

Project Update: October 2021

Just to recap, the major aim of our project was to take the first steps towards standardised monitoring and an integrated management plan for the Selva Maya by training and equipping personnel from the local environmental authority (National Commission of Protected Areas - CONAP) operating in El-Mirador National Park (MNP) in Guatemala to conduct their own monitoring project using methodology already being used in Calakmul Biosphere Reserve (CBR) in Mexico by Operation Wallacea.

The project had two main components, with the first envisioned to occur in MNP-Guatemala in late April 2021 and the second in CBR-Mexico in early August 2021. From our end, we were ready to advance with the first component on time, but unfortunately a sudden rise in COVID-19 cases in Guatemala (due to a relaxation of restrictions during their Semana Santa festivities in late March 2021) resulted in a rapid reestablishment of severe lockdown measures across the country. This meant that most of our participants from both Mexico and Guatemala were unable to travel and/or were no longer allowed by their institutions to participate in the event. We were then forced to cancel this Guatemala section and postpone it to 2022 (the reasoning to why explained below).

As for the second component we were again ready to advance, and watchfully monitored all relevant developments and indications on both sides of the border that could again disrupt our plans. However, this time fortune was in our side, and we were able to carry out the event as planned. I am then proud to report that between August 2nd – 7th 2021 we were able to take the first steps towards standardised monitoring and an integrated management plan for the Selva Maya. During this week we were able to bring together representatives (including university academics, biologists, field technicians, reserve directors and park-wardens) from most institutions actively operating in the Guatemalan and Mexican portion of the Selva Maya. It was a very exciting and productive week regarding knowledge exchange and round table discussions where many have resulted in new collaborative efforts between different institutions. From the Guatemalan side, it was my great pleasure to hear their feedback, namely from the park wardens that have joined us and are now keen to take what they learned and apply it to their reserve management. I have attached some photos taken during the week to illustrate different aspects of the week. I have also attached the PDF distributed to participants prior to arrival overviewing what to expect (translated into English).

In summary, due to not being able to run the session in Guatemala our plans were reversed (i.e., the second component in Mexico became the first) and now the second component will be in Guatemala around March-April 2022. After this first event in Mexico, all parties involved are now very excited for this next event (See below).

The reason to why postponement is to 2022 and not still this year is because we are now in the height of rainy season and so most of the Selva Maya is flooded and inaccessible making field work impossible. Moreover, the specific travel route from CBR to MNP outlined in our project proposal is only possible during dry season. I would like to highlight that so far, we have only spent the grant money allocated to the Mexican component of the project, so financially we have no problem completing the Guatemalan section as planned. Therefore, even though there were no financial reasons to why we could not follow through with the project still in 2021, for logistical

reasons it is not possible until the flooding has subsided, and this will take us up to February 2022.

Selva Maya Monitoring Exchange I: Exchange of information and development of standardized methods for monitoring biodiversity in the Selva Maya

Goals and objectives of the course

The objective of this training course is threefold. First, the course aims to open the dialogue between all the main actors of existing biodiversity monitoring projects and the scope of standardisation and collaboration for the long-term monitoring of reserves in the Mayan jungle. Second, the course aims to develop a unique method to unite existing water body monitoring projects and obtain data on water levels, the characteristics of the vegetation of the aguadas, records of herpetofauna (sightings), felines and ungulates. (footprints) around aguadas, records of mammals and large land birds that visit the aguadas (camera traps) and abundance of primates (sightings) along the access trails to the aguadas. Third, the course aims to conclude with an agreement on standardised monitoring protocols that can be used simultaneously for data collection in Selva Maya reserves starting in 2022. Fourth, the course aims to investigate the subject of bio-acoustic studies for monitoring birds, amphibians and bats and the possibilities of installing SM4 recorders for gougues to include birds and bats in gouge monitoring.

