Project Update: August 2022

After about 1 year of field work in the Bacalar region, our project has substantially advanced in many different aspects.

Passive acoustic monitoring in the Bacalar forest

We have been collecting up to 72 hours of acoustic data per month and site at 26 sites surrounding the Bacalar lake. (From the original planned 30 sites, four sites could not be established due to damaged recording equipment.) Sites cover forested areas with different vegetation structure and composition, as well as different types and degrees of anthropogenic pressure and varying distances from the Bacalar lake (Figure 1). Having a broad variety of site conditions is important in order to evaluate how environmental factors such as land cover influence species presence and distribution.

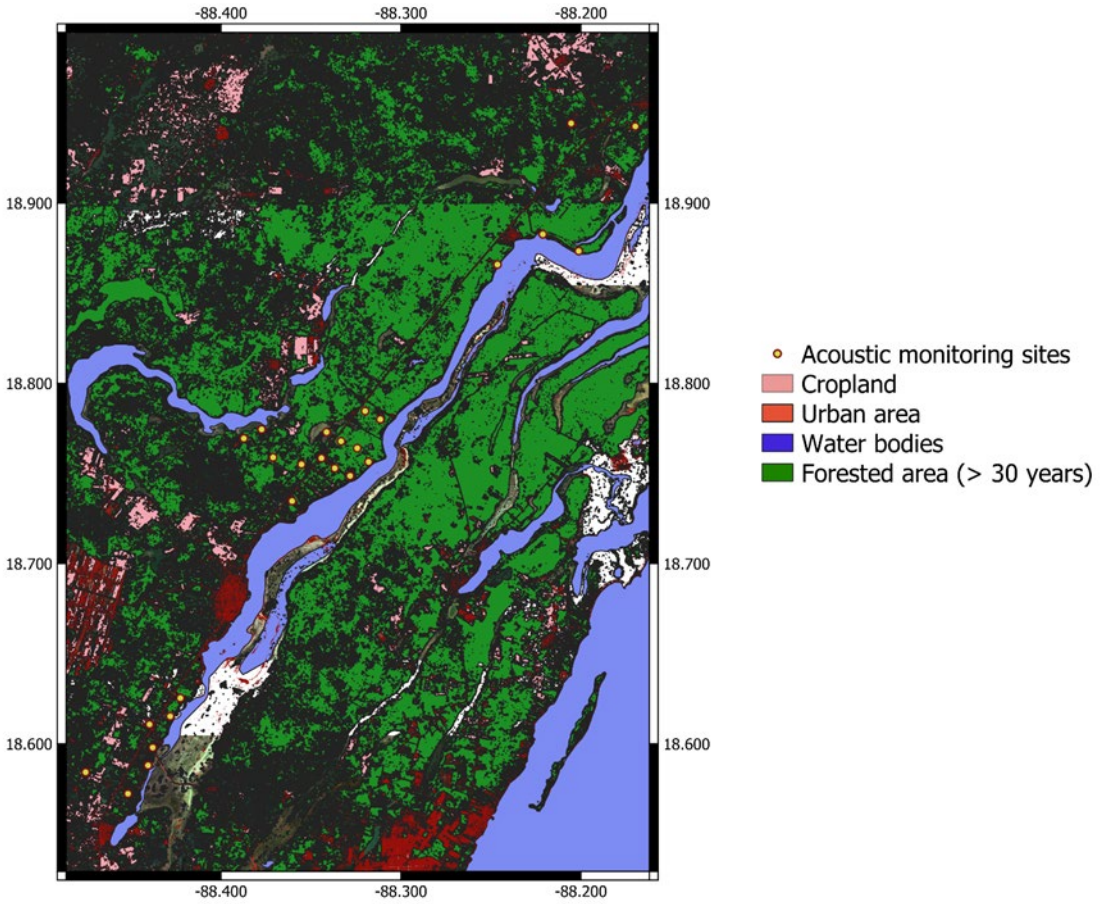

Figure 1. Acoustic monitoring sites distributed across the Bacalar forest and anthropogenic land covers. Sampling locations were not placed randomly but strategically to obtain a high variability of anthropogenic pressure in the surrounding area.

