



## MEXICO DISSERTATION/THESIS PROJECT

ME65 Climate change, reduced water distribution and herpetofaunal abundance and species distribution

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The Calakmul Biosphere Reserve is an UNESCO World Heritage Site of Culture and Nature due to the forest of outstanding biodiversity that surrounds multiple ancient Maya ruins sites, including the city of Calakmul that contained up to 150,000 people during the height of its power between 250BC – 900AD. The tropical semi-deciduous forest in Calakmul Biosphere Reserve is unusual in that areas close to Mayan Ruins contain unusually high densities of large fruiting trees (the result of Ancient Mayan agro-forestry) in comparison to other areas (Ross & Rangel, 2011). As there are no rivers or streams in the reserve, forest structure is also heavily affected by distance from the limited number of lakes in the reserve known as aguadas. In addition, there is a steady increase in mean annual precipitation from the north to the south of the reserve that has a notable effect on tree species composition and forest structure.

The herpetofauna of the Mayan jungle is one of the richest assemblages in the Americas, primarily because of considerable variation in habitat within these forests. Despite this, the herpetofauna of the Calakmul Biosphere Reserve is poorly studied. In Puerto Rico, forest over 20 years of age contained many structural components of mature forest that are important for herpetofauna (Herrera-Montes & Brokaw, 2010). However, evidence from studies in Mexico indicates that, contrary to assumption, the secondary forest found throughout tropical Mexico cannot support a full range of herpetofauna (Luja et al., 2008; Suazo-Ortuño et al., 2008). Consequently, the few remaining strongholds of primary forest such as Calakmul are vital for herpetofauna conservation. Moreover, as Calakmul is so poorly studied, we cannot be sure how many species should be present in the area and thus how many are disappearing.

Herpetofauna assemblage in the unique aguada habitats in Calakmul is also poorly understood. These aguadas are the only water sources in the vast Calakmul reserve and can vary considerably in size and permanence. Some aguadas can reach a diameter of over 2km during the peak of rainy season whereas others are the size of small ponds that form on low lying ground during rainy season. The larger permanent aguadas contain a wide variety of amphibians, turtles, crocodiles and other reptiles, but it is not clear how assemblage changes in relation to the size and permanence of the aguada or the type of vegetation and forest structure around the aguada. Moreover, nothing is known about migration patterns of crocodiles and turtles between aguadas, and very little is known about the abundance and habitat preferences of the endemic Morelot's crocodile in these aguada habitats because virtually all studies of this species have been conducted in coastal regions where they are reported to prefer large rivers (Cendeño-Vasquez et al, 2006).

The aim of this project is to determine the abundance, distribution and habitat preferences of the herpetofauna in Calakmul Biosphere in both terrestrial and aquatic habitats. Research projects could investigate differences in herpetofaunal species assemblages between different sites in the reserve, variation in forest structure and in relation to distance from aguadas. Alternatively, project could focus directly on those species that occupy the aguada habitats. These projects could incorporate a wide range of species or could focus on specific groups (e.g. anurans, lizards, snakes, turtles, crocodiles).

## Methods

### *Variation in herpetofauna assemblage in relation to forest structure*

Data collection will be carried out in 5 different locations within the Calakmul Biosphere Reserve (Figure 1). These camp locations have been chosen due to their accessibility during the wet season and because they cover the full geographical and vegetation range of the reserve. Each camp will contain four 2km long transect lines for data collection that have been mapped using a GPS unit. Five sample sites for habitat surveys will be located along each transect line at 500m intervals, giving rise to 100 sample sites across the 5 research locations in the reserve. Each sample site will consist of a 20m x 20m area adjacent to the transect line. These sample sites are used for habitat surveys to provide a corresponding set of habitat variables for each herpetofauna encounter (by linking each encounter to the nearest habitat plot). Each site will be marked and the GPS location recorded.

