Tent-making bats

Is there a correlation between the density of tent capable leaves and tent density?

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- January 2016 -

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Preface

You are reading the paper: Tent-making bats: is there a correlation between the density of tent capable leaves and tent density? This paper was written as a result of an internship project. The project was undertaken in September 2015 and finished 5 months later.

I took great joy in fulfilling this project, as I have acquired many useful qualities and improved my ability to work independently and writing a paper whilst doing so. I acquired considerable knowledge of tent-making bats and their roosting behaviour, for which I am thankful. This project truly sparked my interest in ecological research.

I would like to thank my supervisor Tamara Lohman for her excellent supervision and support. I would also like to thank HAS university of applied sciences and the organisation Coterc, for providing me with this internship opportunity and their support and cooperation within my project. More specifically, I would like to thank Luis Diaz and Molly McCargar – my research coordinators – for their help and assistance. I would also like to thank Manuel Arias for his guidance in the forest and for sharing his knowledge about tent-making bats, and more, with me. Finally I would like Charlotte Foale for her supervision and advice.

I hope you enjoy reading.

Kyra Vervoorn

January 22, 2016

Contents

Abstract

Tent-making bats play an important role in the pollination and dispersion of many tropical plants. This makes it important to gather enough information about the ecology of these bats. Tent-making bats are able to construct their own roosting site, and subsequently improve their roosting conditions. Their self-made tent roosts are extremely important resources to them, because they spend almost half their lives roosting. This study is therefore focused on the roosting ecology of bats. Is there a correlation between tent-capable leaves and tent density? How do location preference and tent quality play a part in this? In order to find out, plots were set up along an existing transect behind the Caño Palma Biological Station. The plots have been set up in two locations. Location 1 lays slightly higher than location 2 and is less likely to be flooded. Location 2 is wetter and lower laying then location 1. Every plot was systematically searched in order to find tent-capable plant leaves and bat tents, which were all marked and revisited for a period of 15 weeks. The quality of the tents were rated on a scale from 1 to 5, with 1 being a poor quality and 5 a good quality. The tents were also inspected for bat activity, either from a diurnal, or a nocturnal tent. A one-way anova and a LSD test have been conducted to test if bats differentiate between different tent qualities. Then an independent t-test has been conducted to determine differences in tent-capable leaves and bat activity for location 1 and 2. Lastly, a Pearson correlation coefficient was calculated to test the correlation between tent-capable leaves and tent density. Only *Artibeus watsoni* has been observed roosting in tents. But it is not known which bat species were active for the majority of tents. This is because most of the tents were used as nocturnal tents. Results show that bats require tents to be in excellent conditions in order to be used as roosting sites, probably because tent quality plays a big part in mate selection in females. Bats furthermore preferred location 2 over location 1. This is most likely because location 2 contained more good quality tents than location 1. However, most activity was found in diurnal tents, therefore more research should be conducted to determine if bats specifically differentiate in nocturnal tent quality. Finally, it was determined that tent-capable leaves do indeed affect the tent density in a positive manner, but only when looking specifically at bifid tent-capable leaves and bifid tents. For upcoming research it is advised to design bigger plots in order to get a reliable result for tent-capable leaves in general.

1. Introduction

Bats spend more time roosting than any other activity (Hayes, Kurta, & Lacki, 2007). Some bats spend their time roosting in caves, like the gray bat (*Myotis grisescens)* (R. K. LaVal, Clawson, M. LaVal & Caire, 1977), whereas *Nyctophilus* spp roost in trees (Turbill & Geiser, 2008). But certain bats have a unique ability, namely tent-making bats. Tent-making bats are able to construct their own roosting site, and subsequently improve their roosting conditions, because of their ability to modify plant leaves into so-called tents (Barbour, 1932; Chapman, 1932; Koepcke, 1984). The reason why these bats do this is presumably because the benefits of making tents are greater than the costs. This is probable because leaves are more abundant then other roosting sites such as caves and hollow trees. Another benefit would be that the leaves are immediately ready to be used (Rodriguez-Herrera, Medellín, & Timm, 2007). The tents provide protection from predators and harsh weather, such as temperature extremes and rain, and are furthermore used as a site for feeding, mating, grooming, and caring for young (Barbour, 1932; Boinski & Timm, 1985; Foster & Timm, 1976; Timm & Lewis, 1991; Timm & Mortimer, 1976). All modified leaves are called tents because some styles of modified leaves are tent-shaped. Other kind of tent styles are therefore also called tents (Kunz & McCracken, 1996; Timm & Lewis, 1991). Tents are made in a period of 1-50 days depending of the tent structure, with difficult tent styles, like conical, taking a longer time than easier tent styles, like bifid (Balasingh, Koilraj, & Kunz, 1995; Bhat & Kunz, 1995; Brooke, 1990; Tan & Kunz, 1997).

Tent-making bats play an important role in the pollination and dispersion of many tropical plants (Fleming, Heithaus, & Opler, 1975). It is therefore important to gather enough information about the roosting ecology of these bats, since roosts are extremely important resources to them, because they spend almost half their lives roosting (Chaverri & Kunz, 2006; Hayes et al., 2007; Kunz & Lumsden, 2003).

