Bird abundance, diversity and distribution patterns in relation to forest structure in the Calakmul Biosphere Reserve

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Deforestation and its impact on climate and diversity is a major concern throughout the world. Fauna such as birds, mammals and herpetofauna are often used as indicators of forest health due to the direct relationship between species abundance and diversity and forest disturbance. In the Neotropics, birds have been cited as good indicators of forest health because both abundance and diversity of bird species is effected by habitat disturbance (Mas & Dietsch, 2004; Harvey et al., 2006). The Yucatan Peninsula of Mexico contains naturally fragmented forest and savannah due to variation in rainfall patterns (Montiel et al., 2006). In addition, the tradition farming techniques of the indigenous Mayan communities have resulted in a mosaic landscape of old growth forest, regenerating forest of varying ages and farmland (Hartter et al., 2008). Much of the wildlife appears to be adapted to this changing habitat with little variation in bat (Montiel et al., 2006), butterfly (Vester et al., 2007) and herpetofaunal (Luja et al., 2008) diversity between old growth and regenerating forest.

A study of resident and migratory birds across different stages of successional forest in the buffer zone of Calakmul found no significant differences in bird abundance and diversity across different forest types although a number of resident frugivorous bird species were reported at lower numbers in all but old growth forest (Smith et al., 2001). Large frugivorous birds in the Yucatan Peninsula are reported to be more abundant in old growth forest (Urquiza-Haas et al., 2009), particularly where large fruiting trees such as ramon (*Brosimium alicastrum*) and chicozapote (*manilkra zapota*) are present (Weterings et al., 2008). In addition, birds (and bats) living in mosaic landscapes can take advantage of agricultural crops as food sources. Consequently, birds (and bats) play a major role in seed dispersal crop species, forest regeneration via seed dispersal of fruiting trees (Medellin & Gaona, 1999) and reducing insect biomass and associated damage to new leaves (Morrison & Lindell, 2012).

The Calakmul Biosphere Reserve in the south of the Yucatan Peninsula 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. Consequently, bird diversity, in particular that of frugivorous birds is expected to vary across different locations in the Calakmul Biosphere Reserve.

Over 20,000 people live in and around Calakmul in traditional Mayan villages where the major source of income is agriculture. Data from a range of taxa suggest that the forest/farm matrix surrounding the reserve can still maintain high biodiversity providing that corridors of primary forest remain. However, the direct relationship between habitat variables and the abundance and diversity of birds has yet to be documented.

This current study aims to investigate the abundance and diversity of birds in the core and buffer zone of the Calakmul Biosphere Reserve in relation to forest structure, distance to water and vicinity to Mayan ruins.

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 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 bat survey location (by linking each mist net location to the nearest habitat plot). Each site will be marked and the GPS location recorded.

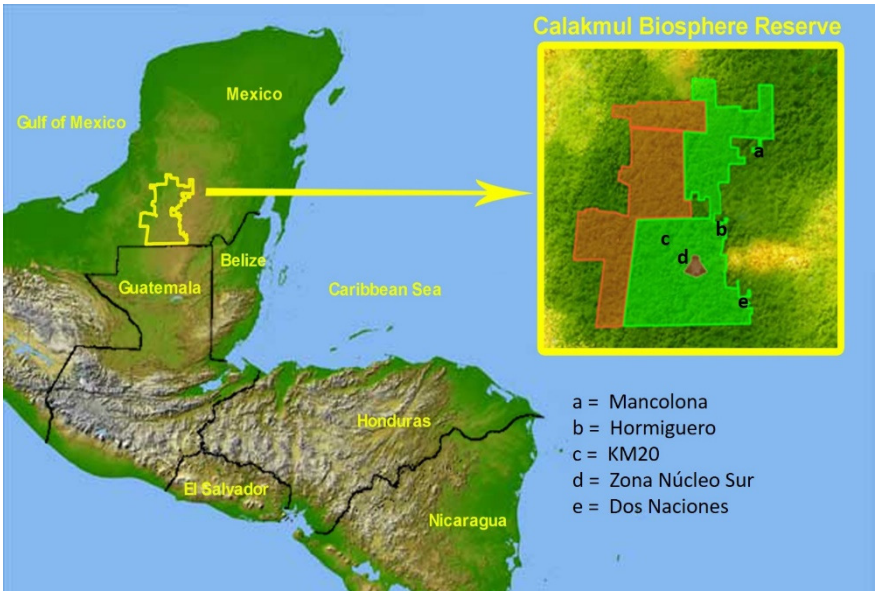

Figure 1: Location of research camps in Calakmul

Bird data will be collected using point counts and mist netting. The point count surveys will be completed between 05:30am and 09:00am. Point counts of birds (by sight or call) will be conducted at 10 different points along the transect a 200m intervals. At the start of each point count, weather conditions and insect noise (that could affect bird activity or the ability to detect bird calls) will be recorded at the time of the point count. No settling down period should be allowed with counts starting immediately. Then over the next 10 minutes for each species the following details should be recorded: species, number of individuals, whether the bird(s) was seen or heard, and the approximate distance of the bird from the observer (recorded at 5m intervals). Bird species will be identifies using field guides (e.g. Howell & Webb, 1995).

