Figure 29: Percentage of time events that A. chamek has spent in each behavior including months from May to August and all categories. They seem to spent more time resting, traveling and feeding than the socializing or others (Kruskal-Wallis, p<0.05, H= 39.22, H'= 39.4). PASTprogram.

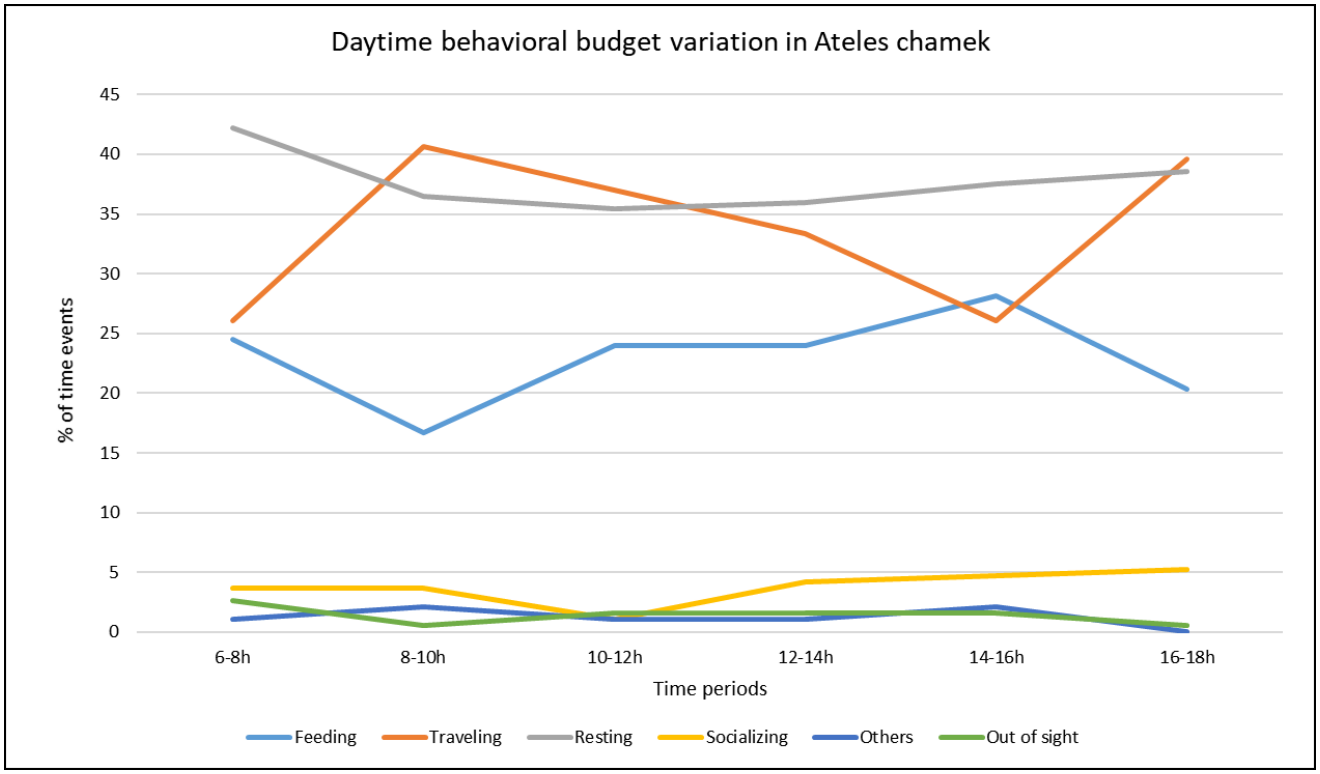


Figure 30: Daytime behavioral budget variation in A. chamek divided in two-hour periods. Excel2016.

