KAWSAY BIOLOGICAL STATION

Methods of conservational research

KAWSAY

Labrotation Focus II - Working in Bioscience

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Introduction

This report summarizes my internship at the Kawsay Research Center as part of the **Focus II: Working in Bioscience** module of Molecular Bioscience master program. I chose this internship as means to broaden my horizon of different areas of biological research and learn more about conservation efforts in the Amazon Rainforest first-hand. I was already familiar with the region and heard about the Kawsay Station during my 2 month volunteer stay at the Taricaya Wildlife Rescue Center in 2019, where I had my first encounter with the spider monkey reintroduction program and had helped in the rehabilitation process of them and other native animals.

The Station. The Kawsay (*quechua, "life"*) Research Center is located in the Madre de Dios region in the southeast of Peru near the border to Bolivia, downriver of the Madre de Dios river from the nearest city Puerto Maldonado. It has been established somewhat recently in 2018 by Raul Bello Santa Cruz to provide an increase of protected area for the release and continuous monitoring of spider monkeys (*Ateles chamek*) in addition to the reintroduction efforts of the Taricaya Wildlife Rescue Center since 2010 and since then has been grown as a study area for a variety of biodiversity research and learning opportunity for scientists, students and volunteers. The study area is located within the buffer zone of the adjacent Tambopata National Reserve and encompasses 7 ha private land and a 172 ha conservation concession, granted by the peruvian government (Servicio Nacional Forestal y de Fauna Silvestre, SERFOR). Tasks of a conservation concession include, amongst others, protecting and guarding the area from anthropogenic influences, allowing natural recuperation of degraded areas, and promoting scientific investigations and monitoring of flora and fauna including educational and trainee programs with inclusion of the local community (Ley Forestal y de Fauna Silvestre, LFFS [1]). The goals for the implementation of these tasks have to be laid out in 5-year plans and annual progress reports have to be provided in order to preserve the concession status of the area.

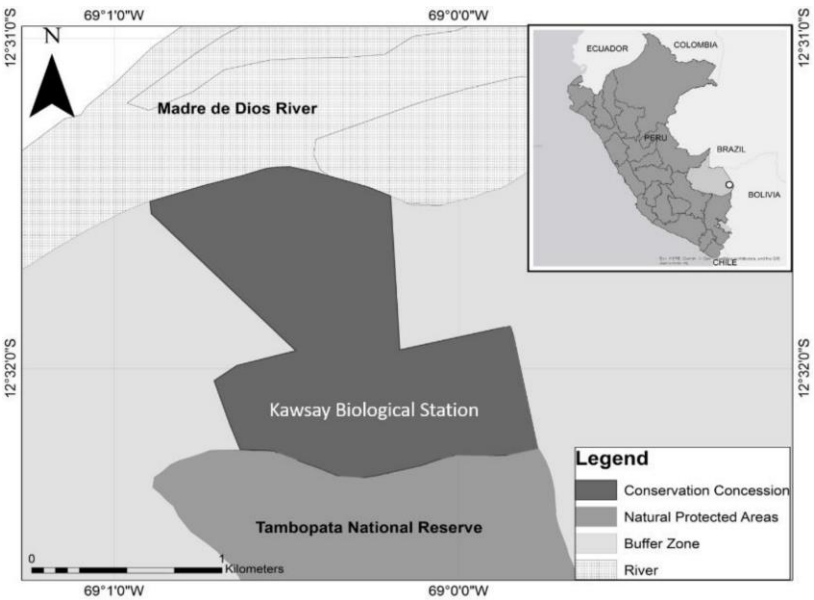

Figure 1: Outline of the Kawsay conservation concession within the buffer zone of the Tambopata National Reserve in the Madre de Dios region. Figure by Raul Bello et al. [4]

Ateles chamek. The peruvian black-faced spidermonkey (*Ateles chamek*), one of the largest species of primates found in South America, is classified as Endangered by the IUCN Red list since 2008 [2] and has been locally extinct in the Madre de Dios region since approximately the 1980s [3]. Several reasons led to the rapid decline of their population. Due to their size, vocality and lack of shyness these primates are an easy to spot target for bushmeat hunting and their young a popular item for illegal pet traders. Expansion of residential and agricultural areas, logging either as complete deforestation or selective extraction of timber (focusing on older and large trees required by the monkeys) and illegal gold mining activities which are rampant in the Madre de Dios region (see Discussion) led to displacement, habitat loss and fragmentation. Their social dynamics require a large area with several active populations and unhindered migration routes, as female individuals tend to disperse from their troupes of ideally 20-30 individuals upon reaching adulthood (4-5 years) in search for mates to ensure genetic diversity, while males tend to stay within their natal groups. Their reproduction rate is quite slow with single offspring and inter-birth intervals of about 3 years [4]. The large-bodied species of primates is believed to play an important part in influencing the compositional diversity, structure and dynamics of the rainforest by dispersing seeds over long distances [5], thus their conservation as keystone species may be essential for long term preservation of the ecosystem, especially for plants with large seeded fruits with little other dispersal mechanisms.

As reaction to rapidly declining wildlife biodiversity, the Tambopata National Reserve was established in the region in the year 2000, providing a large protected area with limited human influence. Since 2010 the nearby Taricaya Wildlife Rescue Center is working on the reintroduction of Ateles chamek into the region, having released a total of 8 groups and 32 individuals over the years. All individuals were raised in captivity and have a history as pets, originating from confiscations from illegal pet traders or being donated to the Rescue Center. Within the Rescue Center the monkeys underwent an extensive rehabilitation process of at least 2 years in which they recuperate from abuse, build up health, form social bonds with other to-be-released spider monkeys and undergo intensive veterinary controls to prevent diseases like human Herpes viruses spilling over into the wild population. The reintroduction program so far had an average success rate of 41.8% (i.e. individuals remaining in the wild over 6 months) [3] and has recorded successful wild births of several individuals, one of those in the second generation.

A main challenge of the reintroduction success includes a lack of initial self-confidence of the captive-raised and -rehabilitated spider monkeys to supply themselves and navigate the forest, leading to dispersal of the groups within days of release in search for their way back to the Rescue Center and human support. This can be remedied by having a group of trusted humans accompanying them somewhat continuously in their first weeks of adaptation in the wild and intensive post-monitoring in the months thereafter. Other concerns are instinctive dispersal of adult females with not enough groups to migrate into, a lack of genetic diversity within the released groups and a low success rate of male individuals, which tend to form less close-knit social bonds during their rehabilitation process and disperse more frequently from their groups and were more likely observed to display intergroup aggression, making beneficial fusion with established groups more complicated. Long-term population growth will be dependent on a high survival probability of adult females and availability of genetically diverse males throughout the subpopulations [4].

Projects, activities and methods

While the focus of the station is the monitoring of the spider monkeys from the reintroduction program, several projects and activities are part of the weekly schedule, shifting with the needs and expertise of the current cast of researchers, students and volunteers on station as well as season and weather conditions. Kawsay offers an open framework for any researcher or student interested to conduct studies within the concession, supported by a number of current local and international volunteers and interns. On occasion a variety of focused courses e.g. for veterinarians or university students are offered by associated vets and scientists. A typical day at Kawsay usually consists of several blocks (morning, afternoon, night) of different activities in the jungle within small groups of at least 2-3 people. Habitual book-keeping of planned routes taken and returns to the station for communal lunch and dinner are required to keep track of and ensure the safe return of every group. Theoretical classes and/or presentations are held on a weekly basis. Following are some of the projects and activities I had the chance to partake in during my stay.