Strong leaf selecting pressures are involved, because modifying leaves in specific styles requires a lot of energy (Timm & Lewis, 1991). There are currently 8 specific architecture tent-styles known, including: conical, umbrella, pinnate, apical, bifid, paradox, inverted boat, and boat/apical (Rodriguez-Herrera et al., 2007) (figure 1.1, boat/apical is not displayed). It has also been know that at least 77 tent-capable plant species exist in the

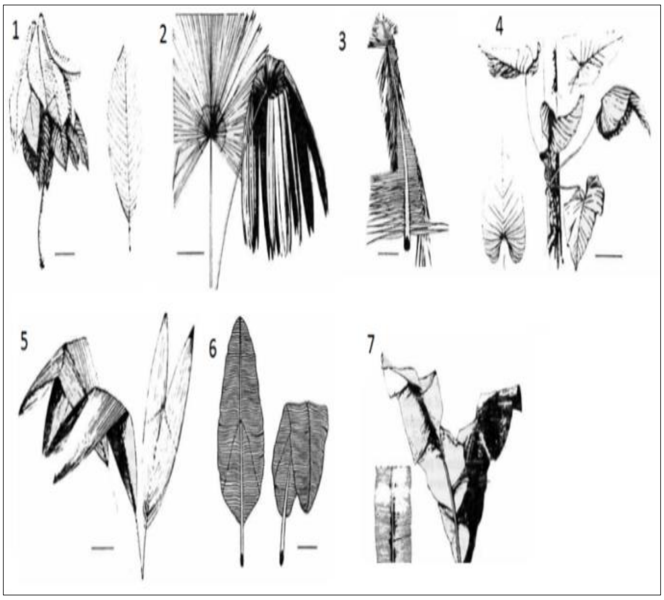

Figure 1.1. Different tent styles Neotropical bats have been reported using as roosting sites. 1=Conical; 2=Umbrella; 3=Pinnate; 4=Apical; 5= Bifid; 6=Paradox; 7=Inverted boat.

Neotropics. Most of these plant species belong to the families Arecaceae and Arraceae, which together comprise 55% of the tent capable plant species. (Campbell, Reid, Zubaid, & Adnan, 2006; Chaverri & Kunz, 2006; Hodgkison, Balding, Zubaid, & Kunz, 2003; Rodriguez-Herrera et al., 2007).

There are at least 14 Neotropical bats species that have been known to modify plant leaves. These bats belong in the family *Phyllostomidae* (leaf-nosed bats), subfamily *Stenodermatinae* (Kunz, Fujita, & Brooke, 1994; Kunz & McCracken, 1996). This study focuses on three abundant bat species in Costa Rica: *Artibeus watsoni, Uroderma bilobatum* and *Ectophylla alba* (Timm & LaVal, 1998). *A. watsoni* (also known as Thomas's fruit-eating bat) is the most studied bat, especially in Costa Rica (Rodriguez-Herreraet al., 2007). This bat uses 41 different plant species for its tents, which is the most of all tent-making bats, and uses 5 of the 8 known tent shapes: umbrella, apical, bifid, inverted boat and boat/apical . It is a small bat (11 grams), commonly found below elevations of 800 m in second growth lowland forests (Reid, 1997). *U. bilobatum* (Peter's tent-roosting bat) uses after *A. watsoni* the most different plant species (Chaverri & Kunz, 2006; Kunz & Lumsden, 2003; Rodriguez-Herrera et al., 2007; Storz & Kunz, 1999). It also uses the most tent styles out of all tent making bats: conical, umbrella, pinnate, apical, bifid, paradox and inverted boat. This bat is also known to roost in hollow trees, caves or even unmodified banana leaves. It also uses tents of other bats such as *E. alba*. *E. alba*, also known as the Caribbean white tent bat, is the most specific tent-making bats of the three, as it rarely uses any other leafs except for the genus Heliconia. It furthermore only uses one tent shape: the inverted boat (Rodriguez-Herrera et al., 2007).

Because bats spend so much time roosting, more information should be gathered about these bat species and their tent creation. It is known that some plants are capable to be used as tents and that plant species result in different tent styles. Chaverri and Kunz (2010) claim that even though some tent-capable plants are very abundant, tent-roosts are not equally frequent. This begs the question how plant density effects tent density. For example: Is there a correlation between the density of available plants, or rather their tent-capable leaves, and tent density? How do location preference and tent quality play a part in this? It is expected that a higher tent capable leaf density results in a higher tent density, as it is known that *U. bilobatum* for example, is more abundant where there is a higher density of coconut palms (Sagot , Rodríguez-Herrera, & Stevens, 2013).

2. Methods & Materials

In order to gather more information about the tent creation of tent making bats and their location preference in doing so, plots have been set up to give a representation of the study site. Setting up plots for tent-making bat research is not unheard of (Medellín, Equihua, & Amin, 1998; Sagot et al., 2013). Subsequently, 15 weeks of fieldwork has been conducted. The procedure will further be described in this chapter.

2.1 Study site

This study is conducted at Caño Palma Biological Station, Pococí, Limón, Costa Rica (N 10°35’36.1”; W 83°31’39.4”) which is located 8 kilometres north of Tortuguero (figure 2.1). The station is adjacent to the Caño Palma river, to which the station owes her name. Lowland Atlantic tropical wet forest surrounds the station (Caño Palma Overview). On average, the yearly temperature is about 26 °C, and rainfall can extend to 6000 ml annually. The humidity is high and constant, as hot air from the Caribbean Sea continually hits Costa Rica’s mountains (DeVries, 1987). The study started September 2015 and ended January 2016.