We manually revised a subset of the acoustic data collected during the first months of field work in order to identify species of key conservation concern. From the total of 43 vertebrate species, we identified so far by their vocalisation, 11 are considered species of key conservation concern given that they are either endangered or near threatened according to the IUCN red list or listed as species with special protection status or endangered according to the NOM-059 released by the Mexican Secretariat

of Environment and Natural Resources (SEMARNAT, Table 1). To date, identified taxa include mammals and birds, while we are still in the process of identifying amphibia species (i.e., frogs).

Table 1. List of identified species of key conservation concern from acoustic recordings collected in Bacalar, Mexico, October – November 2021.

Taxon	Common name	Latin name	Justification
Bird	White-eyed Vireo	*Vireo griseus*	LC (IUCN), Threatened (SEMARNAT)
Bird	Yellow-lored Parrot	*Amazona xantholora*	LC (IUCN), Threatened (SEMARNAT)
Bird	White-fronted Parrot	*Amazona albifrons*	LC (IUCN), Special protection status (SEMARNAT)
Bird	Northern Barred Woodcreeper	*Dendrocolaptes sanctithomae*	LC (IUCN), Special protection status (SEMARNAT)
Bird	Gray-headed Tanager	*Eucometis penicillata*	LC (IUCN), Under special protection status (SEMARNAT)
Bird	Collared Aracari	*Pteroglossus torquatus*	LC (IUCN), Special protection status (SEMARNAT)
Bird	Rufous-browed Peppershrike	*Cyclarhis gujanensis*	LC (IUCN), Special protection status (SEMARNAT)
Bird	Olive-throated Parakeet	*Eupsittula nana*	NT (IUCN), Endangered (SEMARNAT)
Bird	Bright-rumped Attila	*Attila spadiceus*	LC (IUCN), Special protection status (SEMARNAT)
Mammal	Geoffroy´s spider monkey	*Ateles geoffroyi*	EN (IUCN), Endangered (SEMARNAT)
Mammal	Black howler monkey	*Alouatta pigra*	EN (IUCN), Endangered (SEMARNAT)

Notes. Species vocalizations were identified with the help of local species experts and available information from open-access databases such as Xeno-canto and BirdNET.

More than 6,400 hours of acoustic data have been uploaded to our Bacalar project at the Arbimon platform (https://arbimon.rfcx.org/) which includes recordings from all sites between October 2021 and February 2022 (upload ongoing). Using the Arbimon platform, we systematically scan recordings for the presence of species of key conservation concern, which so far includes Geoffroy´s spider monkeys, the rufous-browed peppershrike, and the bright-rumped attila. For the same amount of data, we calculated a variety of acoustic indices including indices to estimate biodiversity (ACI, BI, NP) and anthropogenic noise (NDSI) at sites.

Assessment of anthropogenic pressure

In order to assess sources of anthropogenic disturbance around sites, we used a Google Earth Engine algorithm developed by Pinel-Ramos (2022) to determine land cover including urban areas, cropland, and forest areas covered with forest of at least 30 years age (Figure 1). Using a total of more than 120 verification points taken in the field, all three land covers proofed sufficient sensitivity and precision estimates (ranging between 0.71 - 0.98 and 0.8 - 0.96, respectively). By calculating the total area

covered by each land cover in a buffer zone around sites, we will be able to evaluate their impact on species distribution and species richness in the Bacalar region.

Using the Arbimon platform, we have also scanned our acoustic recordings from each site for the systematic detection of chainsaw sounds indicating logging activity and are currently looking for a viable method to detect gunshot noise as indicator of hunting pressure at sites. Together with acoustic indices on anthropogenic noise levels, this acoustic information will further aid in assessing anthropogenic pressure and its impact on forest biodiversity across sites.

Water quality assessment

The water quality of the Bacalar lake has been constantly monitored by the NGO Agua Clara at 13 sites distributed across the northern, central and southern zone of the lake. The monthly assessment includes the determination of eight indicators (*E. coli*, ammonium, nitrates, nitrites, nitrogen, phosphorus, DBO5, CLA) determined from water samples taken at sites. By applying a landscape ecology approach, we will aim to relate the anthropogenic pressure from agriculture and urban areas to the water quality of three distinguished lake zones that differ in their natural chemical composition once the year of water data collection is completed.