PROGRAM ACTIVITIES (Every 2 weeks)

	MONDAY	TUESDAY	WEDNESDAY	THURSDAYS	FRIDAY	SATURDAY	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAYS	FRIDAY	SATURDAY	SUNDAY
MORNING	Vegetation plots	Phenology	Vegetation plots	Monitoring Spider Monkey	Monitoring Spider Monkey	Data entry	*Cleaning house*	Day mammal transects	Phenology	Vegetation plots	Monitoring Spider Monkey	Collecting cameras	*Optional free weekend in Puerto Maldonado*	
AFTERNOON	Installing cameras	Phenology determin.	Data entry	Monitoring Spider Monkey	*Sports Games*	*Laundry + Cleaning house*	*Laundry*	Vegetation plots	Phenology determin.	Data entry	Monitoring Spider Monkey	*Sports Games*		
NIGHT	Theoretical classes	Night mammal transects	*Free*	*Free*	*Campfire Social Night*	*Free*	*Free*	Theoretical classes	*Free*	*Free*	*Free*	*Campfire Social Night*	*Free*	*Free*

Fauna activity, Flora activity, Theoretical activity, Cleaning activity, Free time → *The combination of the activities depends on the number of people in the station, weather, etc.*

Figure 2: Example activity schedule. Days are devided into three blocks (morning, afternoon and night). Theoretical classes and presentations are given on a weekly basis. Every two weeks an optional stay in the nearest city is possible.

Spider monkey monitoring

Groups headed out to search and check up on the released spider monkeys several times a week. During release they used to wear radio collars for easy localization, but those stop working after some time and fall off. Instead, dedicated spots near their known sleeping- and/or foraging trees or their last known position are visited and two distinct call-outs that resemble the monkeys short-distance/social and long-distance vocalization calls are used to try to grab their attention. If spotted in this manner, or by chance encounters, the monkeys were followed to identify possible problems, observe behavior, identify eaten fruit and GPS-mark preferred sites/trees or collect fecal samples which may be used to identify foraging plants by excremented seeds or for future genetic studies.

Herpetofauna species inventory

One major goal during my time there was to assess the diversity and generate a species inventory and visual identification plates of amphibia and reptiles encountered at the Kawsay concession together with the herpetologists Romina Camus and Juan Daniel Valencia.

Herpetology transects. A direct approach to the assessment were herpetology transects. Amphibia and reptiles were located within the jungle during both dedicated daytime and night walks of 3 hours each daily to target both diurnal and nocturnal species. For these transects, we followed the existing trails and were looking for terrestrial and arboreal species on and near (+- 10 m) the trails on ground, on top of leaves and on trunks and low tree branches. The encountered species were recorded and, whenever possible, caught and pictures taken for the identification guide. When handling amphibia special care should be taken to keep the hands clean and free of toxic chemical agents such as insect deterrent, as their skin is very sensitive and permeable. After pictures were taken, the animals were released at the spot they were caught.

Pitfall traps. Two pitfall trap transects were used on occasion. These are 100-meter lanes of 80 cm high stretched plastic canvas with 20L buckets lowered into the soil every 10 meters. The plastic canvas prevents small ground dwelling animals like terrestrial frogs, spiders and rodents from traversing the lanes, which subsequently attempt to walk or jump sideways and eventually fall into one of the buckets. The buckets can be closed for periods of disuse and are opened in the afternoon and checked the next morning. The caught animals were recorded and released.

Camera traps

For the study of medium to large-bodied mammals and birds, camera traps (BUSHNELL Trophy Cam) were installed at three sites of interest (1) collpa árbol, a site near the creek where a tree had fallen and below its roots the clay was laid bare, (2) collpa grande, a wide claylick with an elevated soil step and (3) collpa altura, an elevated claylick beside a natural pond bordering on the Tambopata National Reserve.

The cameras are equipped with an infrared body heat sensor and movement sensor and are set up to record a ten second video once a warm-blooded animal enters (or remains within) the frame. They were collected in a two-week cycle to retrieve the footage and reinstalled the next day. For future data analysis the footage was sighted and the species, number of individuals, dwelling time within frame and behavior recorded.

Bat identification

During a one-week course on rodent and bat biodiversity research for university students given by the bat expert Hugo T. Zamora several methods to assess bat diversity were introduced.

Localization of sleeping sites. The most straight-forward method is to localize the bats within the forest at typical sleeping sites. These can include, amongst others, suspiciously folded leaves of palms or Heliconia, abandoned and hollowed termite nests or holes and hollows in big trees.

Mistnets. A more direct approach is to catch the bats during their activity hours at night using mist nets, i.e. nets of fine mesh barely visible by eye or echolocation that can be stretched vertically through the forest. Bats (or birds) that attempt to fly through get entangled in the mesh and can be caught, identified, examined and measured and released. They can be set up at different heights in varying microhabitats to target different species. Once opened the nets must be checked frequently to not increase the distress and risk of injury of caught animals higher than necessary.

Acoustics. A non-invasive approach to identification is to record echolocation calls, which are characteristic for families or even genus and species. For this specialized audio recording devices exist, which can be either placed statically at a heightened position or handheld and targeted towards individuals. Some such devices like the Echo Meter by Wildlife Acoustics can be used with merely a smartphone.

Phenology transects

To study the phenology of trees and woody shrubs to assess seasonal availability of fruit, four transects of 500 meters each were used (Figure 10, F1-4). On one transect per week in a one-month cycle fallen fruits, flowers or fresh seeds of woody plants were searched on the trail. If more than one fruit, flower or seed was found, the corresponding tree or shrub was located and pictures and information about available identification features like leaves, bark, latex production and smell were collected for later identification on station. As guide for identification on station mainly visual identification plates assembled and provided by several National Reserves and literature including Seeds of Amazonian Plants (F. Cornejo, J. Janovec)[6], Trees of Peru (T.D. Pennington, C. Reynel, A. Daza)[7] and Woody Plants of Northwest South America (A.H. Gentry)[8] were used.

Figure 3: Collection of features and plant material for plant identification. Pictures show (1) the trunk of *Sorocea pileata* (Moraceae) with characteristic free-flowing “café-con-leche” colored latex, (2) male flowers and leaves of *Sorocea pileata*, (3) found seeds of *Triplaris poeppigia*.

Vegetation plots

Ten vegetation plots ("parcelas", Figure 10) were distributed throughout the concession, each a rectangle of 20x50 m² and consisting of ten 10x10 m² subplots. In these, trees of a diameter >10 cm (~ circumference >31.4 cm) are permanently labelled with stamped metal plates and their circumference and height recorded periodically to study their growth and dynamics over time and compare them between the different microhabitats. The circumference was taken when possible at a height of 130 cm or, for trees with deformations or larger trees with pronounced tabular roots, the lowest representative circumference was taken and the height of measurement recorded. To measure the trees height a "tangent height gauge" was used, a tool that helps to identify a spot from where the highest point of the tree is in a 45° line of sight. The horizontal distance from this spot and the point perpendicular below the highest point (ideally but not necessarily the tree trunk, Figure 4 [9]), plus the height of the observer's eye, amount to a more easily measurable approximation of the tree's height. For very high trees where this method would be impractical, a hypsometer is used, a combined laser-rangefinder and clinometer that trigonometrically calculates the height difference between your position and the point the laser is aimed at, in this case the highest bunch of leaves in the crown.