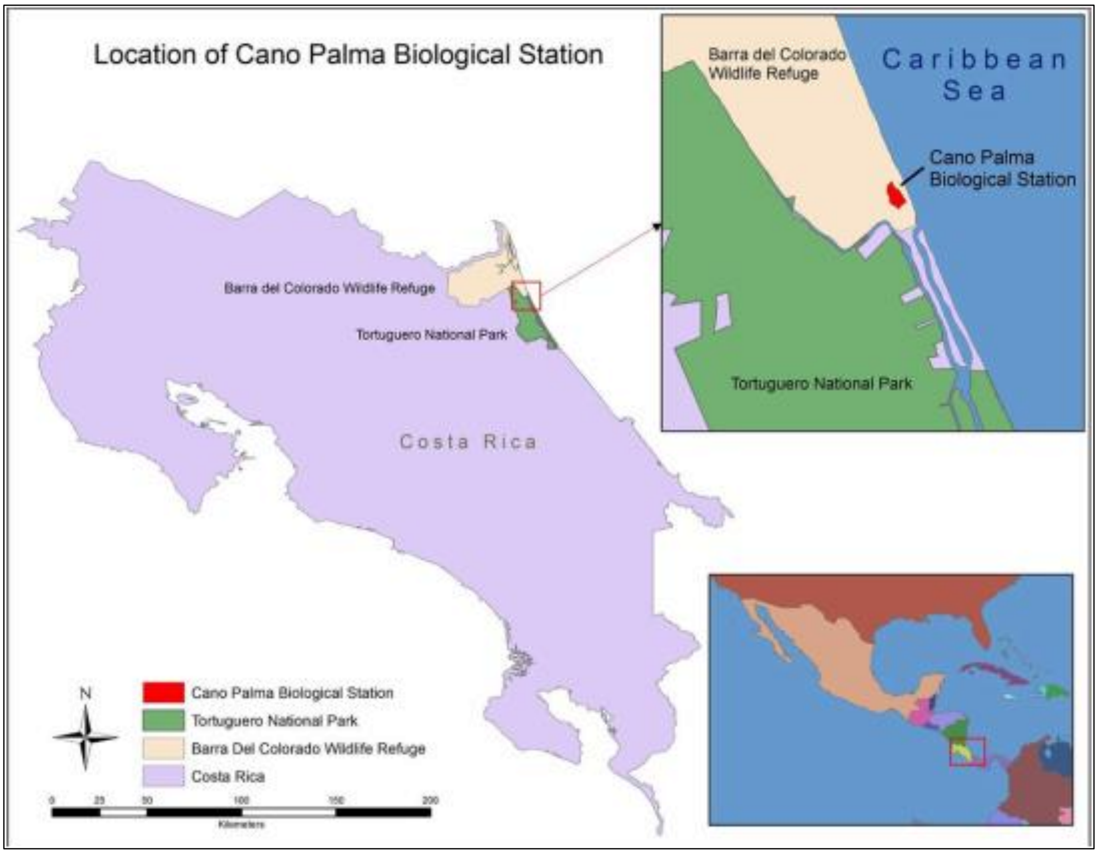

Figure 2.1. Map of the location of Biological station Caño Palma in Limón, Costa Rica.

Just behind the Caño Palma station lies an existing transect that ventures into the lowland forest (Starting point= 10°35'38.1"N 83°31'39.7"W. Ending point= 10°35'36.7"N 83°31'40.0"W). This transect is approximately 1,5 km long, and consist of two different parts with different vegetation types that will be referred to as "location 1" and "location 2". Location 1 is an area located near the river (Caño Palma), which lays slightly higher than location 2 and is subsequently less likely to be flooded. Location 2 is conversely wetter and lower laying then location 1. In total, ten plots (10 m²) have been created, four of which are set up in location 1, and six that were set up in location 2.This way difference in rate of tent creation can be found between two different vegetation types. Figure 2.1 shows an abstract and simplified map of the study site.

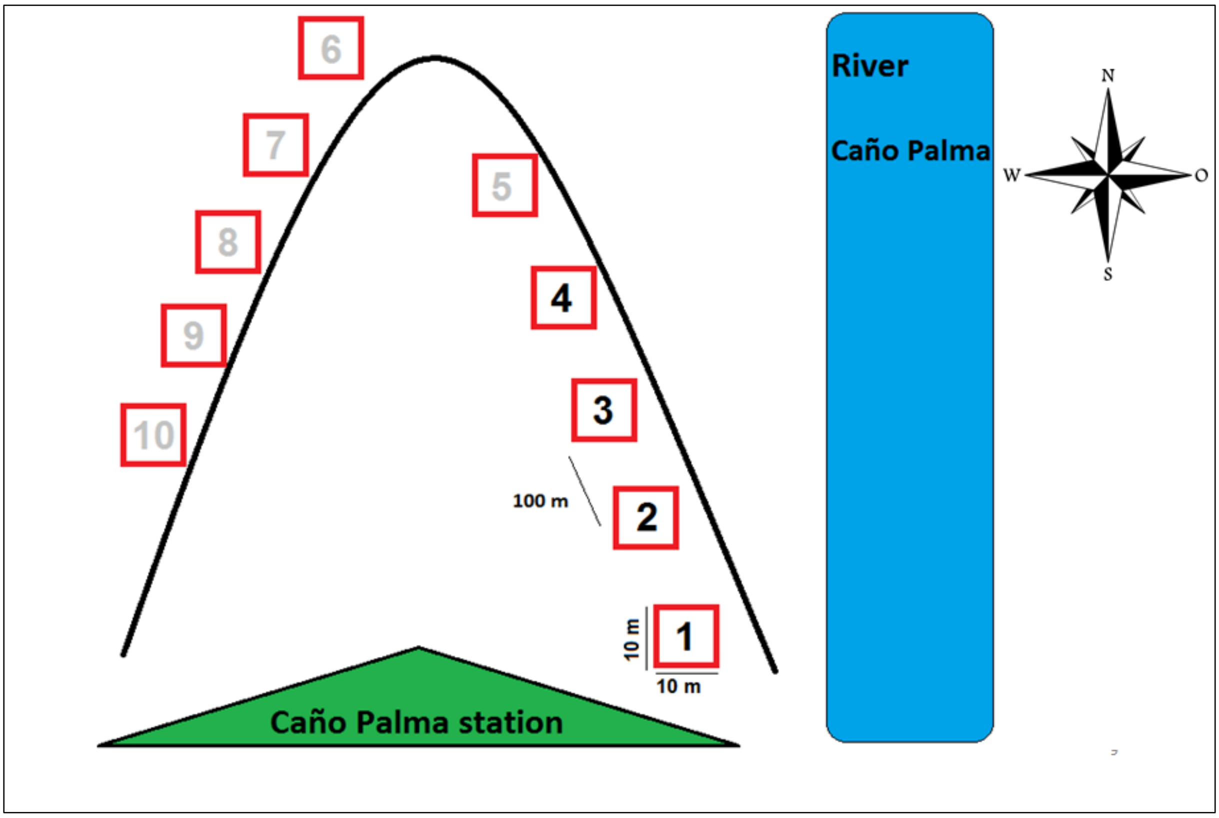

Figure 2.2. Abstract and simplified version of the transect behind the Cano Palma station. Featuring 10 plots each separated about 100 meters from each other (with the exception of plot 5 and 6). Plot 1-4 represented in black include the plots within location 1, whereas plot 5-10 represented in grey include the plots within location 2.