The abundance and diversity of understorey birds will be assessed using mist nets. Mist nets surveys will run 6 days per week at each research camp using a suitable existing clearing along each of the sample routes with enough space to erect six, 12m long mist nets, each 2.5 meters high. Additional opportunistic mist netting sites in specific habitats (e.g. aguadas) were also used. The location of each mist net site will be marked and the GPS location recorded. All mist netting will be conducted at the same sites per camp. Mist netting with occur in the mornings between 6:30am and 10:30am and in the afternoons between 3.30pm and 6:00pm. The opening and closing time of the nets will be recorded each session and nets will be checked every 20 minutes for the duration of the survey. When birds are found in the net, the time of capture will be noted. The birds will be taken out of the net, placed in a cotton bag for holding whilst other birds are being processed. As previous studies of avifauna in Calakmul have indicated that recapture rates are extremely low, a band system using nail varnish of 10 different colours will be used to mark birds when captured. The birds will be weighed (to the nearest gm) and standard morphological measurements taken.

Habitat surveys will be conducted in each of 20m x 20m survey sites to investigate tree diversity and forest structure. On each transect the first plot will be located at 200m, the second at 600, the third at 1000m, the fourth at 1400m and the fifth at 1800m along the transect line. The number of saplings (trees with circumference <15cm and a minimum height of 2 metres) will be counted for each plot. For each tree in the plot with a circumference >15cm, the circumference at breast height (which will be converted to DBH), whether the tree is alive or dead, and the tree species, will be recorded on datasheets. Where species cannot be identified in the field, photographs of leaves, fruit (if available leaves and bark will be taken for later identification from textbooks. The number of fallen trees and cut stumps in the plot will also be recorded along with measures of 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 up to a maximum of 10 touches, every 1m along these bisecting tapes. If one of the positions coincides with a tree, then each of the 0.5m segments will be recorded and having vegetation touches. The openness of the canopy will be measured by taking a reading with a canopy scope (Hale & Brown, 2005) facing the largest opening in the canopy from the centre of each of the four quadrants and one from the centre of the overall 20m X 20m square. Leaf litter depth should also 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.

Suggested Reading

Hartter, J., Lucas, C., Gaughan, A.E. and Aranda, L.L., 2008. Detecting tropical dry forest succession in a shifting cultivation mosaic of the Yucatán Peninsula, Mexico. *Applied Geography* 28: 134-149.

Harvey, C.A., Medina, A., Sánchez, D.M., Vílchez, S., Hernández, B., Saenz, J.C., Maes, J.M., Casanoves, F. and Sinclair, F.L., 2006. Patterns of animal diversity in different forms of tree cover in agricultural landscapes. *Ecological applications* 16: 1986-1999.

Howell, S.N.G. & Webb, S. (1995). *Birds of Mexico and Northern Central America*. Oxford, Oxford University Press.

Luja, V.H., Herrando-Perez, S., Gonzalez-Solis, D., Luiselli, L. 2008. Secondary rain forests are not havens for reptile species in tropical Mexico. *Biotropica* 40: 747–757.

Mas, A.H. and Dietsch, T.V., 2004. Linking shade coffee certification to biodiversity conservation: butterflies and birds in Chiapas, Mexico. *Ecological Applications* 14: 642-654.

Medellin, R., Gaona, O. 1999. Seed dispersal by bats and birds in forest and disturbed habitats in Chiapas, Mexico. *Biotropica* 31: 478–485.

Montiel, S., Estrada, A., & Leon, P. 2006. Bat assemblages in a naturally fragmented ecosystem in the Yucatan Peninsula, Mexico: species richness, diversity and spatio-temporal dynamics. *Journal of Tropical Ecology* 22: 267–276.

Morrison, E.B & Lindell, C.A. 2012. Birds and bats reduce insect biomass and leaf damage in tropical forest restoration sites. *Ecological Applications* 22: 1526–1534.

Ross, N.J. & Rangel, T.F. 2011. Ancient Maya agroforestry echoing through spatial relationships in the extant forest of NW Belize. *Biotropica* 43: 141–148.

Smith, A.L., Ortiz, J.S. & Robertson. R.J. 2001. Distribution patterns of migrant and resident birds in successional forests of the Yucatan Peninsula, Mexico. *Biotropica* 33: 153-170.

Urquiza-Haas, T., Peres, C.A. and Dolman, P.M., 2009. Regional scale effects of human density and forest disturbance on large-bodied vertebrates throughout the Yucatán Peninsula, Mexico. *Biological Conservation* 142: 134-148.

Vester, H.F.M., Lawrence, D., Eastman, J.R., Turner, B.L. Calme, S., Dickson, R., Pozo, C. & Sangermano, F. 2007. Land change in the southern Yucatan and Calakmul Biosphere Reserve: Effects on habitat and biodiversity. *Ecological Applications*, 17: 989–1003.

Weterings, M.J.A., Weterings-Schonck, S.M., Vester, H.F.M. and Calmé, S., 2008. Senescence of Manilkara zapota trees and implications for large frugivorous birds in the Southern Yucatan Peninsula, Mexico. *Forest ecology and management* 256: 1604-1611.