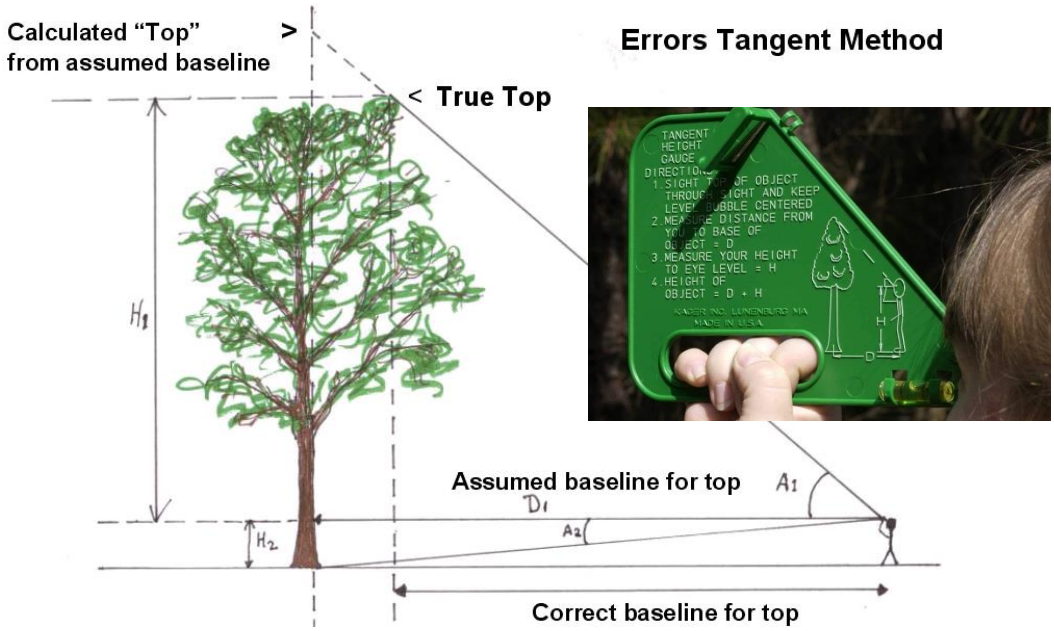

Figure 4: A potential source of inaccurate tree height estimation using the tangent method using a Tangent Height Gauge. Distance has to be measured perpendicular to the highest point, which might not always be over the trunk, leading to overestimation of tree size when the highest point is closer to the observer [9].

Sleeping trees. Similarly, the sleeping trees of spider monkeys were identified and measured. During behavioral studies of the released monkeys the trees where the troupe decided to settle for the night were recorded and revisited at a later point to take in the measurements (height, circumference) and species of the tree to see whether certain preferences such as height, branching behavior and strength and fruit availability can be observed.

Weather data

To see how the weather and local climate changes over the seasons and years and explain certain behavioral patterns, weather parameters humidity (%rH, min/max/current) and temperature (°C, min/max/current) were collected three times a day at 7:00 (timeframe 19:00-07:00), 13:00 and 19:00 (timeframe 07:00-19:00). The amount of precipitation (mm) was noted every evening at 20:00.

Trail maintenance and mapping

To facilitate orientation in the jungle, trails were labelled systematically with color-coded distance marks every 25 meters, counting down to 0 towards the station on the main-trail (yellow) or to 0 towards the main-trail for tributary trails (red). These trails and their markings have to undergo maintenance regularly and after storms as underbrush encroaches back onto the trails, fallen branches and trees block the way and weather and wildlife degrade markings over time. Furthermore, a new trail was established ("Chato"), connecting the Taricaya "Quebrada" trail with Kawsays "Lindero" as a short-cut between the two trail-systems.

To update the trail map (Figure 5) with more recently established or newly generated trails, I activated GPS logging of my camera (Olympus TG5) during activities on new trails, recording the current coordinates every 15 seconds. The resulting NMEA 0183 files were converted to KML files (https://mygeodata.cloud/converter/) and imported into Google Earth. Based on the resulting map overlaid on the existing map an updated map was generated using a graphical software (Paint Tool SAI 2.0).

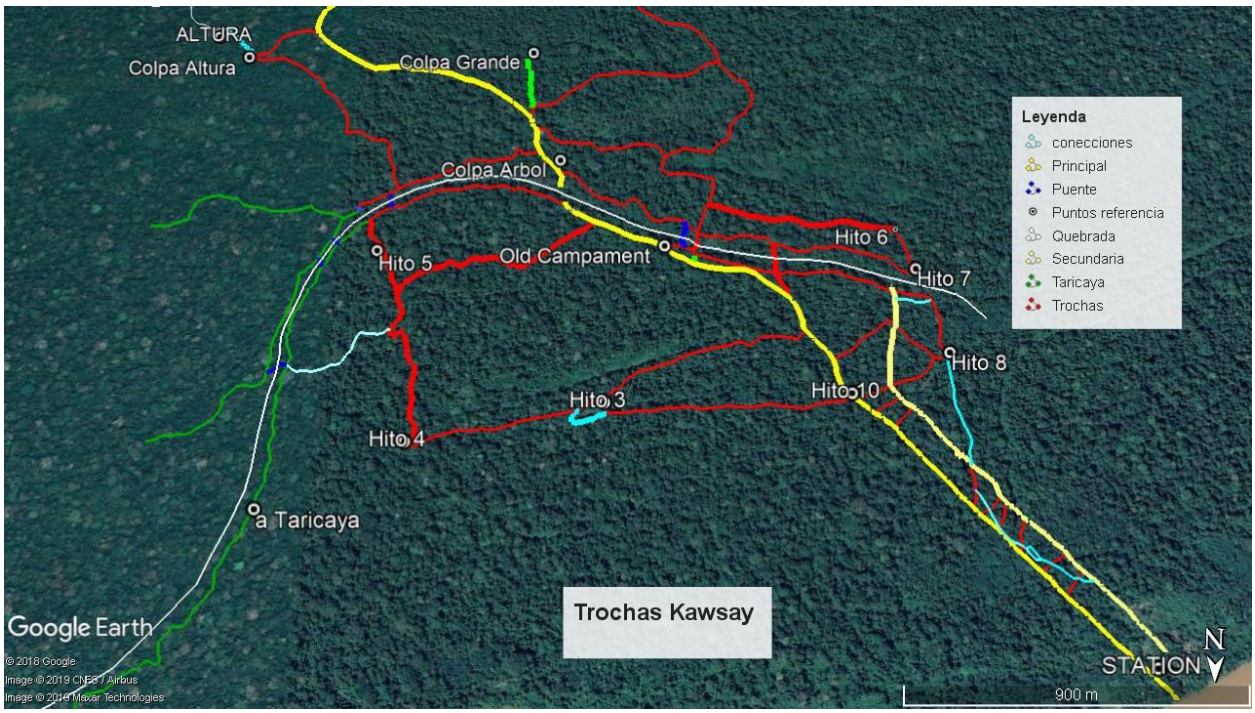

Figure 5: Map of the Kawsay trail system, with one maintrail (yellow) leading towards the station and several tributary trails (red, light blue) spanning the perimeters of the concession.