The main objectives of the course are:

1. Provide an exchange of information on existing monitoring projects in CBR and PNM-RA, including details of the methods used for data collection and the results generated so far.
2. Train course participants in two existing mobile applications for collecting biodiversity data: Epicollect 5 and SMART. Provide practice data collection sessions using both applications to assess the pros and cons of each and then collectively decide the most appropriate standardised use for each application for continuous monitoring in CBR and PNM-RA.
3. Take advantage of the existing standardised monitoring of aguadas and felines and ungulates that use aguadas in CBR and PNM-RA to include follow-up studies of felines and ungulates in aguadas to complement existing camera trap data and include timed searches for herpetofauna during visits to aguadas to change SD cards and batteries for camera traps.
4. Examine existing trail systems to and from aguadas to identify established transects for monitoring primates as they travel to or from aguadas for existing monitoring.
5. Provide training and investigate possibilities to include bio-acoustic monitoring of birds and bats by the waterways.
6. Provide training in vegetation survey methods that could be added to continuous monitoring along transects, in aguadas, or at camera trap stations (as part of jaguar monitoring) to allow investigation of wildlife habitat preferences.
7. Carry out a series of discussions to determine the best standardised monitoring protocols, with data collection on aguadas, herpetofauna, primates, felines, ungulates and habitat studies in multiple reserves in the Selva Maya and the use of mobile applications for such monitoring.

Participants from Mexico

Operation Wallacea: OW

Comisión Nacional de Áreas Naturales Protegidas: CONANP

Reservas Estatales Balam-Ku y Balam-Kim: BK

Pronatura Península de Yucatán: PPY
El Colegio de la Frontera Sur: ECOSUR
Universidad Autónoma de Campeche: UAC
World Wildlife Fund: WWF

Participants from Guatemala

Comisión Nacional de Áreas Protegidas: CONAP
FUNDAEDO: FE
Centro de Estudios Conservacionistas, Universidad de San Carlos de Guatemala: CECON-USAC
Wildlife Conservation Society: WCS

Methods

Design of the investigation

The first Selva Maya monitoring exchange will be located in the Calakmul Biosphere Reserve (RBC) in the state of Campeche, Mexico. The participants of the exchange are personnel from the RBC, Balam Ku and Balam Kim reserves in Mexico and from the Mirador - Rio Azul National Park in Guatemala and NGOs and academics who manage monitoring projects in said reserves. The monitoring project carried out by OW and PPY in the RBC is being carried out in five locations: Km20, Zona Núcleo Sur, Mancolona, Hormiguero and Dos Naciones (Figure 1). Four of the five locations have associated camps, and the South Core Zone is accessed by vehicle from Km20. Each camp has four 2 km long transect lines for data collection that are marked with marker tape every 50 and the GPS location of the entire transect is recorded on Garmin GPS units. The 2021 Selva Maya Monitoring Exchange will be based on the KM20 camp, which will allow the collection of data in the four transects and aguadas in this place and the four transects and aguadas in ZNS that are accessed by vehicle.