Dissemination of project progress

During the past year, we have sent out progress reports to some interested landowners who granted us permission to conduct our research on their properties. These reports include lists of identified species at the respective sites, examples of acoustic recordings, and general information about the project. Also, we disseminated information about the project through the Facebook and Instagram page of the NGO ConMonoMaya (Figure 2). Results of the monthly water-quality assessment carried out by NGO Agua Clara have been published on their website (https://aguaclara-por-bacalar.org).

By the end of 2021, the NGO Agua Clara released a public report on the importance and threats of the different ecosystems in the Bacalar region with emphasis on aquatic conservation needs (https://aguaclara-por-bacalar.org).

Since the planned trajectory of the Tren Maya through the Bacalar region is not final yet (a delayed start of the railway road construction is expected), we were not able to inform decision makers on the potential environmental impact of the trajectory. However, we are currently in search of options to disseminate preliminary project results to the local people and authorities in Bacalar in form of a community event in fall 2022.

In January 2022, we presented the project in front of a scientific audience at the meeting of the International Primatological Society in Quito, Ecuador (funded by the German Academic Exchange Service).

Figure 2. Example of social media post by the NGO ConMonoMaya (http://facebook.com/conmonomaya) distributing project information for the general public.

Additional project work

Since the start of our project in August 2021, we had the chance to add a few building blocks to our conservation efforts in the Bacalar region. This includes the setup of three cellular-based camera traps at selected acoustic monitoring sites in collaboration with the Conservation AI lab of the Liverpool John Moore University in April 2022. By the combination of acoustic information from our recording units and visual information from camera traps, we are able to get a more complete picture of the forest biodiversity in Bacalar and collect vocalisation recordings from species we can visually identify (Figure 3).

Furthermore, the National Geographic Society in collaboration with Synthaetics has loaned us five cellular-based camera traps as support for a 1-year monitoring project starting in August 2022 to assess illegal logging and hunting pressure at selected sites. In order to push forward the ecohydrological approach of our project aiming to link the health of the forest with aquatic ecosystem health, we started exploring the feasibility of the use of drone surveys with a multispectral camera in April 2022 to identify levels of water stress in vegetation of the Bacalar forest (Figure 4). The collaborative work with the University of Veracruz, the Liverpool John Moore University and the NGO Agua Clara is planned to be further developed over the upcoming year.