2.2 Fieldwork

The fieldwork consisted of two major parts: monitoring of the vegetation, and monitoring of the tents. Before entering the forest, temperature, humidity and rainfall were measured at the station. This way, abnormalities could be compared and perhaps even explained by climate factors. Each week, the ten plots were systematically combed through, and thoroughly searched in order to find available plant leaves, and also bat tents. When all data was obtained, it was collected in Spss where it was further tested for connections in order to answer the research questions. This has been achieved with the means of specific test that will be described later in this chapter.

2.2.1 Monitoring of the vegetation

In each plot, all plant families that could be used as tents (attachment 1), were examined. It was then determined whether the leaves had a quality good enough to be used as tents, since not all leaves can be used for tents (Kunz & McCracken, 1996). This was done bearing in mind multiple factors that did not meet the requirements of tent making bats, such like: sturdiness of the leaf; leaf size; presence of wasp nests, ants and/or other arthropods; height; amount of holes in the leaf, and if the leaf was suffering from severe necrosis (Sagot et al., 2013; Timm & Choe, 1985). Then the usable plant leaves were marked and numbered, in order to find them back. Afterwards the total number of usable plant leaves was noted. Every week, these plant leaves were checked to see if they were still tent-capable. New plant leaves were again marked and noted.

2.2.2 Monitoring of the tents

In each plot, located tents were examined and rated in quality. The tents were rated on a scale from 1 to 5. 1=poor, 2= below average, 3=average, 4=above average and 5=good (attachment 3). The same factors that determine if a plant leaf is tent capable, determine the quality rating (Sagot et al., 2013). Any changes in quality and the cause for the change were also noted. Furthermore, the tent-style was noted, and the tents were inspected for any bat activity. This includes presence of bat feces, visuals of seeds from the consumed fruits lying underneath the tent, and of course sightings from roosting bats (Brooke, 1990). When roosting bats were sighted, the number of bats was noted, and their species were determined on sight. This is done according to bat characteristics described by Timm and LaVal (1998), and Timm et al. (1999). Finally, all tents will be counted and their location will be recorded.

2.3 Statistics

Several tests have been conducted in order to test the hypothesizes. In order to test if bats differentiate between different tent qualities, a one-way anova and a LSD test have been conducted. Then an independent t-test has been conducted to determine differences in tent-capable leaves and bat activity for location 1 and 2. The p-value for all these test was set on p=0.05. Lastly, a Pearson correlation coefficient was calculated to test the correlation between tent-capable leaves and tent density. See attachment 1 for the interpretation of the values (Rumsey, 2011).

3. Results

The mean number of tents that were found was about 19 tents each week (figure 3.0.1). Of these 19 tents an average of 2.8 tents had bat activity. The minimum amount of activity was 1 tent and the maximum amount was 4 tents, as can be observed in figure 3.0.2. Only *Artibeus watsoni* was found roosting, either in groups of three or alone.

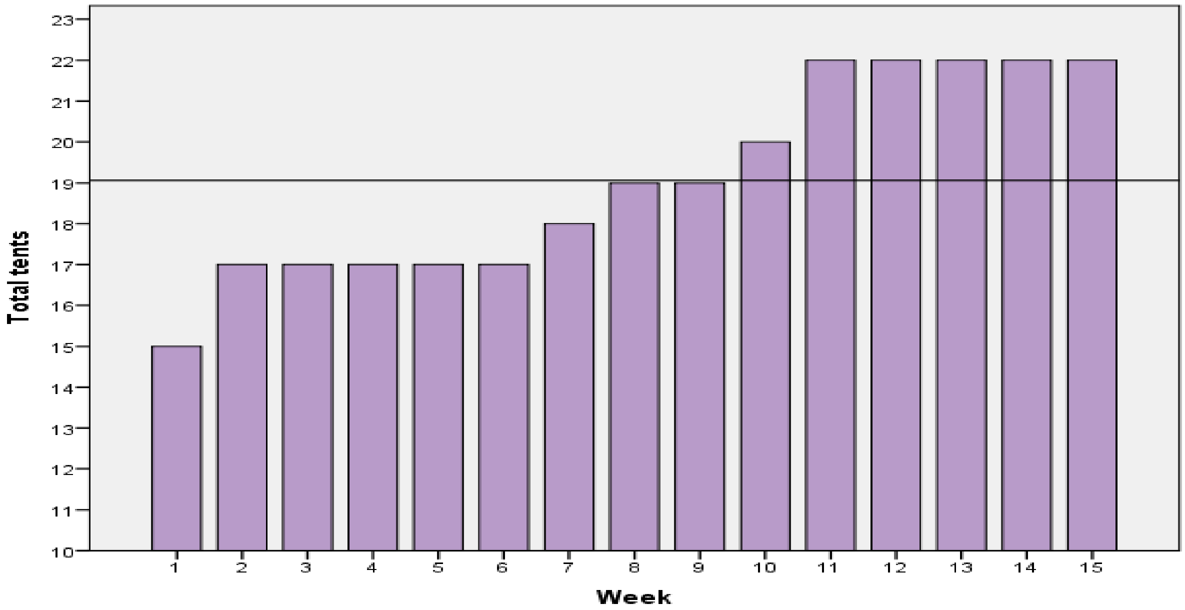

Figure 3.0.1. Total tents. The total amount of tents is displayed for 15 weeks. A reference line shows the average number of tents found per week (19 tents). The lowest amount of tents found was 15 tents in week 1. The highest amount was 22 tents in week 11, 12, 13, 14 and 15.