Results & Discussion

Recorded weather data shows the transition between the dry and wet season

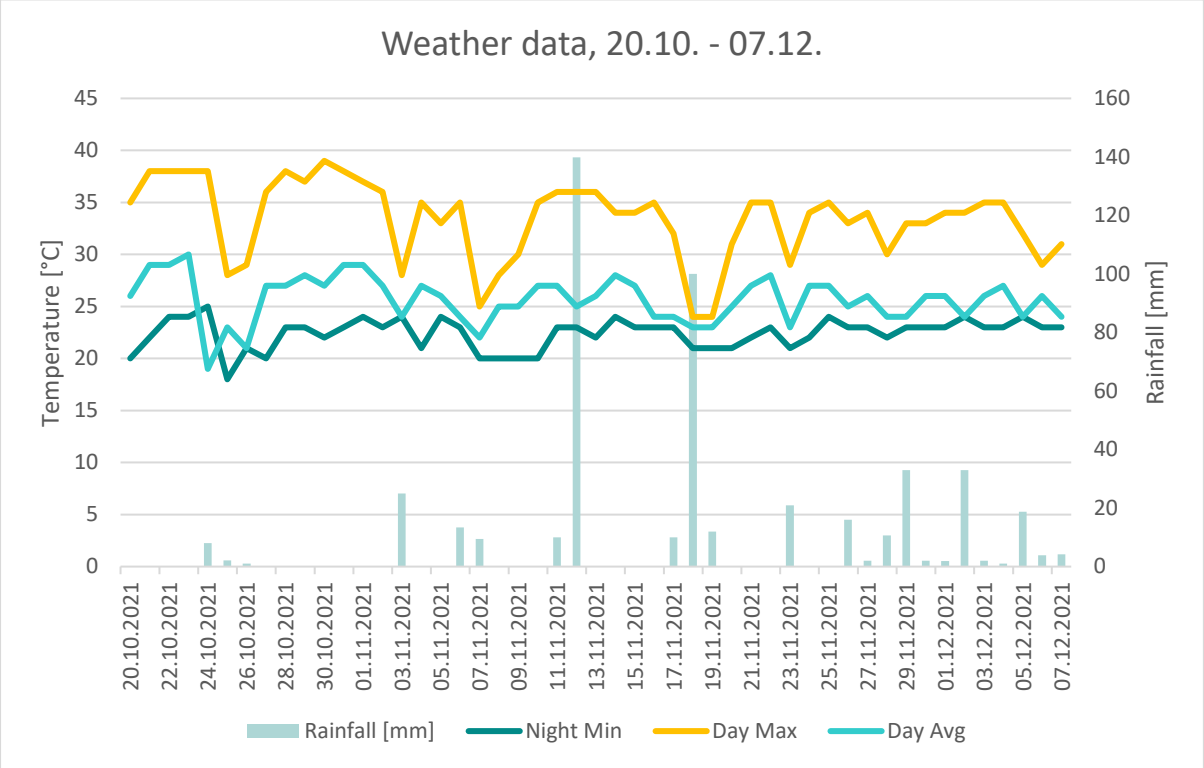

Figure 6: Weather parameters show a transition from dry to wet season. Graph shows parameters nighttime (19:00-7:00) minimal temperature, daytime (7:00-19:00) maximum and average temperature as well as precipitation volume at the Kawsay Station within the timeframe of end of October and beginning of December.

Weather parameters were taken daily at several time points a day (Figure 6). During my stay from end of October to beginning of December a total of 480.5 mm precipitation (average 18.5 mm / day) and an average temperature of 25.1 °C was recorded.

The Madre de Dios region is part of the Amazon basin and has a tropical to tropical monsoon climate (Af-Am, Köppen), with an annual average temperature of 26.5°C and annual precipitation exceeding 2000 mm. The precipitation is strongly seasonal with a dry season (May-October) and a wet season (November-April).

The transition from dry to wet season is reflected within the collected weather data, as precipitation events were rare in late October, while a daily occurrence by early December. Interestingly, the strongest rainfall events happened during the transition period with precipitation events exceeding 100 mm on a single day.

Camera traps were able to capture several mammalian and avian species at clay licks

Camera traps were installed at three sites of interest with clack licks. **Clay licks** ("collpa") are sites of special interest within the rainforest in which the top layer of soil is eroded away and mineral-rich clay laid bare. These sites are frequented by many animals, most famously by macaws, but also herbivorous mammals, which consume the clay ("geophagia"). Several hypotheses as to why exist, including a supplementation of their diet with minerals like sodium [10] or essential compounds like microbial B12 and help with detoxification of dietary chemical compounds like alkaloids and tannins by providing negatively charged cation-exchange sites [11].

Between May 2018 and December 2019 a total of 22 mammal species and 14 bird species were recorded and identified using clay lick camera traps (Alejandra Chumbimune, 2020, unpublished [12]). Similar projects in the area within Taricaya with traps on clay licks but also at trails and natural bridges were able to capture 31 mammalian and 43 avian species between 2017 and 2019 (Sam Pottie, 2019, unpublished). These 31 species represent about 72% of medium to large bodied non-volant mammal species (excluding small rodents, marsupials and bats) sighted at Taricaya.

The most commonly captured mammals include the brown agouti (*Dasyprocta variegata*), the collared peccary (*Pecari tajacu*), the tapir (*Tapirus terrestris*) and the red brocket deer (*Mazama americana*). The most common bird was the Spix's guan (*Penelope jacquacu*). As expected, the most frequent visitors are herbivorous animals that can be frequently seen to either directly consume some of the clay or drink clay-rich water from collecting water puddles at the collpas, but also some predatory animals like hawks (*Buteo magnirostris*), tayra (*Eira barbara*), ocelots (*Leopardus pardalis*), jaguarundi (*Puma yagouaroundi*) and pumas (*Puma concolor*) appear on footage occasionally.

While footage collected during my time at Kawsay has not been quantitatively reviewed yet, as the review of the large quanitity of raw footage (100s of GB of 10 sec clips) is a time-consuming endeavor, some species that have been captured are presented in Figure 7.