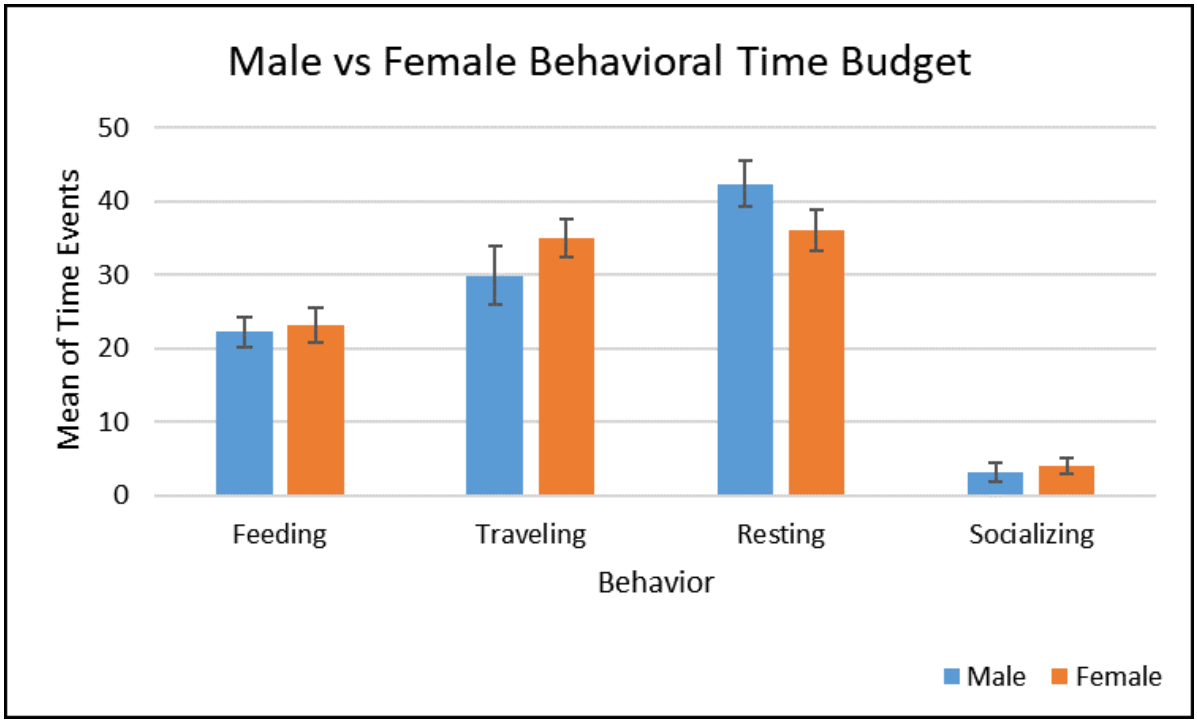


Figure 31: Mean of time events that the Male/Female A. chamek spends in each behavior; standard error bars are shown. It is seen that there is no significant difference between male and female (Mann-Whitney, p>0.05). Excel2016.

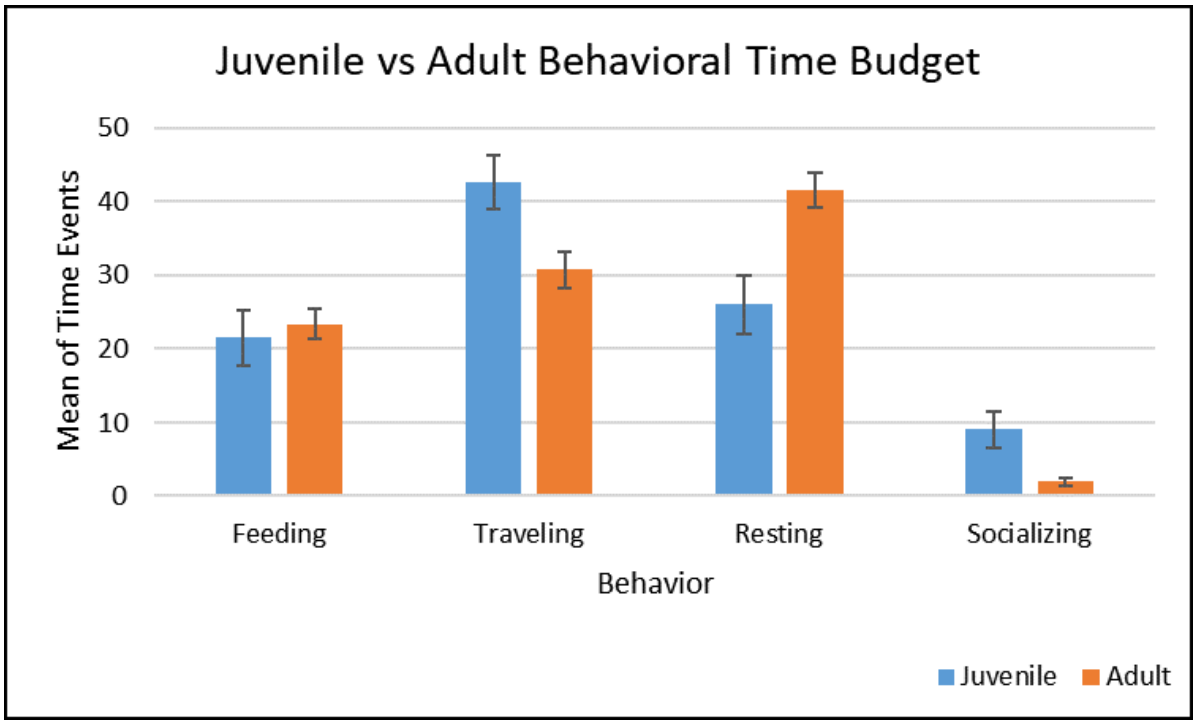


Figure 32: Mean of time events that the Juvenile/Adult A. chamek spends in each behavior; standard error bars are shown. Juveniles seem to use a greater part of the day traveling and socializing than adults (Mann-Whitney, p value<0.05), but less time resting (Mann-Whitney, p value<0.05). Still, they seem to use about the same time on feeding (Mann-Whitney, p value>0.05). Excel2016.