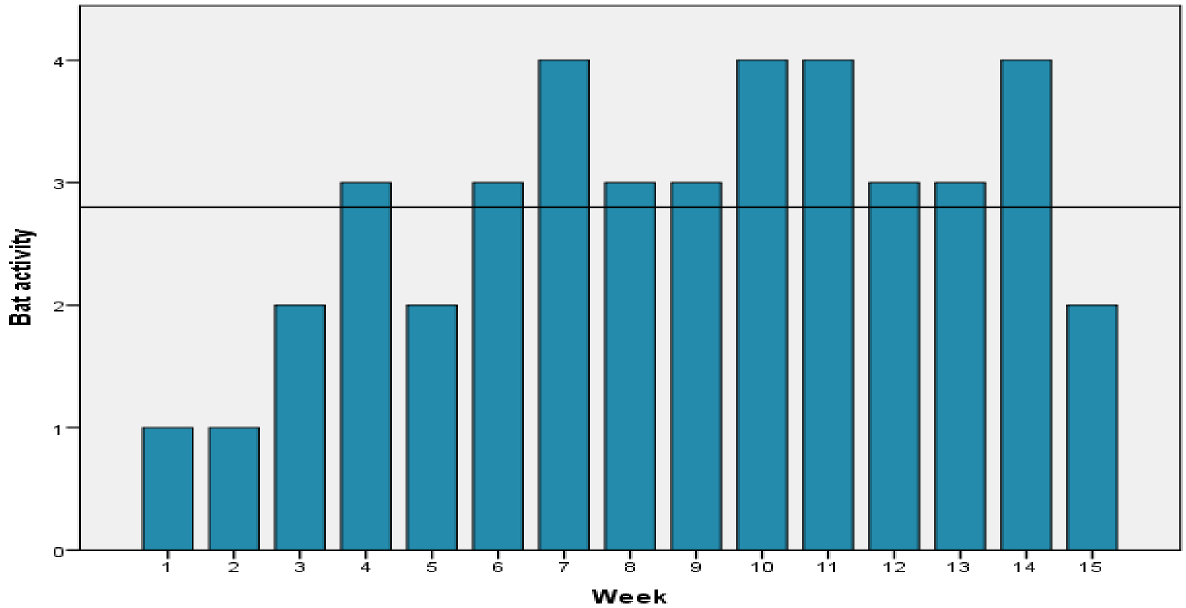

Figure 3.0.2. Bat activity per week. The total amounts of tents with activity, either diurnal or nocturnal, is displayed for 15 weeks. A reference line shows the average number of tent with activity found per week (2,8 tents). The lowest amount of activity was 1 tent in week 1 and 2. The highest amount was 4 tents, in week 7, 10, 11 and 14.

Of all tents recorded with activity, about 83 % were used as nocturnal tents, indicated trough seeds and faeces, and 17% of the tents were used as diurnal tents, indicated through sightings of roosting bats (figure 3.0.3). All bat activity took place in bifid tents.

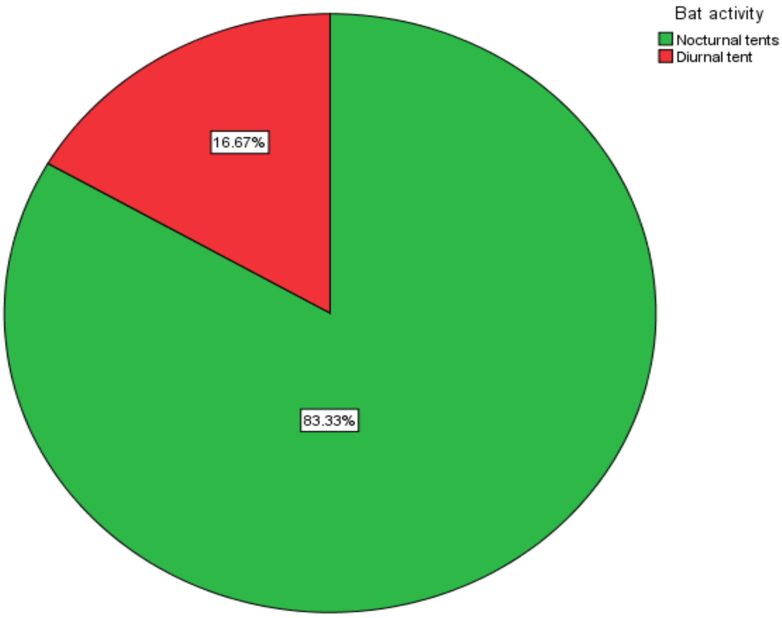

Figure 3.0.3. Type of bat activity. Two different types of tent use. 83.33% of the tents with activity were used as nocturnal tents (displayed in green), indicated by the findings of seeds and bat faeces in and around the tent. The remaining 16.67% were used as diurnal tents (displayed in red), indicated by roosting bats.

3.1 Tent quality

There was significantly ($p= 0.00$) more bat activity in tents with a "good" quality than tents with lower qualities as is displayed in figure 3.1. There did not seem to be any significant differences between the other qualities: poor, below average, average and above average. Most of the activity took place in tents with good quality, with the exception of a few outliers.