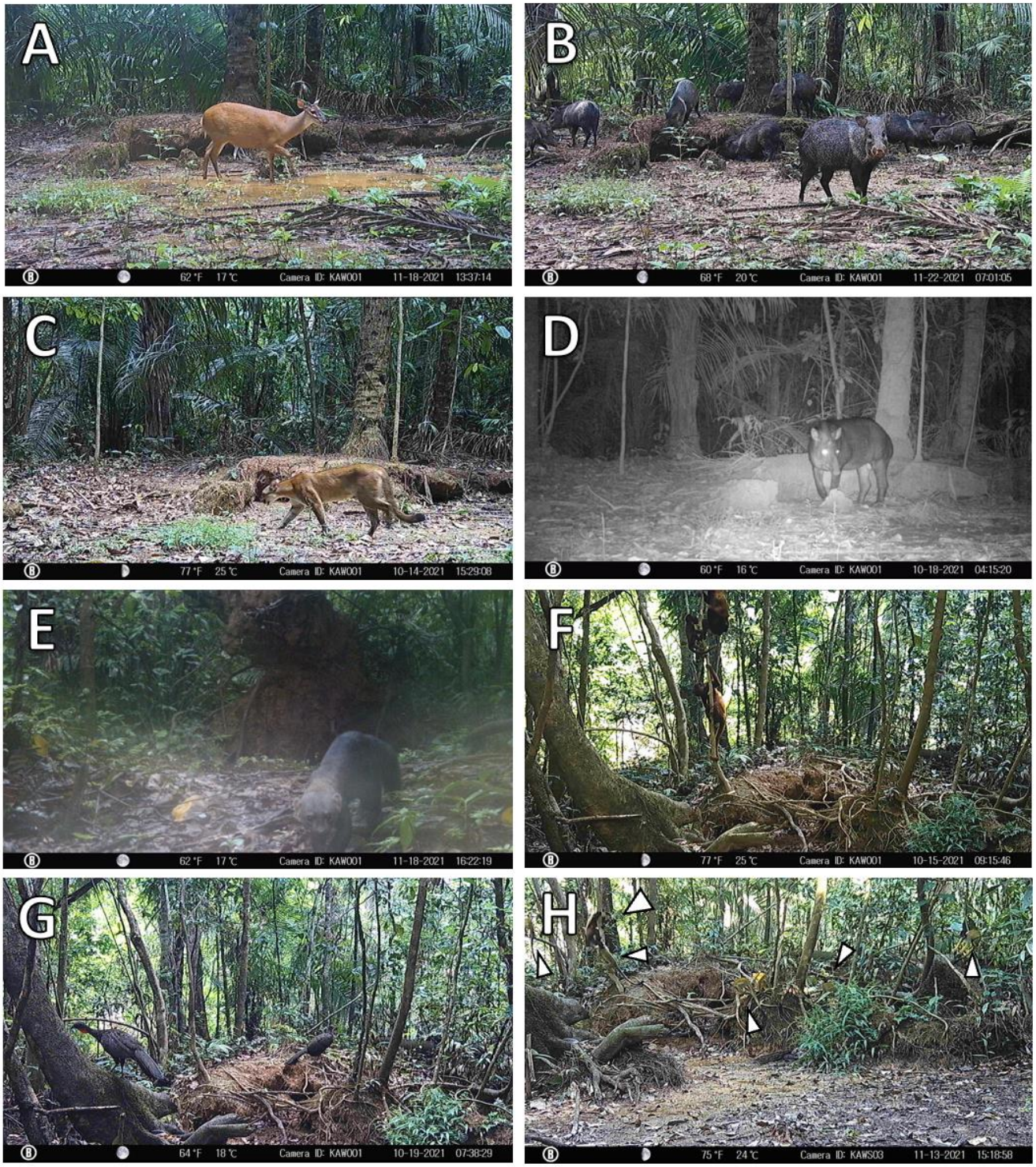

Figure 7: Selected species caught on camera by traps near clay licks. (A-D) collpa grande, (E) collpa arból (F-H) collpa altura. (A) Red brocket deer, *Mazama americana* (B) a group of Collared peccary, *Pecari tajac*u (C) Puma, *Puma concolor* (D) Tapir, *Tapirus terrestris* (E) Tayra, *Eira barbara* (F) Howler monkey family, *Alouatta sara* (G) two Spix's Guan, *Penelope jacquacu* (H) mixed species troupe of capuchin monkey (*Sapajus spec*., big arrow) and squirrel monkeys (*Saimiri boliviana*, small arrows)

A species inventory for terrestrial and arboreal amphibs and reptiles has been generated using herpetology transects

Using herpetology transects and pitfall traps a total of 27 amphib and 25 reptile species have been captured, identified and photographed over the course of 7 weeks and identification plates were successfully assembled by Juan Daniel Valencia.

An accumulation curve as shown in Figure 8 allows a rough approximation of the true species number that can be found in these habitats using these sampling methods, as these over time will reach a plateau that asymptotically approaches the true species number. While the cumulative number of species found is flattening, further sampling and using different sampling methods might reveal more species in the area in the future. The pitfall traps especially have been under-utilized during this time and the transects might underestimate species that are hard to see or catch, prefer to stay higher up in trees or stay hidden below ground.

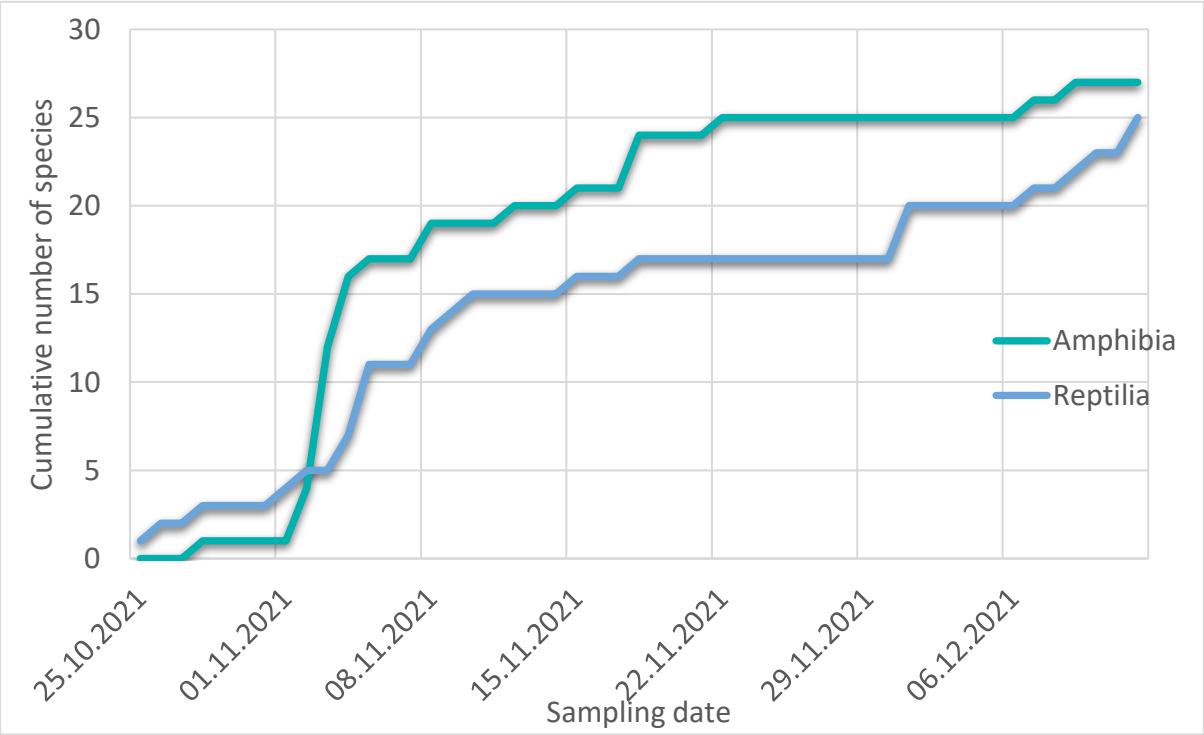

Figure 8: Accumulation curve showing the number of species of terrestrial and arboreal amphibs and reptiles found over time utilizing herpetology transects and pitfall traps.

Tree and shrub phenology transects might give insight into seasonal fruit availabilty

On one of four dedicated trails per week the occurrence of woody plants that are currently flowering, fruiting or shedding seeds has been assessed. A species list of plants that have been able to be identified can be found in table 1 (only including transects I had been involved in).

