Apr 25th, 6:00 PM - 7:00 PM

# Flight and Wing Comparison of Bats in a Cloud and a Dry Forest in Costa Rica

Makali Haines
*Ohio Wesleyan University*

# Flight and Wing Comparison of Bats in a Cloud and a Dry Forest in Costa Rica

**By Makali Haines**

## Introduction

Costa Rica is home to one hundred and ten species of bats, which makes up about half of the mammals in that country (Pfau, 2002-2019). With such a large number they occupy many different types of habitats. My goal was to compare some of the effects of the environment on the bats. More specifically to determine the difference between the wings and flight of bats in a Costa Rican cloud forest and a Costa Rican dry forest. The habitat that they call home could greatly change how they fly, it is already known that just the presence of artificial light changes the flight patterns of bats (Polak, 2012). Some species like *Rhinolophus hipposideros, Myotis nattereri* and *Plecotus auritus* "are adapted for flight and foraging in cluttered airspace" (Abbott, 2012). When presented with obstacles like trees, vines, and leaves bats find a stable paths around their obstacles and they continuously repeat these paths (Barchi, 2013). If the obstacles change, that could potentially cause a crash and inflict damage to the bat. My goal was to look at the effects of habitats keeping in mind that some places have air that is heavier and denser with rain, and some places have more particle clutter and obstacles which may harm their wings. I measured multiple aspects of their wings to see if there are any noticeable differences. I hypothesized that the cloud forest bats will have wings that allow them to be more agile, but they will have more damage on their wings. I also hypothesized that the bats in the cloud forest will be slightly smaller compared to the bats in the dry forest. This last theory was supported by another study by Kalcounis and Brigham. They studied male and female bats in different stages of pregnancy and the habitats they occupied were studied. It was concluded that "heavier bats (great wing loading) foraged in less cluttered areas" (Kalcounis and Brigham, 1995).

## Hypotheses

- The cloud forest bats will have wings that allow them to be more agile compared to the bats in the dry forest
- The cloud forest bats will have more damage on their wings.
- The cloud forest bats will be slightly smaller.

## Methods

We caught bats by using a mist net between 6 pm and 8:30 pm for 6 days. We caught bats for two days in the cloud forest at the San Gerardo field station. We tried to catch them during three collecting days but on one of these days it was raining too hard. We collected the bats in a variety of areas, like secondary forest, open fields and pastures. This ensured we had a good variety and had no bias of the bats. Then we caught bats for three days in a dry forest in a field station called Cirenas. Here we also caught bats in multiple locations.

They were mist netted and identified with the help of a scientist who has been catching bats for years. Once caught, the bats' forearm, second and third finger, the fifth finger, the tibia, calcar, middle section of the tail, shoulders, and weight was measured. Some of the bats did not have a membrane between their legs, thus the tibia, calcar, and middle section of the tail was not measured. We also took note of the species, sex, and wing damage.

The data was then used to determine the aspect ratio, wing loading, wing area (figure 1,2,3), and cord length. The formulas are as follows:

**Aspect Ratio** (Pennycuick, 1989)

$$AR \equiv \frac{b^2}{S} = \frac{b}{\bar{c}}$$

b - Wingspan

S - Wing area

$\bar{c}$ - Mean cord length

**Wing Loading** (Norberg and Rayner, 1987)

$$WL = \frac{kg}{m^2}$$

kg -Mass

m- Surface area of the wing

**Wing Cord** (Norberg and Rayner, 1987)

$$\bar{c} = \frac{S}{b}$$

b – Wingspan

S - Wing area

The wing area was determined as follows:

**Bat wing area calculations**

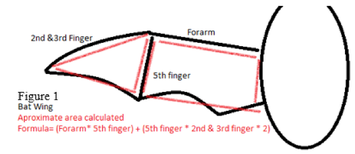



Figure 1
Bat Wing
Aproximate area calculated
Formula= (Forarm * 5th finger) + (5th finger * 2nd & 3rd finger * 2)

**Bat tail calculations**

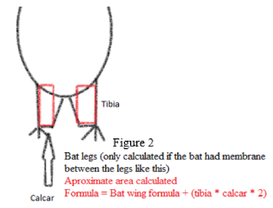



Figure 2
Bat legs (only calculated if the bat had membrane between the legs like this)
Aproximate area calculated
Formula = Bat wing formula + (tibia * calcar * 2)

**Bat extended tail area**

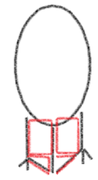
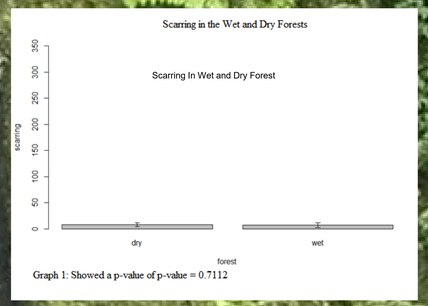