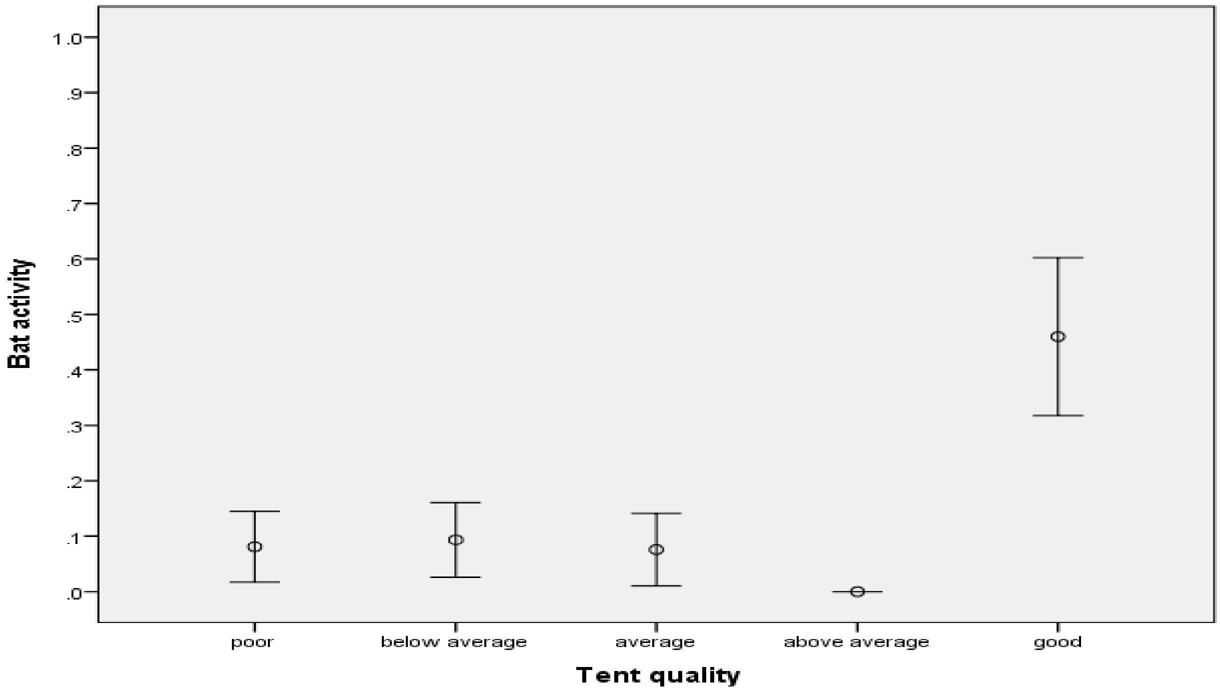

Figure 3.1. Bat activity in tents with different qualities. The frequency of bat activity measured over different qualities: poor, below average, average, above average and good. Good quality had significantly more activity than any other quality. There was no significant difference between the other qualities. Almost all activity took place in tents with good quality, with only a few exceptions, displayed by the error bar.

3.2 Location

Location 1 had a significant (p=0.00) higher number of tent-capable leaves than location two, as can be seen in figure 3.2.1. Location 1 has an average of 48 tent-capable leaves whereas location two only has a mean of 23 tent-capable leaves. Location 1 has furthermore significantly (p=0.00) more bat activity than location 2.Figure 3.2.2 shows this bat activity measured for both locations 1 and 2 and shows that almost all activity took place in location 2, with the exception of one outlier. It is important to note however, that his outlier is one of the few diurnal tents that were found and therefore important to keep this outlier in the analysis. In location 2, a total of 47 tents with a “good quality” were found, as opposed to 3 tents in location 1.

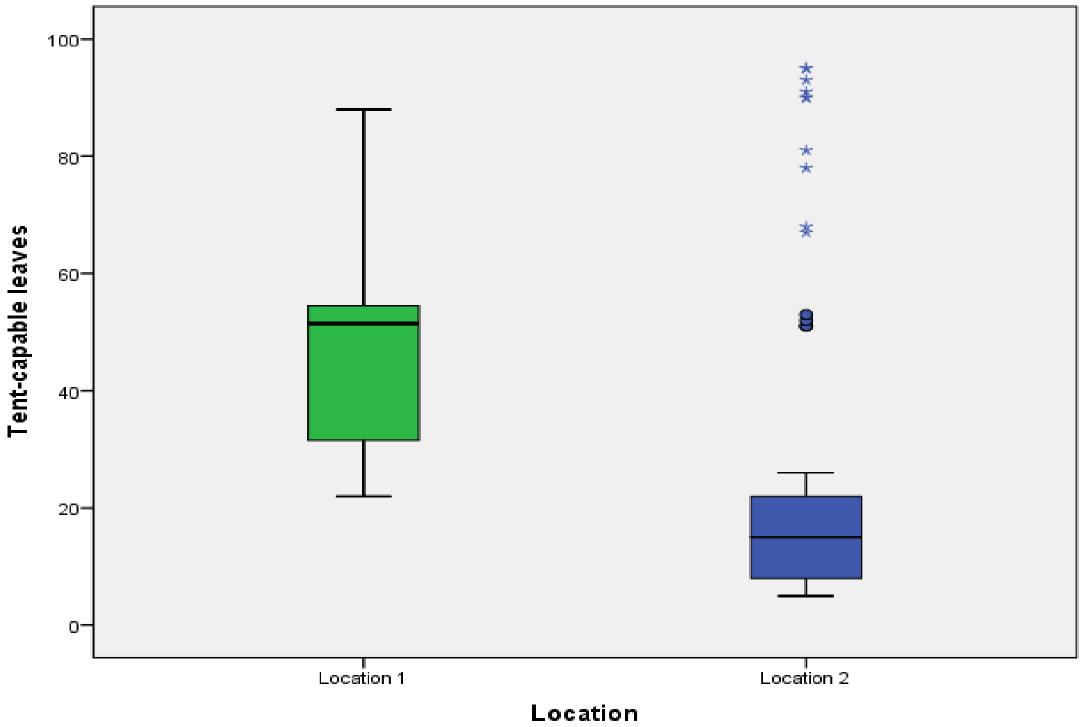

Figure 3.2.1. Difference in tent-capable leaves per location. The average of tent-capable leaves in location 1 and location 2. Location 1 (displayed in green) is a higher area then location 2 and therefore rarely flooded. Location 2 (displayed in blue) lays lower and is subsequently more flooded. Location 1 shows an average of 48 tent-capable leaves, whereas location 2 shows an average of 23 leaves. Outliers are displayed as dots and stars.