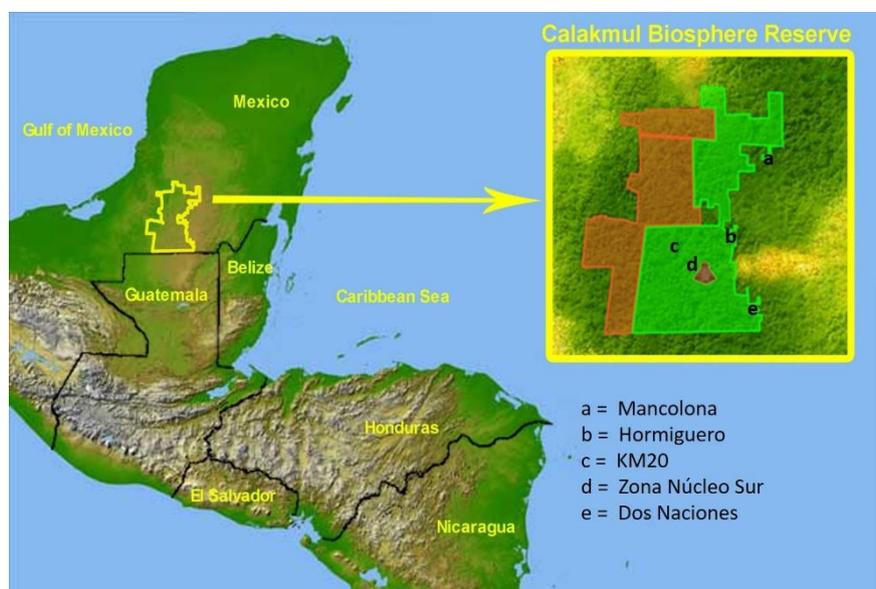


Figure 1: Location of research camps in Calakmul

Visual encounter surveys (VES) will be conducted night and day along the transect lines in each camp during the period when herpetofauna are most active. During the VES, all possible microhabitats will be searched, including leaf litter, tree trunks, decayed logs, fallen palm leaves and bromeliads. Due to the cryptic nature of anurans the disturbance of this vegetation using a probe is the most systematic method of detection (Rodel & Ernst, 2004). This will be achieved by methodically probing through the area directly in front of the observers, including up to approximately 2m on either side of the trail. On occasion, some herpetofauna will be observed beyond 2m, but as the study aims to abundance and diversity, these specimens must be recorded separately on the “opportunistic encounter” data sheets and must not be included in abundance analyses. To identify herpetofauna during night transects instead of probing through leaf litter, torches will be used to catch the reflection of light from the eyes.

Before each survey the following information will be recorded: date, name of observer, camp, and transect searched, weather conditions, start time and finish time. Upon detection and capture of an

individual the distance along the transect line, GPS location, time of day, species, sex, age (adult or juvenile), colouration (aposematic or camouflage) and substrate in which the specimen was found (e.g. aguada, forest) will be recorded. Each specimen will be handled carefully by the herpetologist and morphological characteristics will be recorded, namely: snout to vent length (SVL) and body mass (g).

Habitat surveys will be conducted in each of 20m x 20m survey sites to investigate tree diversity and forest structure. The number of saplings (trees with circumference <15cm and a minimum height of 3 metres), and epiphytes will be counted for each plot. For each tree in the plot with a circumference >15 the species and DBH of the tree, and whether the tree is alive or dead will be recorded on datasheets. For each tree with a circumference >30cm, height of the tree will also be recorded on datasheets. The DBH and length of each fallen tree within the plot will also be recorded. Forest structure measurements include understory vegetation, canopy cover and leaf litter depth. To measure understory vegetation, the plot will be bisected to produce the four quadrants. A 3m pole marked in 0.5m segments will be used to record the number of vegetation touches on the pole in each 0.5m segment every 1m along these bisecting tapes. The openness of the canopy will be measured by taking a reading with a canopy scope from the centre of each of the four quadrants and one from the centre of the overall 20m X 20m square. Leaf litter depth will be recorded in each of the 4 quadrants and in the centre of the plot using a ruler to give 5 separate leaf litter measurements (mm) per plot.

### ***Variation in herpetofauna assemblage in relation to aguada size and permanence***

Each of the 5 research locations in Calakmul contain a series of aguadas of varying size and the water levels in these aguadas fluctuate throughout the year, with some aguadas managing to retain water throughout the year, while others dry up completely towards the end of the dry season. In addition, aguada vary considerably in terms of the presence of vegetation around them with some aguadas surrounded by savanna, other by huge trees from the ficus family and some aguadas with extensive areas of mud and virtually no adjacent vegetation. All these variables are expected to have a significant influence on herpetofauna community assemblage. GPS units will be used to map out the perimeter of each aguada and thus calculate the surface area. Depth of the aguada will be recorded using graduated measuring poles. These measurements will be taken on a weekly basis. Habitat surveys will be conducted adjacent to the aguadas (one side of the square plot touching the aguada), using the method described earlier in this document. Variation in herpetofauna may be compared across aguadas of varying size and within the same aguadas over time. Turtles and crocodiles may also be permanently marked to investigate migration patterns between aguadas.

Data collected in and around aguadas will involve various capture methods. Pitfall and funnel traps will be arranged at various locations around the perimeter of the aguada and baited traps for turtles will be placed at the water's edge. Morelet's crocodiles will be captured with nooses while wading into the aguadas. Pitfall and funnel traps will be arranged in a Y shape consisting of 3 buckets buried flush with the ground surface, a fence of mosquito netting to connect the buckets and a funnel trap at the end of each fence (3 funnel traps in total). The traps will be left in-situ each night and will be checked for captures each morning. For each capture, the sex, age (adult or juvenile), weight (g), the length of the animal (SVL), length of the head, and length of tail (were relevant) and colouration (camouflage or aposematic) will be recorded. In addition, the animal will be photographed in situ (back, head and side).

## Recommended Reading

- Cendeño-Vasquez, J.R., Perran-Ross, J., & Calmé, S. 2006. Population status and distribution of *Crocodylus acutus* and *C. moreletii* in southeastern Quintana Roo, Mexico. *Herpetological Natural History* 10: 53–66.
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- Platt, S.G., Rainwater, T.R., Finger, A.G., Thorbjarnasan, J.B., Anderson, T.A. & McMurray, S.T. 2006. Food habits, ontogenetic dietary partitioning, and observations of foraging behaviour of Morelet's crocodile (*Crocodylus moreletii*) in northern Belize. *Herpetological Journal* 16: 281-290.
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- Ross, N.J. & Rangel, T.F. 2011. Ancient Maya agroforestry echoing through spatial relationships in the extant forest of NW Belize. *Biotropica* 43(2): 141–148.
- Suazo-Ortuño, I., Alvarado-Diaz, J. & Martinez-Ramos, M. 2008. Effects of conversion of dry tropical forest to agricultural mosaic on herpetofaunal assemblages. *Conservation Biology* 22: 362-374.