The identified species only represent a small subset of actual species in flowering and fruiting stages, as many species were not able to be identified. Identification met many challenges, beginning by finding the corresponding tree when fruits and flowers had been found on the trail and the crown is heavily obscured by other vegetation. When trees had been found, accessing the foliage had been the next difficulty so that only some characteristics like production of latex and odor of fresh cuts could be collected, while leaf features in many cases could only be recorded by pictures taken from afar. Odor is supposed to be an invaluable feature in identifying tree species but requires some training and prior experience to be used reliably. As no identification key could be taken into the jungle without risking water damage to books or technical equipment, the collection of potentially identifying features in the field using binoculars had to be somewhat arbitrary and features as needed by the key later inferred from pictures on station. Furthermore, many fruits and flowers were found in immature stages when identifying features might be hard to see, which was a problem for species e.g. belonging to the large Annonaceae family, whose immature fruits and flower buds often look very similar.

The vegetation cover at Kawsay belongs to a seasonally flooded subtropical wet lowland forest according to the Holdridge Life Zones classification. Some of the most commonly identified species include *Leonia crassa, Theobroma cacao, Sorocea pileata, Lecointea peruviana* and *Ruizodondron spec..*

A number of fruits found, such as from *Eugenia uniflora*, *Anomospermum spec.* and *Pouteria procera* are human-edible (and palatable) and may play a role in the diet of spider monkeys and other animals (Figure 9). The seeds of *Licania britteniana* especially have been found frequently with the surrounding fruit freshly consumed by some arboreal mammal. *Garcinia madruno* fruits have been observed to be consumed by *Ateles chamek*. A continuation of phenology transects throughout the seasons might give insight into the seasonal availability and distribution of such food sources. Release of spider monkey groups usually happen around November at the beginning of the wet season when fruit availability is expected to be highest within their first weeks and months to ease their adaptation to self-sustainment.

Figure 9: Some found fruits might be relevant for diet of spider monkeys. (A) *Pouteria procera* (B) *Clarisia racemosa* (C) *Manilkara inundata* (D) *Anomospermum spec.* (E) *Eugenia uniflora* (F) fleshy red fruit, unidentified (G) *Licania britteniana* (H) *Garcinia madruno*

Table 1: Species list of woody plants found flowering, fruiting or shedding seeds, per transect week

Family	Species	Habitus	Flower	Fruit	Seed	Trail	Date
Moraceae	Clarisia racemosa	A		X		F4 (U)	26.10.2021
Arecaceae	Oenocarpus spec.	P		X		F4 (U)	26.10.2021
Annonaceae	Ruizodendron spec.	A		X		F4 (U)	26.10.2021
Arecaceae	Attalea spec.	P		X	X	F4 (U)	26.10.2021
Combretaceae	Combretum spec.	A		X	X	F4 (U)	26.10.2021
Moraceae	Sorocea pileata	A	X			F4 (U)	26.10.2021
Violaceae	Leonia crassa	A	X	X		F4 (U)	26.10.2021
Moraceae	Poulsenia armata	A	X			F4 (U)	26.10.2021
Fabaceae	Stryphnodendron spec.	A		X		F4 (U)	26.10.2021
Malvaceae	Theobroma cacao	A	X	X		F4 (U)	28.10.2021
Fabaceae	Dypterix ferrea	A	X			F4 (U)	28.10.2021
Salicaceae	Hasseltia floribunda	a		X		F4 (U)	28.10.2021
Moraceae	Brosimum lactescens	A		X		F4 (U)	28.10.2021
Myristicaceae	Iryanthera spec.	A		X		F4 (U)	28.10.2021
Myrtaceae	*Eugenia uniflora*	A		X		F3 (D)	15.11.2021
Moraceae	*Pseudolmedia laevis*	A		X		F3 (D)	15.11.2021
Moraceae	*Sorocea pileata*	A	X			F3 (D)	15.11.2021
Meliaceae	*Trichilia quadrijuga*	A		X		F3 (D)	15.11.2021
Rubiaceae	*Faramea multiflora*	a	X			F3 (D)	15.11.2021
Chrysobalanaceae	*Liconia britteniana*	A		X	X	F3 (D)	15.11.2021
Violaceae	*Leonia crassa*	A		X		F3 (D)	15.11.2021
Sapotaceae	*Pouteria procera*	A		X		F3 (D)	15.11.2021
Menispermaceae	*Anomospermum spec.*	A		X		F3 (D)	15.11.2021
Arecaceae	*Socratea exorrhiza*	P		X		F3 (D)	15.11.2021
Arecaceae	*Euterpe precatoria*	P		X		F3 (D)	15.11.2021
Salicaceae	*Hasseltia floribunda*	A		X		F3 (D)	15.11.2021
Malvaceae	*Theobroma cacao*	A	X			F3 (D)	15.11.2021

Moraceae	*Sorocea pileata*	A		X		F3 (D)	15.11.2021
Myristicaceae	*Iryanthera spec.*	A		X		F3 (D)	15.11.2021
Malvaceae	*Matisia spec.*	A	X			F3 (D)	16.11.2021
Annonaceae	*Anaxagorea spec.*	A	X			F3 (D)	16.11.2021
Arecaceae	*Oenocarpus spec.*	P		X		F3 (D)	16.11.2021
Polygonaceae	*Triplaris poeppigia*	A			X	F3 (D)	16.11.2021
Malvaceae	*Pachira aquatica*	A	X			F3 (D)	16.11.2021
Annonacea	*Ruizodendron ovale*	P		X	X	F4 (U)	22.11.2021
Moraceae	*Sorocea pileata*	P	X			F4 (U)	22.11.2021
Malvaceae	*Matisia spec.*	A	X			F4 (U)	22.11.2021
Violaceae	*Leonia crassa*	A		X		F4 (U)	22.11.2021
Chrysobalanaceae	*Hirtella racemosa*	a		X		F4 (U)	22.11.2021
Chrysobalanaceae	*Licania britteniana*	A			X	F4 (U)	22.11.2021
Meliaceae	*Trichilia spec.*	A	X			F4 (U)	22.11.2021
Malvaceae	*Theobroma cacao*	A		X		F4 (U)	22.11.2021
Arecaceae	*Phytelophos macrocarpa*	A			X	F4 (U)	22.11.2021
Nyctaginaceae	*Neea spec.*	A		X		F4 (U)	24.11.2021
Achariaceae	*Carpotroche longifolia*	A		X		F4 (U)	24.11.2021
Euphorbiaceae	*Acalypha spec.*	a	X			F4 (U)	24.11.2021
Boraginaceae	*Cordia nodosa*	a		X		F4 (U)	24.11.2021
Arecaceae	*Euterpe spec.*	P		X		F4 (U)	24.11.2021
Fabaceae	*Inga spec.*	A			X	F1 (MT)	29.11.2021
Annonaceae	*Ruizodendron ovale*	A		X		F1 (MT)	29.11.2021
Chrysobalanaceae	*Licania britteniana*	A		X		F1 (MT)	29.11.2021
Burseraceae	*Tetragastris panamensis*	A		X		F1 (MT)	29.11.2021
Malvaceae	*Matisia spec.*	A	X			F1 (MT)	29.11.2021
Violaceae	*Leonia crassa*	A		X		F1 (MT)	29.11.2021
Sapotaceae	*Pouteria procera*	A		X		F1 (MT)	29.11.2021
Cannabaceae	*Celtis schippii*	A		X		F1 (MT)	29.11.2021