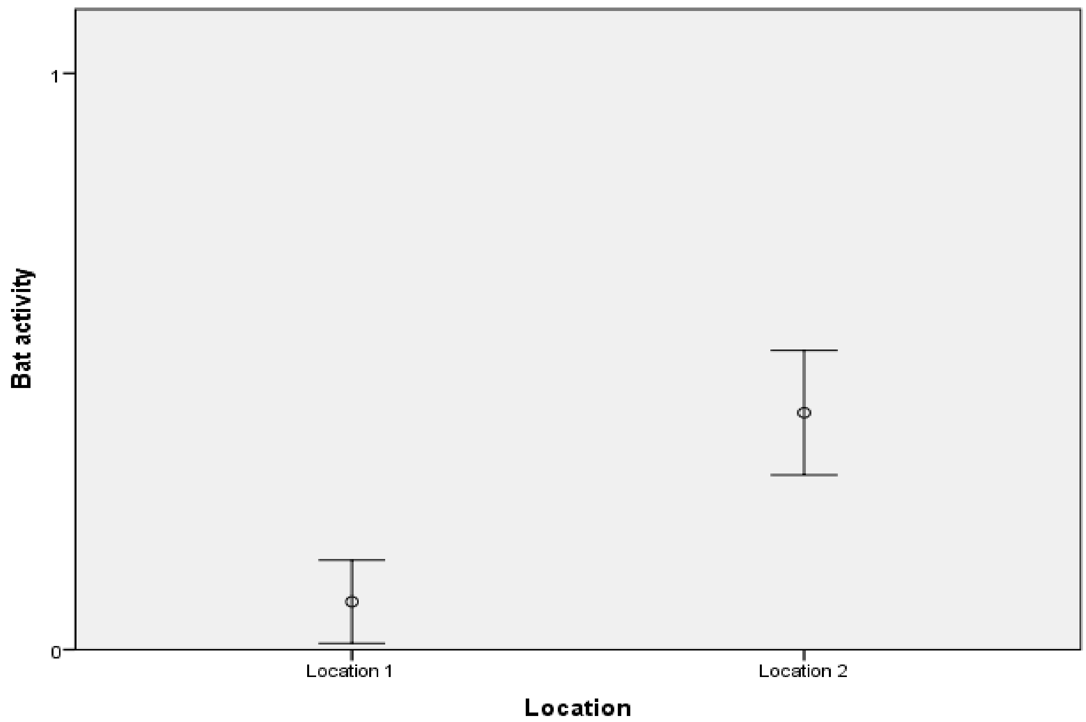

Figure 3.2.2. Difference in bat activity per location. The mean bat activity in location 1 and location 2. Location 1 is a higher area then location 2 and therefore rarely flooded. Location 2 lays lower and is subsequently more flooded. Location 1 shows an average of 0.08 bat activity, whereas location 2 shows an average of 0.41 bat activity. Almost all bat activity took place in location 2 except for one outlier (not displayed), which causes the distribution in location 1. This outlier is important, though, because it is one of the few diurnal tents that were found.

3.3 Tent-density

There is no linear correlation between tent-capable leave density and tent density, as the Pearson coefficient r is 0,036 with p= 0,660 (attachment 4.1). Figure 3.3.1 also shows there is no linear correlation between tent density and tent-capable leaves, a dashed reference line is displayed in the figure assuming a linear correlation.