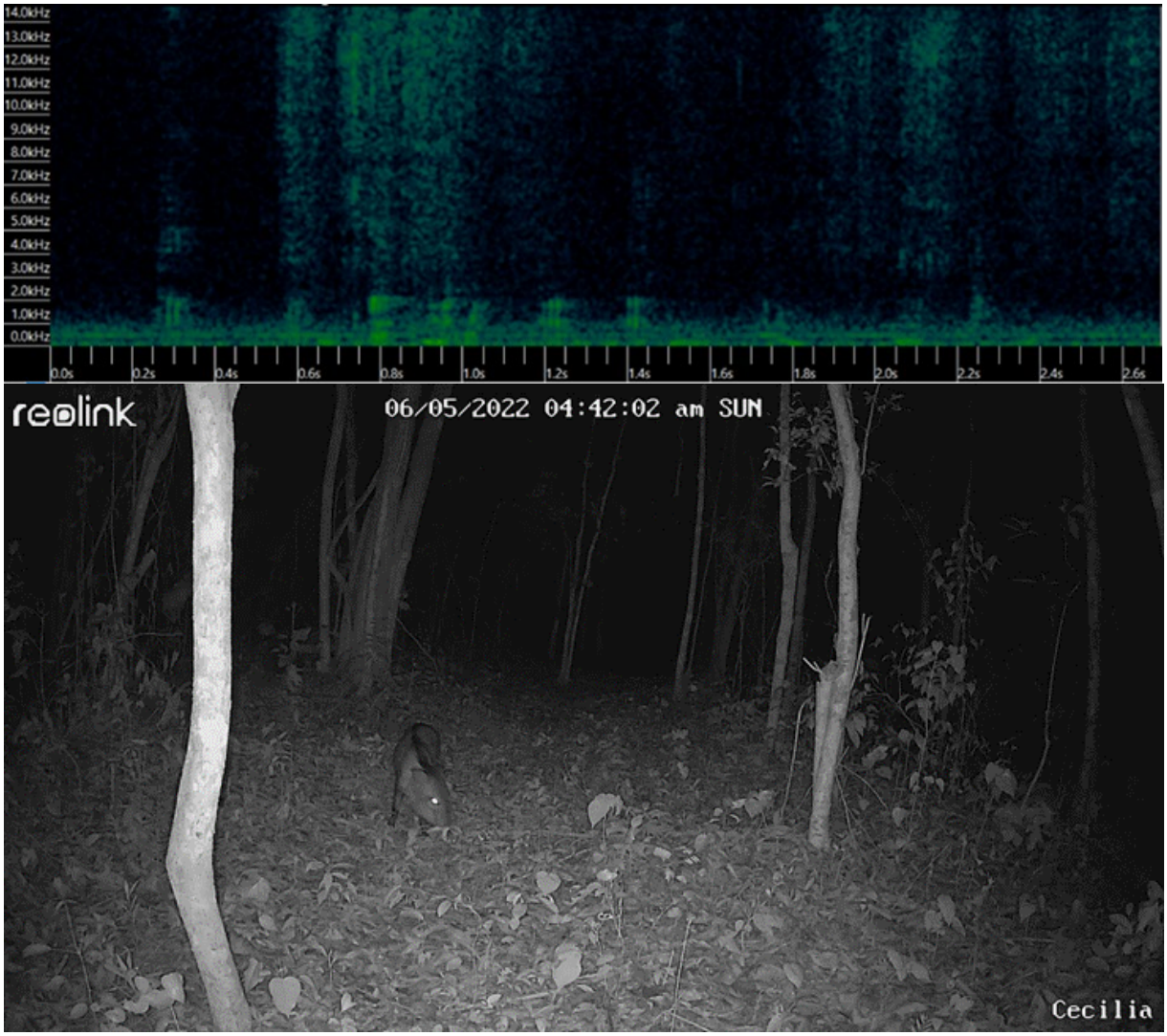

Figure 3. Spectrogram of an acoustic recording (on the top) and camera-trap footage (below) of the collared peccary (Tayassu pecari) collected in the Bacalar forest. Since the species is not identifiable with 100% certainty from acoustic recordings of grunt vocalizations, it is beneficial to relate it to visual information from camera traps positioned next to acoustic recorders.

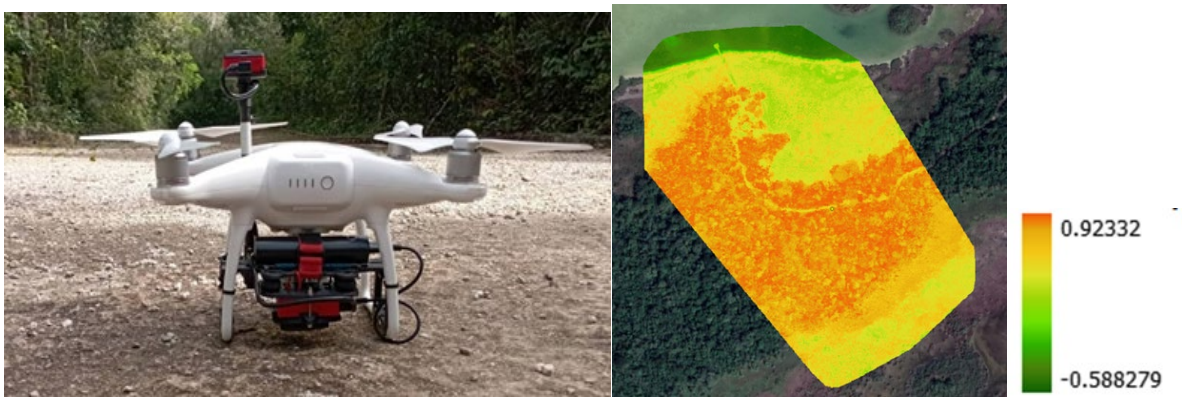

Figure 4. The multispectral camera mounted to a Phantom drone (on the left) can be used to create orthomosaic imagery of the Bacalar forest, e.g., showing NDVI values of present vegetation. Such information might be useful to infer water stress of trees and relate it to the presence of superficial and subterranean water sources.