MEXICO DISSERTATION/THESIS PROJECT

ME66 Felid and ungulate abundance and distribution patterns in relation to changing water distribution and hunting in a Mayan forest

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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 total area covered by the reserve is 1,200,000 hectares, but the vast majority of the land surrounding the reserve is also forest. Over 20,000 people live in and around Calakmul and with more people moving into the area, developments are starting to affect the landscape and hunting rates. Hunting is strictly prohibited inside the reserve, but in the surrounding forest, indigenous communities are permitted to hunt certain species (e.g. peccary and deer). Although these species are abundant, they are the preferred prey of jaguar and puma and a reduction in their preferred prey can lead to increased likelihood of felid attacks on livestock in buffer zone communities (Forster et al., 2010).

Permanent water bodies are rare in CBR due to the geologic characteristics that cause rapid filtration of the rain (García-Gil *et al*. 2002). However, low-lying terrain allows the accumulation of water, and creation of temporary lakes, locally known as *aguadas*. These aguadas are filled by direct rainfall combined with water flowing across the forest floor during the peak of rainy season. As both water and leaf litter collect in these aguadas, the rotting leaf litter creates a mucus layer that stops the water filtering through the limestone karst. This system is entirely reliant on localized rainfall, and so changes to rainfall patterns can very quickly have a devastating effect on water distribution in the reserve. The prevalence of water in the a*guadas* of CBR has suffered alterations due to the effects of global warming (Reyna-Hurtado *et al*. 2010). For example, during the last 50 years Calakmul endured a 16% reduction on the annual median precipitation values (Zuniga-Morales & Sima-Pantí 2015). Changes to water availability in CBR have altered ranging patterns of ungulates such as peccary and tapir that are closely associated with water, which in turn is expected to affect ranging patterns of sympatric jaguar and puma.

Large mammal density at Calakmul Biosphere Reserve is very high and the forest is one of the last remaining strongholds of endangered mammals such as spider monkeys, jaguar and tapir. 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). 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. Consequently, the forest is not uniform and thus abundance and distribution of felids, ungulates and primates is expected to vary considerably throughout the reserve. Moreover, ungulates in CBR are reported to change their habitat preferences in relation to hunting pressure (Reyna & Tanner, 2005).

The aim of the large mammal research project is to investigate the relationship between changing water distribution and felid and ungulate abundance and ranging in Calakmul. The major concern in the reserve is changing rainfall patterns and the disappearance of aguadas. Data from camera trap monitoring in CBR and to the south in reserves in Guatemala have indicated a mass migration of peccary and tapir to the wetter climate of Guatemala in response to changing rainfall patterns and drought in CBR. Not only are these ungulates vulnerable to hunting if they range outside of the core zone of the reserve, but the change in abundance in ungulates in the core zone will result in a lower abundance of preferred prey for felids. During the last two years of drought in CBR, there has been a reported increase in felid attacks on livestock in buffer zone communities suggesting that the change in ungulate distribution is affecting felid behaviour. Data relating to felid and ungulate use of aguadas and their abundance and habitat preferences in the core and buffer zone of the reserve are urgently required to assess the severity of the situation.

Methods

Data collection will be carried out in 5 different locations with 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 camps in the reserve. Each sample site will consist of a 20m x 20m area adjacent to the transect line. These sample sites will be marked, and the GPS location recorded.

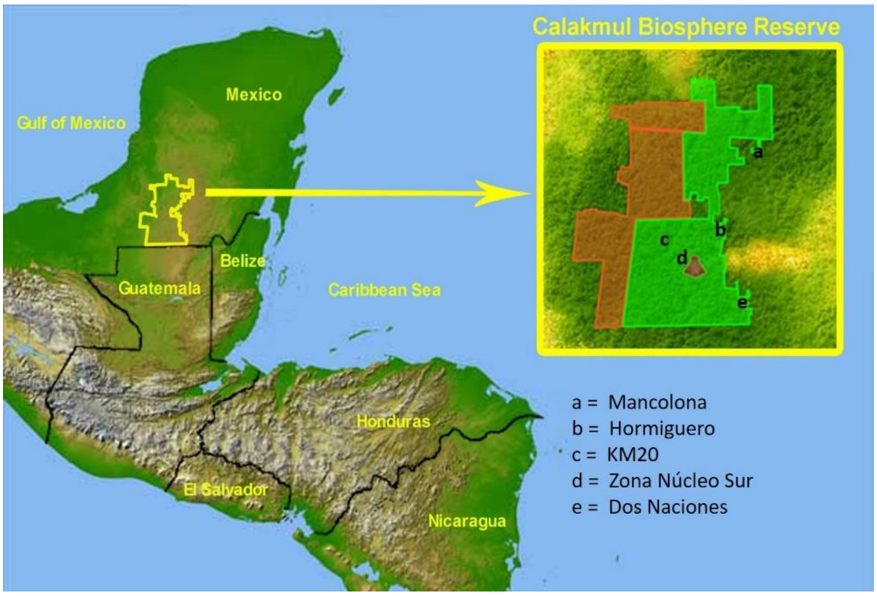

Figure 1: Location of research camps in Calakmul

Terrestrial mammals will be surveyed along line transects (that are not placed with any pre-determined knowledge of the distribution of the animals: Peres, 1999), using patch occupancy sampling (Mackenzie, 2005). Patch occupancy sampling involves detecting animals based on tracks and faeces rather that visual or vocal sightings of the animals and is the most appropriate methods for monitoring elusive animals that naturally occur at low densities (e.g. jaguar and tapir), for which visual encounters are likely to be rare. The entire length of the transect line will be walked by small groups of 3-4 observers walking quietly and slowly (500-1,000 m/hr), starting at 7.00am when light levels are sufficient to detect tracks. Each line must be surveyed on four separate occasions.