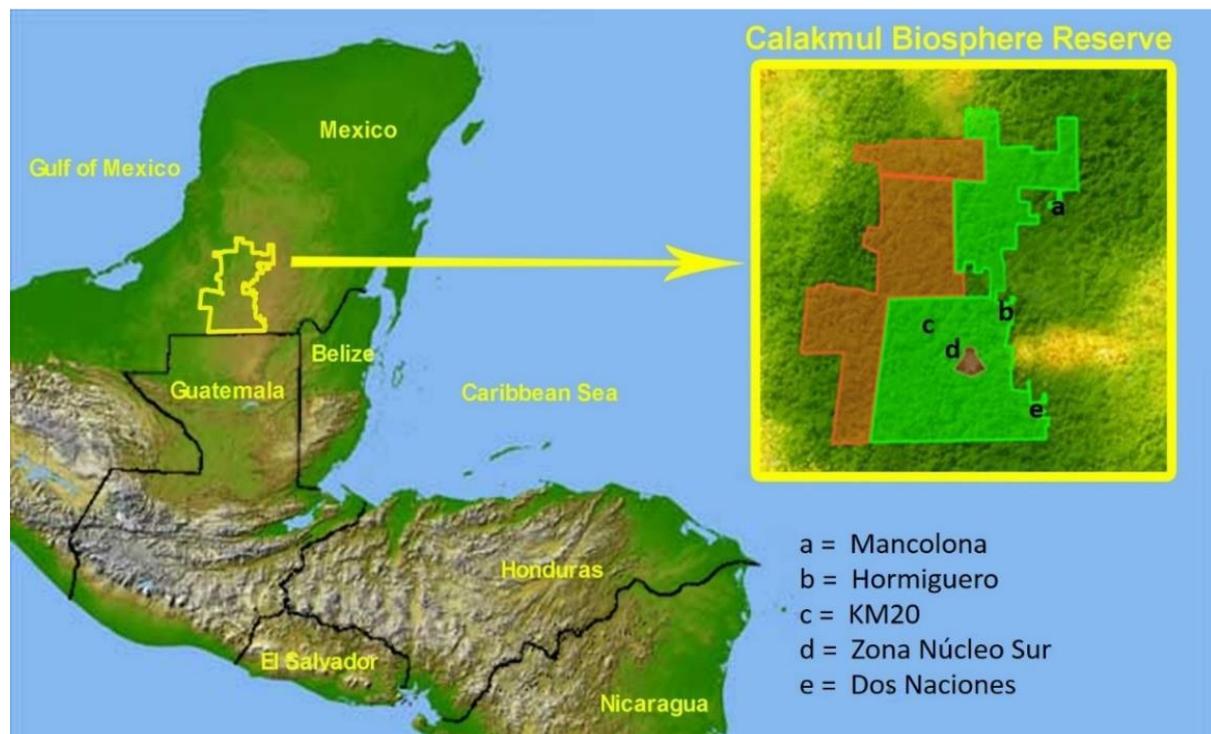


Figure 1: Operation Wallacea research locations in the Calakmul Biosphere Reserve

Exchange of information on monitoring projects in the Selva Maya

The first part of the course aims to exchange information on existing biodiversity monitoring projects in BK, RBC and PNM-RA, the methods they use and the results they have generated so far. Operation Wallacea will provide information on the ongoing monitoring project at RBC in collaboration with PPY and CONANP. CONANP and ECOSUR will provide information on continuous monitoring of aguadas, and associated aguada restoration methods and drought mitigation strategies used in CBR. ECOSUR, and WCS and CONAP and FUNDAECO will provide information on the continuous monitoring of aguadas in PNMRA. WWF CONANP and WCS will provide information on the collaborative jaguar monitoring project at the RBC and PNM-RA. CONAP FUNDAECO and collaborating academic institutions will provide information on other existing monitoring projects in the PNM-RA.

Exchange of monitoring and data collection methods with the Epicollect and SMART applications

The demonstration of the Epicollect 5 mobile app for data collection will consist of an introductory session from Operation Wallacea in which we will introduce the system, explain how it works, and provide examples and practical demonstrations of its many applications for data collection in the field. The application will also be used to demonstrate data collection in the field, during all practical activities (e.g., visits to aguadas), so that participants can experience how the system works during the samplings. For those interested in having the application on their phone for independent practical use throughout the course (i.e., without having to share devices), instructions on how to download the application and data collection forms will be sent before the course begins.

The demonstration of the SMART mobile application for data collection will consist of an introductory session of CONAP / FUNDAECO in the same format and the introductory session of Epicollect given by Operation Wallacea. The SMART app will be used in a similar way during hands-on activities (for example, visits to aguadas) to allow comparison of both applications and their suitability for use in monitoring the biodiversity of felines, ungulates, and herpetofauna in aguadas.

Data collection sessions in order to take advantage of existing monitoring to develop a standardized method for monitoring aguadas, primates, felines, ungulates and herpetofauna.

Another objective of this course is to align existing monitoring methods for aguadas, primates, felines, ungulates, and herpetofauna into a standardised and cost-effective method that can be used across multiple reserves. ECOSUR, WCS, FUNDAECO, CONANP and CONAP already have an ongoing monitoring project for aguadas and felines and ungulates that uses camera trap data for felines and ungulates in relation to water levels in aguadas. OW and PPY have an existing project that involves monitoring herpetofauna in relation to water levels in aguadas, in addition to continuous monitoring of primates, felines, ungulates, and herpetofauna along transects with different distances from aguadas. Consequently, it should be possible to combine these methods to establish established travel routes to and from aguadas to be used as transects to monitor primates in conjunction with monitoring of felines and ungulates (camera trap and footprints) and herpetofauna (timed searches) located in the watered down. The idea is that these combined methods can be incorporated into scheduled visits to aguadas to change batteries and SD cards for camera traps as part of the existing monitoring project.

In addition, standardised floristic inventories can be added to the survey design (to be completed only once a year) at established locations along travel routes to aguadas (i.e., transects), in aguadas, or at locations of camera capture (may or may not match gouache).

Accordingly, the OW will provide details of the methods that we use to monitor waterways, primates, felines, ungulates, and herpetofauna during hands-on sessions in order to learn how to align them with existing methods used by other actors monitoring BK, RBC and PMN-RA. The OW monitoring methods that can be adapted for the new standardised method are:

Watered down

Aguadas should be monitored every year during the dry and wet seasons. Consequently, the monitoring of waterways during this training course will be carried out using the OW cell phone application that provides data for the dry season that can be added to the data collected during June and July 2021 as part of the annual monitoring. For each wash, a photograph will be taken using cell phones and it will be uploaded to the application. The application will use the cell phone's GPS to determine the location of the aguada. For each aguada, the type of water body (small pond, pond or lake), type of surrounding vegetation and predominant flora species, type and % of vegetation cover in the aguada, water depth and presence of herpetofauna and mammals will be recorded.