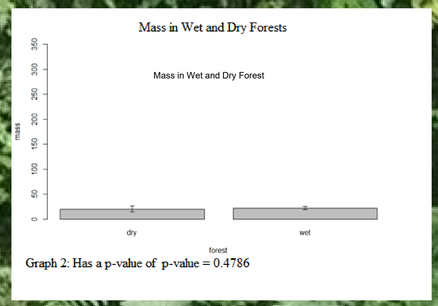
Figure 3
Bat legs (only calculated if the bat had a membrane between the legs like this)
Aproximate area calculated
Formula = Bat wing formula + (middle- tibia * calcar) + (tibia * calcar * 2)

## Methods Cont.

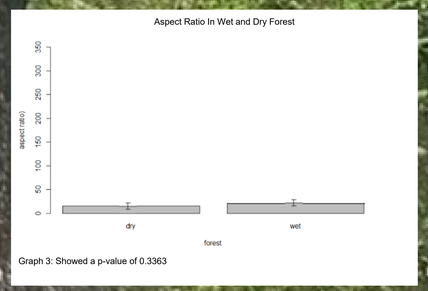
It was suggested but not conclusively found that whether a bat ate fruit, insects, nectar or blood could change the wing characteristics. To control for this fact all of the bats that were caught and weren't frugivorous were taken out of the data set. There was only 3 non-frugivorous bats caught. After all the data was put into the formulas and the calculations were done it was run through the statistical program R studio. A t-test was used for each of the following components: aspect ratio, wing loading, wing damage (scarring), and mass.



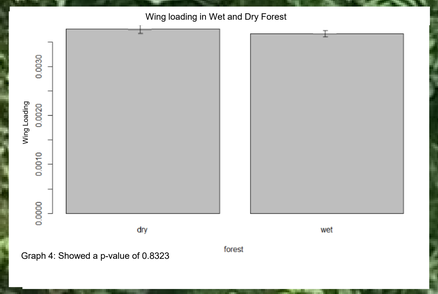

Graph 1: Showed a p-value of p-value = 0.7112




Graph 2: Has a p-value of p-value = 0.4786




Graph 3: Showed a p-value of 0.3363




Graph 4: Showed a p-value of 0.8323

## Implications and further studies

These tests showed no difference in mass, wing damage, aspect ratio nor wing loading, not only that but they all have very similar averages. This in itself is a surprising find. Even though they live in different habitats and have different obstacles it had no effect on their genetics. This could mean that the habitats are similar enough that they don't need to have different adaptations or that they just haven't started to evolve yet.

Future studies could test for the aerodynamic differences in bats in habitats that have bigger differences, like tropical and temperate. This would determine if the bat wings have evolved based on habitat. Or perhaps a study could be done with the aerodynamics of species who evolved at different times in the phylogenetic tree. It is possible a shift could be seen with an older species of bats, or one could compare and contrast the bats and other flying animals like, birds and insects.

**Acknowledgments:**

Thank you to Dr. Jeff Norris, Dr. Federico Chinchilla for guiding us through Costa Rica and crating out projects. Also a thank you to Dr. Federico Chinchilla for being instrumental in collecting the bats and helping us learn. Thank you to Courtney Fobel for the bat picture. Finally thank you to Kate Falco and Rachel Hitt and any other students that helped collected data.

## Literature Cited

Abbott, I. M., et al. "Clutter-Adaptation of Bat Species Predicts Their Use of under-Motorway Passageways of Contrasting Sizes - a Natural Experiment." Journal of Zoology, vol. 287, no. 2, June 2012, pp. 124–132. EBSCOhost, doi:10.1111/j.1469-7998.2011.00894.x.

Barchi, Jonathan R., Jeffrey M. Knowles, and James A. Simmons. "Spatial memory and stereotypy of flight paths by big brown bats in cluttered surroundings." Journal of Experimental Biology 216.6 (2013): 1053-1063.

Kalcounis, Matina C., and R.Mark Brigham. "Intraspecific Variation in Wing Loading Affects Habitat Use by Little Brown Bats (Myotis Lucifugus)." Canadian Journal of Zoology, vol. 73, no. 1, Jan. 1995, pp. 89–95. NRC Research Press, doi:10.1139/z95-011.

Norberg and Rayner (1987). Ecological morphology and flight in bats (Mammalia; Chiroptera): wing adaptations, flight performance, foraging strategy and echolocation. Philosophical Transactions of the Royal Society of London B: Biological Sciences 316.1179 (1987): 335–42.

Norberg, Ulla M. "Some advanced flight manoeuvres of bats." Journal of Experimental Biology 64.2 (1976): 489-495.

Pennycuick, Colin J. Bird Flight Performance: A Practical Calculation Manual. Oxford: Oxford University Press, 1989. Print.

Pfau, Pia. "Animals in Costa Rica, Nicoya Peninsula." Curu Wildlife Reserve Costa Rica. Description and Tourist Information, nicoyapeninsula.com/wildlife/bats.php.