Additional data from the core zone of the reserve will be provided from our permanent camera trapping grid. Jaguar and puma are reported to use existing animal and man-made trails through the forest whereas many prey species actively avoid existing trails (Harmsen *et al.* 2010). With this in mind, the camera stations are located on and around existing human trails, game trails, and aguadas in order to capture representative samples of both felids and their prey. Camera traps are attached to trees at 30-60 cm above ground with a detection view of 15m and will are checked monthly to change batteries and SD cards. The design of the camera trap study is similar to this of the CENJAGUAR project (The National Census of the Jaguar and its Prey) in order to compare the results with nationwide monitoring of jaguars in Mexico (Chavez *et al.* 2011). This design uses a grid system 3 camera trapping stations per 3km^2 section of the grid, with a minimum of 27 camera trapping stations.

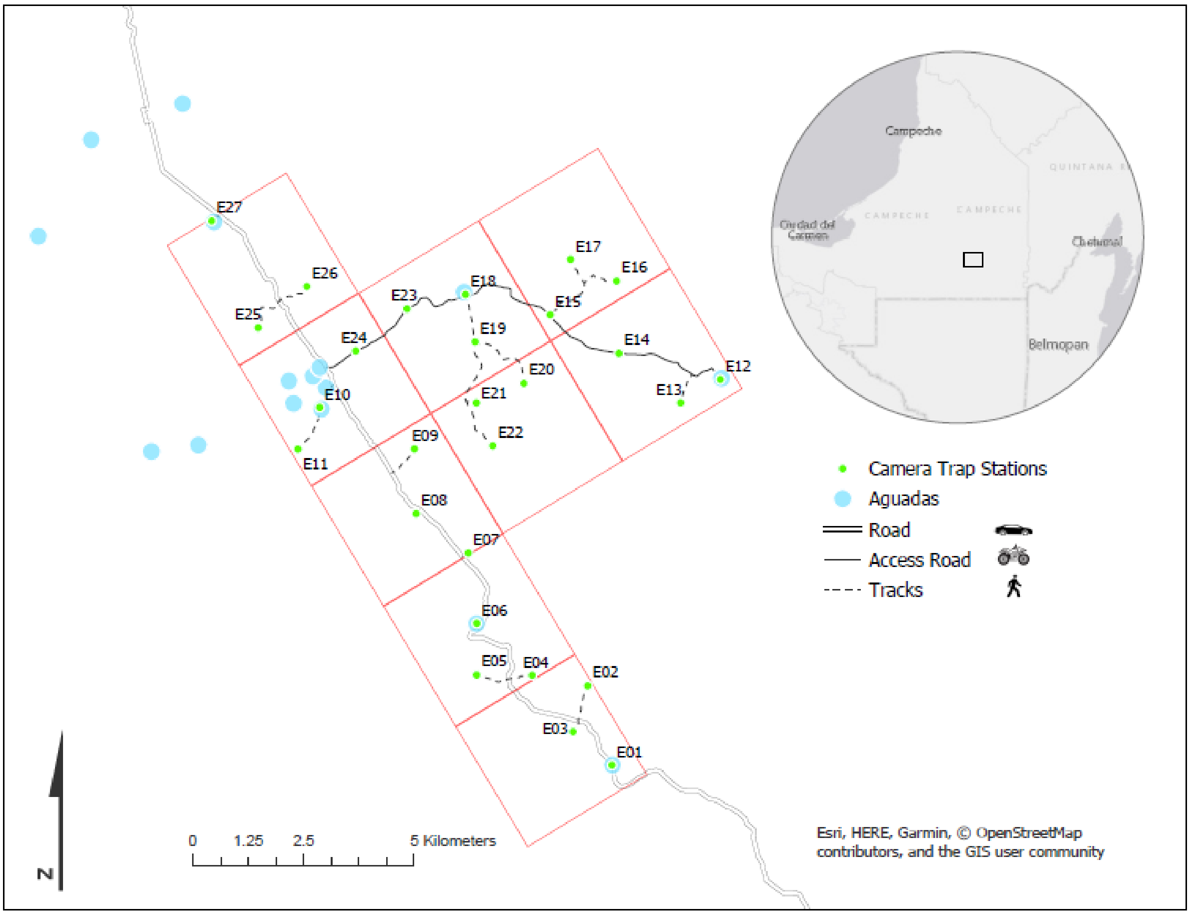

Figure 2: Operation Wallacea Camera Trapping Grid adapted from the National Jaguar Survey (GENJAGUAR) (Chavez *et al.* 2011).

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 understorey vegetation, canopy cover and leaf litter depth. To measure understorey 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 center of each of the four quadrants and one from the center of the overall 20m X 20m square. Leaf litter depth will be recorded in each of the 4 quadrants and in the center of the plot using a ruler to give 5 separate leaf litter measurements (mm) per plot.

Each large mammal track can then be linked to the nearest habitat plot along the transect providing a corresponding set of habitat variables for each track. From this, habitat preferences of each species may be calculated and the habitat variables effecting large mammal abundance at each plot can also be investigated. In addition, abundance estimates of large mammals may be calculated from both camera traps and tracks in order to compare the differences in estimates between the two methods.

Recommended Reading

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