Amphibians and reptiles

Herpetofauna data will be collected in and around aguadas. Day and night timed records of amphibians, snakes and lizards will be carried out. Nightly crocodile count censuses will be conducted based on counting the glow of the eyes reflected by the torches. Each count will involve walking around the perimeter of the gouache looking for eyes with torch lights. The process will be repeated several times until the final recorded numbers are consistent in separate counts.

For each animal observed, the species will be identified using field guides (Lee, 2000; Kholer, 2008; Mandujano et al., 2010; Cedeño-Vásquez et al., 2010), the GPS location and the distance travelled along the of the transect. along with weather, climatic conditions and habitat type. Whenever possible, the animal will be captured to mark it for recapture (reptile scaling only) and to record additional information before releasing the animal to the same capture location. For each captured animal, sex, age (adult or juvenile), weight (g), animal length (SVL), head length and tail length (were relevant) and coloration (camouflage or aposematic) will be recorded. In addition, the animal will be photographed in situ (back, head and side).

Felines and Ungulates

Although Operation Wallacea has a grid of camera traps in the RBC core area to monitor felids and ungulates, it is not possible to have corresponding camera traps elsewhere in the reserve for financial reasons. Consequently, the cat and ungulate footprint censuses are carried out through a network of 25 transects, each 2 km long transect, in the core and buffer zone of the reserve at different distances from the aguadas to allow the comparison of relative abundance between areas of the reserve and in relation to the distance to waterways.

The remote sampling method is only suitable when the animals are relatively easy to detect and therefore not suitable for monitoring elusive species or species that live naturally at low densities such as the jaguar. Therefore, an additional method will be used to monitor these species known as Track Encounter Rate (TER: Reyna-Hurtado & Tanner, 2007). TER involves the detection of animals based on footprints and feces rather than visual or vocal sightings of the animals. These data will be collected at the same time as the primate censuses. For each track found, the following data will be recorded: species, track length and width, approximate track age (days) and depth of litter.

For the inclusion of TER in the monitoring of watersheds, the number of footprints found per distance walked along the shore of the watershed can be noted using the Epicollect App.

Primates

Primates and large terrestrial mammals will be studied along linear transects (which were placed without any predetermined knowledge of the distribution of the animals: Pérez, 1999). The primates will be studied by remote sampling (Buckland et al., 2001), since they are conspicuous, and the species present in the reserve do not shy away from observers. These data will be collected by walking along the entire transect line in small groups of four to five observers walking silently and slowly (500-1,000 m / h) starting at 06:00, when the primates are most active, and they are easier to detect. Each time a primate is found, the species, whether the animals have been seen or heard, number of individuals (visual sightings only), perpendicular distance from individual to transect line, habitat, time, distance travelled along the transect line and climatic conditions. will be recorded. Although OW does primate monitoring in the mornings, it also works in the afternoons after 4:30 PM.

Other methods for consideration in the standardized monitoring of the Selva Maya

Vegetation

Vegetation studies will be conducted in each of the 20m by 20m lots along the transects (at 200m, 600m, 1000m, 1400m and 1800m) to investigate tree diversity, forest structure, forest health in relation to the number of dead trees and young trees, and to investigate fauna habitat preferences recorded by the same transects. Each tree with a circumference of > 15cm in each lot will carry a numbered tag to document the species, the diameter of the tree at breast height (DBH) will be measured, and whether the tree is dead or alive will be recorded. When the species cannot be identified, photographs of the leaves and / or fruits will be taken for further research with books. If identification is impossible with photographs, the tree will ultimately be sampled for a full examination. The DAP measurement will be taken with 50-meter tapes. For estimates of forest health, dead and living trees will be taken into account, as well as young trees. Therefore, the number of young trees (DBH <15cm, and minimum height of 2m) in each plot will be counted.