Moraceae	*Sorocea pileata*	A	X			F1 (MT)	29.11.2021
Urticaceae	*Coussapoa spec.*	A		X		F1 (MT)	29.11.2021
Arecaceae	*Euterpe spec.*	P		X		F1 (MT)	29.11.2021
Malvaceae	*Theobroma cacao*	A		X		F1 (MT)	30.11.2021
Sapindaceae	*Talisia spec.*	A		X		F1 (MT)	30.11.2021
Moraceae	*Ficus coerulescens*	A		X		F1 (MT)	30.11.2021
Malvaceae	*Matisia spec.*	A	X			F1 (MT)	30.11.2021
Moraceae	*Naucleopsis spec.*	a		X		F1 (MT)	30.11.2021
Meliaceae	*Trichilia pleeana*	A		X		F1 (MT)	30.11.2021
Calophyllaceae	*Caraipa spec.*	A		X		F1 (MT)	30.11.2021
Lecythidaceae	*Couroupita spec.*	A	X			F1 (MT)	30.11.2021
Fabaceae	*Lecointea peruviana*	A		X		F1 (MT)	30.11.2021
Moraceae	*Brosimum lactescens*	A		X		F1 (MT)	30.11.2021
Sapotaceae	*Manilkara inundata*	A		X		F2 (V)	06.12.2021
Moraceae	*Sorocea pileata*	A		X		F2 (V)	06.12.2021
Violaceae	*Leonia crassa*	A		X		F2 (V)	06.12.2021
Malvaceae	*Matisia spec.*	A	X			F2 (V)	06.12.2021
Fabaceae	*Lecointea peruviana*	A		X		F2 (V)	06.12.2021
Annonaceae	*Anaxagorea spec.*	a	X			F2 (V)	06.12.2021
Arecaceae	*Socratea exorrhiza*	A		X	X	F2 (V)	06.12.2021
Meliaceae	*Trichilia maynasiana*	a		X		F2 (V)	06.12.2021
Rubiaceae	*Faramea multiflora*	a	X			F2 (V)	06.12.2021
Moraceae	*Brosimum lactescens*	A		X		F2 (V)	06.12.2021
Malvaceae	*Theobroma cacao*	A		X		F2 (V)	06.12.2021
Chrysobalanaceae	*Licania britteniana*	A		X		F2 (V)	06.12.2021
Nyctaginaceae	*Neea spec.*	A		X		F2 (V)	06.12.2021
Moraceae	*Ficus insipida*	A		X		F2 (V)	06.12.2021
Moraceae	*Ficus paraensis*	A		X		F2 (V)	06.12.2021
Tiliaceae	*Apeiba membranacea*	A	X	X		F2 (V)	06.12.2021
Arecaceae	*Euterpe precatoria*	A			X	F2 (V)	06.12.2021

Menispermaceae	*Anomospermum spec.*	A	X	F2 (V)	06.12.2021
Sapindaceae	*Talisia spec.*	A	X	F2 (V)	06.12.2021
Myristicaceae	*Iryanthera spec.*	A	X	F2 (V)	06.12.2021
Moraceae	*Batocarpus spec.*	A	X	F2 (V)	06.12.2021
Malvaceae	*Theobroma speciosum*	A	X	F2 (V)	06.12.2021
Achariaceae	*Carpotroche longifolia*	A	X	F2 (V)	06.12.2021

Habitus: A = arból (tree), a = arbusto (shrub), P = palmera (palm)

An updated map has been generated

As a personal pet side-project an updated map has been generated (Figure 10) using GPS tracking to georeference the new trails. It includes the more recently established trails U, T, S, LIN and Chato as well as the locations of the vegetation plots ("parcela"), phenology transects, and pitfall trap transects.

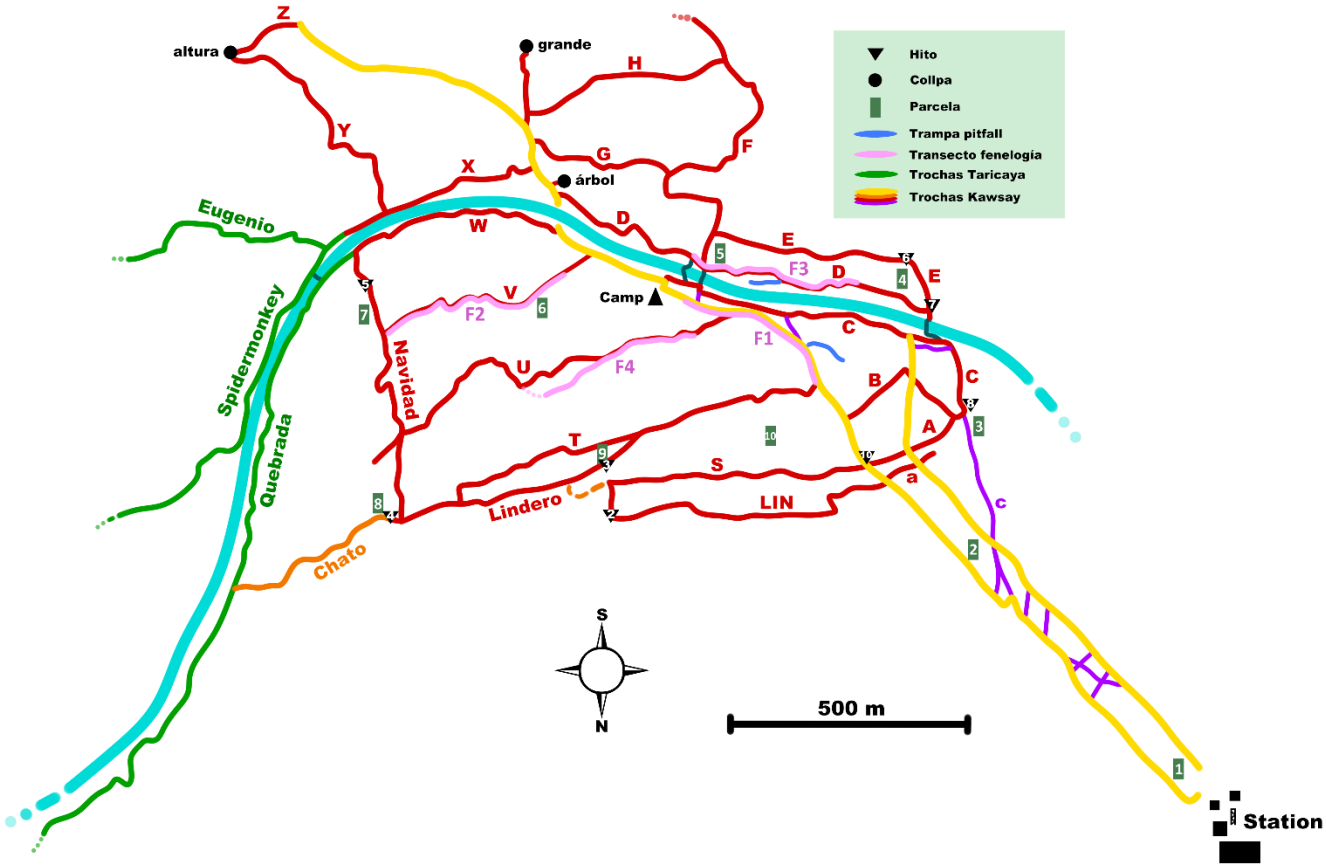

Figure 10: Updated map including newly established trails

Kawsays research activity provides a protected area for the release and re-naturalization of spider monkeys

Kawsay Biological Station offers an interesting and valuable framework for students and scientists to learn and conduct research. At its core Kawsay acts mainly as a learning opportunity for students and volunteers of various nationalities and backgrounds as well as local people to learn about the rainforest, its flora and fauna, the spider monkeys and methods used in conservational research, accumulating data along the way. The scientific value of the work done at Kawsay will greatly depend on further scientists coming in and creating focused projects utilizing the work force of the cast of students and volunteers and analyzing accumulated data.