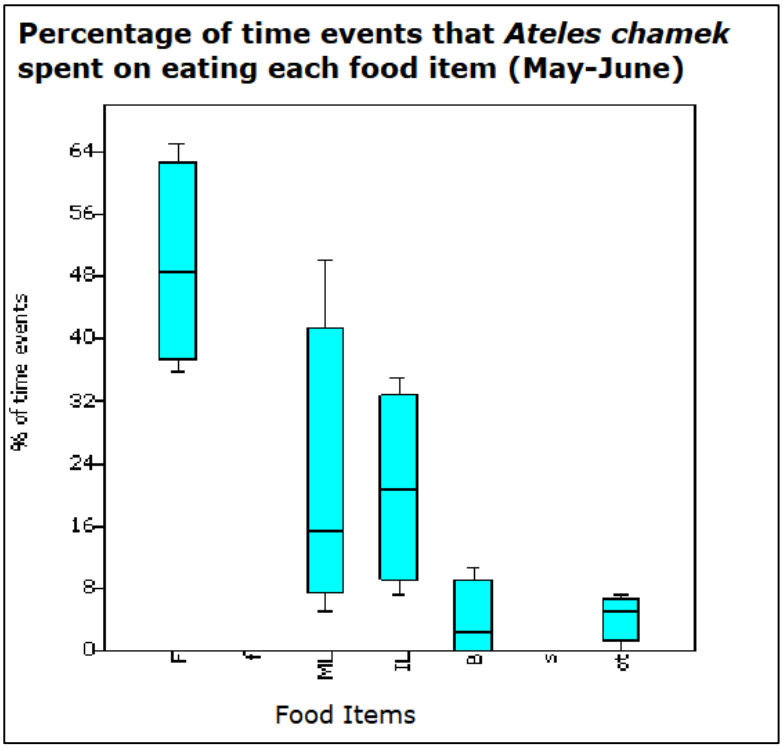


Figure 33: Percentage of time events that A. chamek spent on eating each of the food items (F: Fruit; f: Flower; ML: Mature Leaves; IL: Immature Leaves; B: Bark; s: Seeds; ot: Others) during the two-month period of May-June. Spider Monkeys seem to feed more on fruit than in any of the other food items (Kruskal-Wallis, p value<0.05, H= 21.06, H'= 22.45). PASTprogram.

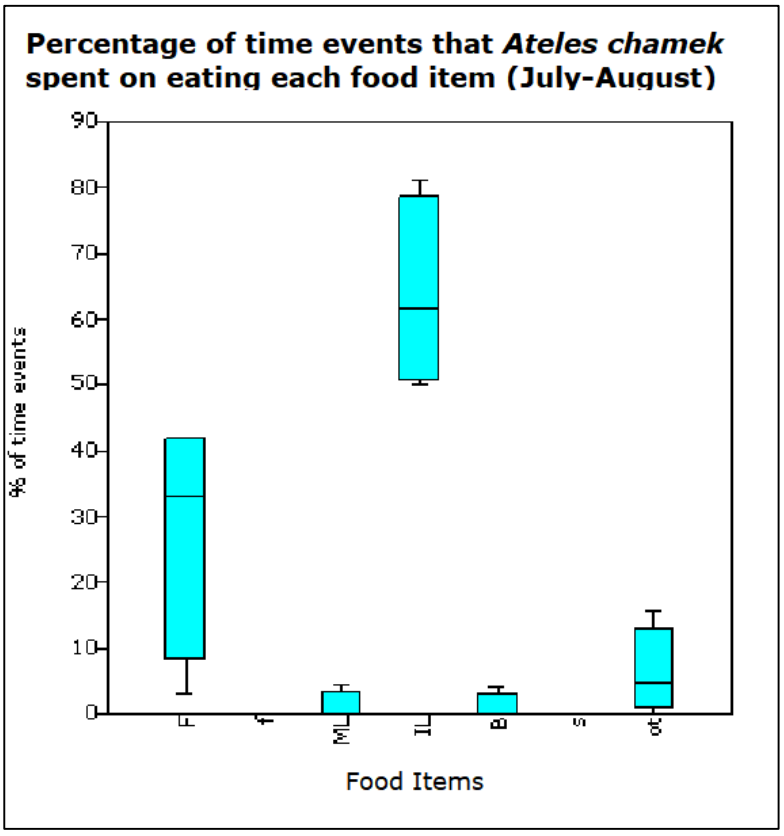


Figure 34: Percentage of time events that A. chamek spent on eating each of the food items (F: Fruit; f: Flower; ML: Mature Leaves; IL: Immature Leaves; B: Bark; s: Seeds; ot: Others) during the two-month period of July-August. Spider Monkeys seem to feed more on immature leaves than in any of the other food items (Kruskal-Wallis, p value<0.05, H= 18.49, H'= 21.84). PASTprogram.