Forest structure measurements include canopy vegetation, canopy cover, and litter depth. To measure the vegetation under the canopy, divide the lot into four quadrants. A 3m pole marked every 0.5m will be used to record the times the vegetation touches the pole in each 0.5m segment. The canopy opening will be measured with a "canopy scope" (Hale & Brown, 2005) in the most illuminated part of the canopies from the centre of each quadrant and from the centre of the 20m x 20m

lot. If the centre of the dial coincided with a tree, the reading position will be moved by one meter. The "canopy scope" (Hale & Brown, 2005) that has 25 points marked: the observer has to look up keeping it at a distance of 20 cm from the eye and count the number of points that coincide with the openings in the canopy. The litter depth measurement will be taken in each quadrant and from the centre of the lot to result in five different foliage measurements per lot.

Bio-acoustic monitoring

Bio-acoustic monitoring can complement bird and bat monitoring by nets or replace the use of nets in situations when there is a lack of experienced personnel to operate nets or (specifically for bats) in very remote places where it will be very difficult to get rabies vaccines. In the case of OW, we are beginning to use bio-acoustic studies for birds and bats to complement network studies for several reasons. In the case of birds, nets can only monitor understory birds so since 2012, we have done bird monitoring by nets and by point counts. Counts per point implies recording all the birds that can be heard for periods of 10 minutes by a series of points for each transect (in the RBC it will be every 200m for the length of the transects). The method requires a lot of experience in identifying bird songs. For which, OW has started to record the songs with Rhode microphones and Tascam DR40 recorders to be able to do the identification later. OW is building a library of bird songs on the RBC to "train" Kaleidoscope's software to identify the songs, so that in the future it will be nothing more than a matter of recording the songs and uploading them to the Kaleidoscope for identification. The same strategy can work using SM4 recorders and fixed points (e.g., by gouges).

The subject of bio-acoustic studies for bats is a bit more complicated because you cannot hear the vocalisations to identify them. Acoustic recorders will be used at the fog net locations to allow the collection of additional data on insectivorous species that are unlikely to be captured during fog net surveys. Then the identification of the recordings can start with Kaleidoscope Pro (not the free version) to do based on "cluster analysis" where all similar recordings are joined to help with the identification and remove other noises such as insects. Using the "auto-ID" function Kaleidoscope can try to identify the species, but it makes many mistakes and for which it is necessary to have academic collaboration with scientists with experience in identifying the recordings.

Additional Monitoring as part of the Selva Maya Monitoring Exchange

Bats

Bat fog net censuses will be conducted 6 nights per week at each research camp using a suitable existing clearing along each of the four 2 km sampling routes near one of the habitat plots with sufficient space. to erect five fog nets 6 m long and 2.5 m high. The location of each site in the fog net will be marked and the GPS location will be recorded to ensure that repeat surveys are conducted at the same location. The fog nets will take place between 6:00 p.m. and 1:00 a.m., but since data collection can be affected by rain, the exact opening and closing time of the networks will be recorded in each session. The nets will be checked every 15-20 minutes for the first 3 hours of sampling and every 30 minutes for the last three. All bats will be extracted from the nets following standardised protocols to minimize stress and will be kept in capture bags for a maximum of 30 min. This time will vary according to the size of the bat and the sex; Pregnant females will be measured and released. The

bats will be weighed, sexed, reproductive status, forearm, foot and leg length will be measured. Bat species will be identified using relevant field guides (e.g., Reid, 2009).

Behaviour of Primates

The Central American spider monkey (*Ateles geoffroyi*) is in danger of extinction and requires large areas of primary forest with high fruit production to sustain them. Monitoring of primates by transects should produce data necessary to make calculations of density of primates (number of individuals per km²) using the DISTANCE method. Although this method works well for howler monkeys, there is evidence that it has limitations for the spider monkey due to the dynamics of fission-fusion social systems and their very fast movements (Spaan et al., 2017). In addition, in Calakmul, the distribution of monkeys is very particular with areas of many monkeys, areas with none, and nothing in between! Consequently, it is possible to understand more about the abundance and distribution of spider monkeys with information on the characteristics of known groups (number of adults and juveniles, males and females, etc.), their movements and territory, diet and habitat preferences, and social interactions. Since 2013, OW has studied the same spider monkey troop collecting behavioural data and how it changes in relation to water and fruit availability each year. Data collection is with "Sampling of instantaneous scans" (Altman, 1974) for 10-minute intervals noting the behaviour of each individual (resting, moving, eating, socializing or watching), the type of forest (low, medium, high), GPS location and subgroup composition (number of adult males, adult females, juveniles and creas). All cases of social interactions will be noted using "sampling of all occurrences" (Altman 1974) noting the actors, type of interaction and context in which it occurred.