A valuable aspect of the Kawsay Station and the continuous activity by volunteers and researchers within the concession is the inherent protection of the area. Illegal extraction of gold and timber is a major issue in parts of the forest that may be protected on paper, but where protection cannot be enforced, resulting in subsequent withdrawal of the protection status. This can be seen in various parts throughout Madre de Dios region (Figure 11)[13].

Conservation and ecotourisms concessions in private hands like Kawsay and Taricaya that result in human presence while aiming for a sustainable use of the land provide a protection of land where government alone is not able to or does not care enough to ensure protection, while on the same time creating a sizeable source of income for the local population that does not rely on destructive methods [14]. Continuous and enforced protection of the area will be essential for the long-term success of the vulnerable budding population of spider monkeys introduced by the reintroduction program.

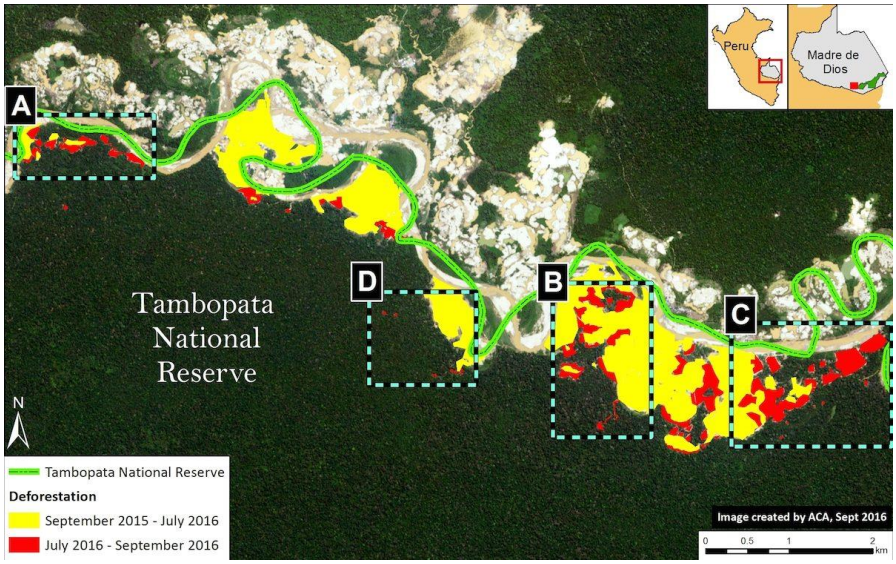

Figure 11: Illegal gold mining activity encroaches onto legally protected land of the Tambopata National Reserve leading to rapid and irreversible habitat loss. Figure by MAAP [13].

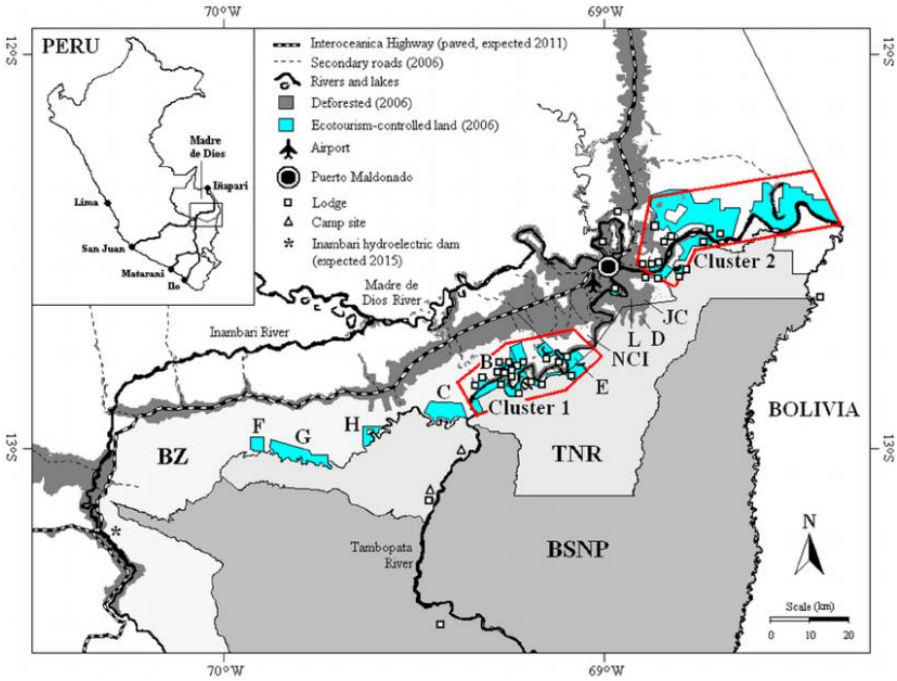

Figure 12: Privately funded sustainable land use and protection in the form of ecotourism create a barrier for habitat destruction and provide a valuable local source of income. TNR = Tambopata National Reserve. Kawsay and Taricaya can be found in Cluster 2. Figure by Kirkby et al. 2010 [14].

The monitoring of the spider monkeys is a major concern for Kawsay. Unfortunately, the current lack of tracking capabilities and reliance on the monkeys to react to human call-outs means a lot of time and effort is spent locating the animals. As the monkeys progressively become more and more unattached to humans the likelihood of them responding decreases, which is a good sign for their re-naturalization, but also results in many trips into the jungle ending up not being able to sight them or only for short periods of time, leading to very little potential data output for time spent, which has inhibited a number of projects focusing on them in the past.

Utilization of remote-accessible GPS tracking collars are attempted for current and future releases, but these technologies are expensive and a lack of funding has been a frequent bottleneck in the past.

Nonetheless, despite inefficiencies in locating the animals, a continuation of monitoring efforts is invaluable for the long-term success of the reintroduction program, as could be demonstrated by Sam Pottie [3].

Several fecal samples were able to be obtained while encountering the monkeys, which may assist future genetic studies. Behavioral studies like the sleeping trees project and further studies of the social dynamics might provide insights into the habitat needs of *Ateles chamek* and thus might help define and shape coming conservation efforts.

Personal conclusion and thanks

On a personal level the time spent at Kawsay has been a very intense, valuable and cherished experience by gaining more first-hand field work experience with methods I had not been familiar before, getting to know the unique ecosystem of the Amazon rainforest a little better, learning the ins-and-outs and challenges of conservational efforts as well as experience to live simple and sustainably amidst the rainforest.

I want to congratulate and thank Raul Bello for his efforts in creating this kind of research and education environment and his efforts towards the preservation of the spider monkeys, without which the reintroduction successes could not persist. I also want to thank Julie Van den Broeck and Juan Daniel Valencia for shaping a large part of my activities and teaching me valuable lessons in plant and herpetology research, respectively. More thanks go to the other volunteers and interns that shared this experience with me and made living in the jungle fun and memorable.

Links

https://www.kawsaycenterperu.org/

https://www.taricayaecoreserve.org/about-us/

https://www.youtube.com/watch?v=HTOKi80nkEQ

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