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Appendix A: First Maya Forest Monitoring Exchange Program

Note: Primate activities can be in the morning or afternoon depending on the movements of the monkeys. Vegetation studies can be in the morning or afternoon so the schedule for this activity depends on the movements of the monkeys

Sunday	Morning	Participants from Guatemala travel from PMN-RA to Xpujil via Arroyo Negro
	Midday	RBC personnel pick them up from Arroyo Negro for the transfer to Xpujil where they spend the night in hotel Balam
	Evening	Dinner at the Balam hotel
Monday	Morning	Breakfast and transfer from Hotel Balam to KM20 (arrival at KM20 at noon). Other participants travel to KM20 to arrive at noon
	Midday	OW / PPY Presentation: Biodiversity Monitoring in CBR: Project Designs and Key Results of Monitoring Since 2012 ECOSUR / CONANP / WCS / CONAP / FUNDAECO Presentation: Monitoring of waters and fauna in the BK, RBC and PNM-RA WWF / CONANP / WCS Presentation: Monitoring of jaguars and ungulates in RBC PNMRA Dundeco / UCAS CECON / CONAP Presentation: Other monitoring projects in PNM-RA and the use of the SMART App
	Evening	OW Workshop: Epicollect application for monitoring waterways and fauna Divide into 3 groups to rotate by activities in the next 3 days
Tuesday	Morning	Group A: Epicollect App for monitoring waterways (water levels, vegetation, herpetofauna sightings and mammal tracks) Group B: Transects and behaviour of primates or habitat lots

		Group C: Bioacoustics studies using Kaleidoscope
	Midday	Group A: Epicollect App Data Review Group B: Lots of habitat or transects and behaviour of primates Group C: Bio-acoustic studies of birds
	Evening	Group A: Monitoring of crocodiles and herpetofauna by aguadas Group B: Review of primate and habitat data Group C: Monitoring of bats by networks
Wednesday	Morning	Group A: Transects and primate behaviour or habitat Group B: Bio-acoustic studies using Kaleidoscope Group C: Epicollect App for monitoring water sources (water levels, vegetation, herpetofauna sightings and mammal tracks)
	Midday	Group A: Lots of habitat or transects and behaviour of primates Group B: Bio-acoustic studies of birds Group C: Epicollect App Data Review
	Evening	Group A: Review of primates and habitat data Group B: Monitoring of bats by networks Group C: Monitoring of crocodiles and herpetofauna by aguadas
Thursday	Morning	Group A: Bioacoustics studies using Kaleidoscope Group B: Epicollect App for monitoring waterways (water levels, vegetation, herpetofauna sightings and mammal tracks) Group C: Transects and behaviour of primates or habitat
	Midday	Group A: Bioacoustics studies of birds Group B: Lots of habitat or transects and behaviour of primates Group C: Review of data App Epicollect
	Evening	Group A: Monitoring of bats by networks Group B: Review of data App Epicollect Group C: Monitoring of crocodiles and herpetofauna by aguadas
Friday	Morning	Group discussion: Collaborations for the standardized monitoring of aguadas, felines, ungulates, primates and herpetofauna in BK, RBC and PNM-RA <ul style="list-style-type: none"> • Share fixed monitoring locations • Options for standardized monitoring of water levels, vegetation and the presence of herpetofauna, felines and ungulates and watered down. • Options for transect studies for primates while walking through the waterways • Online platform for sharing camera trap photos and jaguar IDs • Online platforms for water monitoring data

		<ul style="list-style-type: none"> • Strategy for monitoring using existing effort and money <p>Group discussion: Collaborations to add bio-acoustic monitoring and vegetation studies to standardized BK, RBC and PNM-Ra monitoring</p> <ul style="list-style-type: none"> • Implementation of bio-acoustic studies • Academic collaborations to identify recordings of birds and bats • Implementation of habitat plots by camera traps sites or by transects to aguadas where primates are monitored with the corresponding series of habitat plots to monitor • the abundance and habitat preferences of primates, felines, and • ungulates, and herpetofauna. • • Strategy for new collaborations and to obtain necessary funds to increase standardized monitoring in the Selva Maya
	Midday	Exchange evaluation: what we have learned, the next steps to establish a standardized monitoring in BK, RBC and PNM-RA, review of the proposed content for the second training course in PNM-RA in February / May 2022
	Evening	Closing meeting and dinner
Saturday	Morning	Departure for those traveling to Guatemala