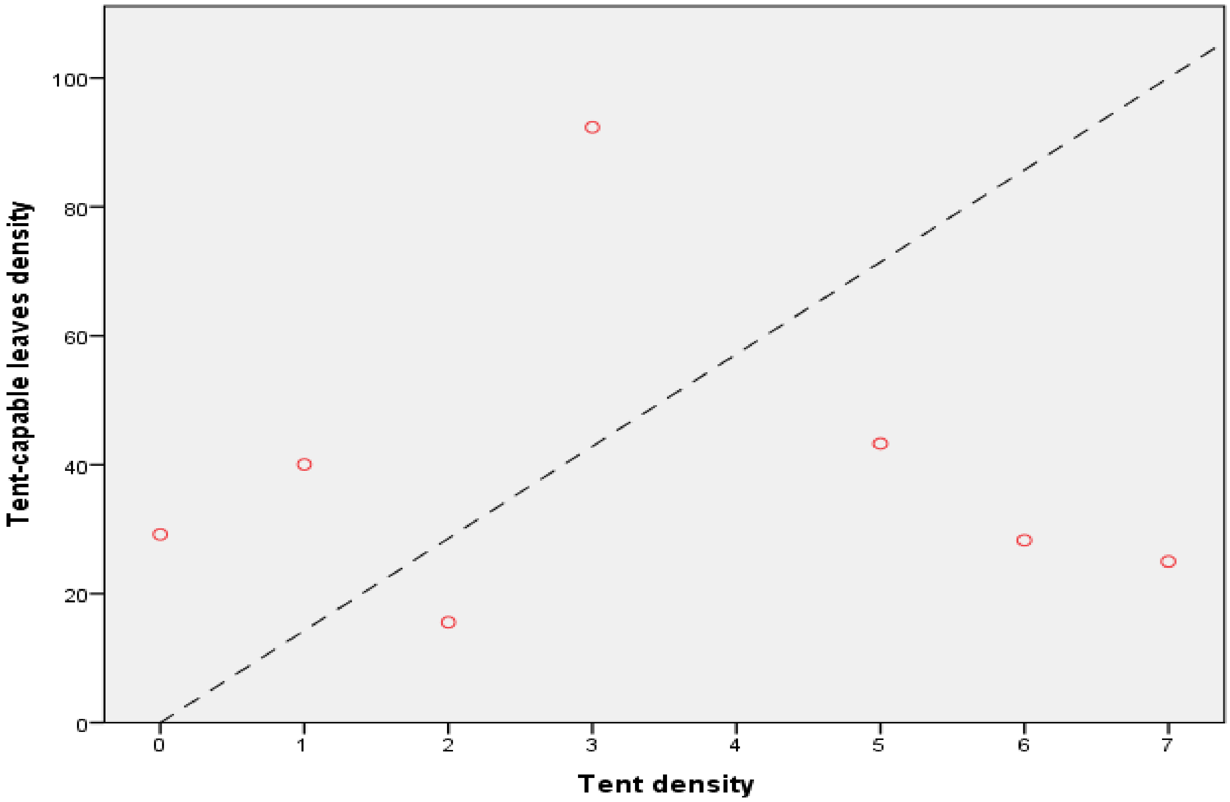

Figure 3.3.1. Correlation between tent-capable leave density, and tent density. Tent-capable tent leaves and tent density are compared. A reference line for a linear correlation is displayed (y= 14.2857 * x + 0). There is no linear correlation between tent-capable leaves density and tent density.

A linear correlation is found however, when looked at specifically bifid tent-capable leaves in correlation with bifid tent density (figure 3.3.2). The Pearson correlation is 0.646 which should be interpreted as a strong positive correlation.

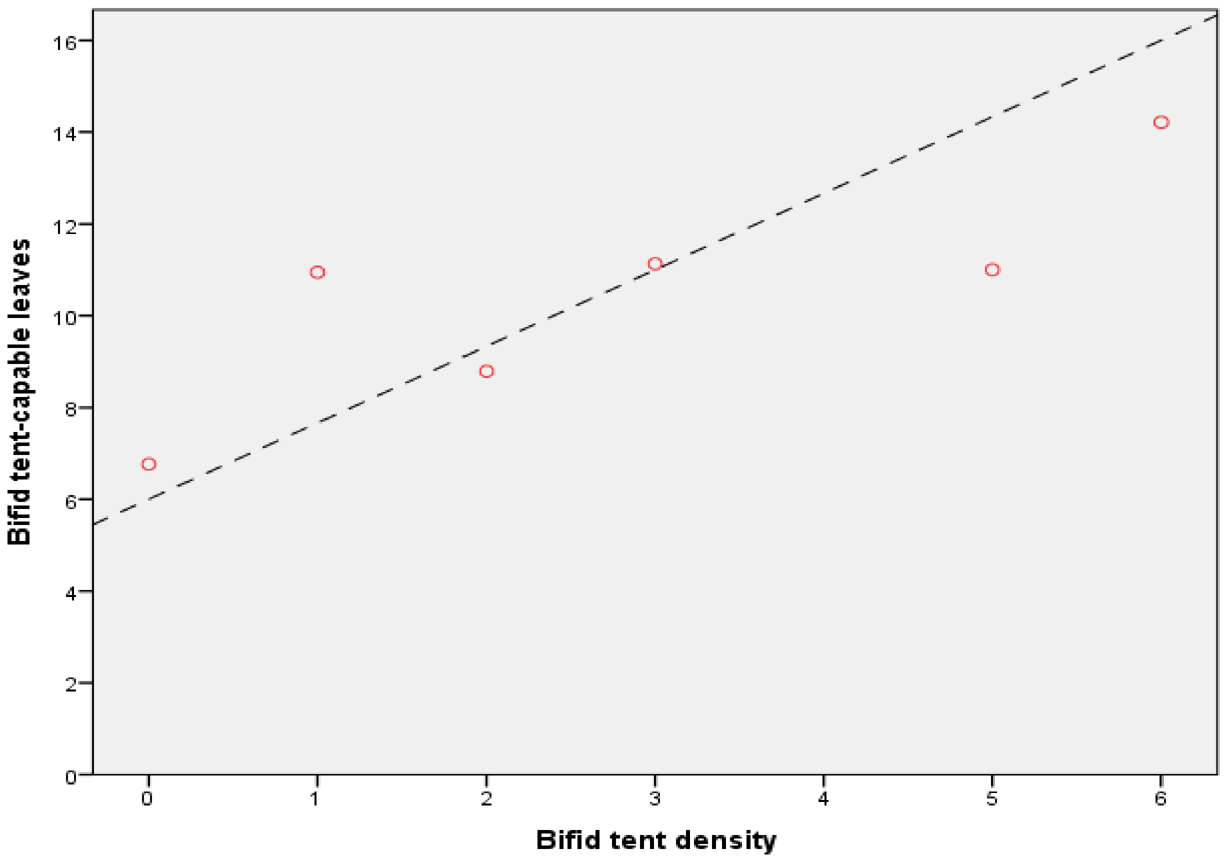

Figure 3.3.2. Correlation between bifid tent-capable leave density, and bifid tent density. Tent-capable tent leaves and tent density are compared. A reference line for a linear correlation is displayed (y=1.6667 * x + 6). There is a moderate positive correlation between tent-capable leaves density and tent density.

4. Discussion

Of all three species only *Artibeus watsoni* has been observed roosting in tents, even though *Ectophylla alba* and *Uroderma bilobatum* are considered abundant in the area (Timm & LaVal, 1998). This may suggest that *A. watsoni is* just the most abundant of the three, but it could also be the result of a small sample size. Just 16.67% of the tents with activity were diurnal tents. Indeed a stunning 83.33% of the activity took place in nocturnal tents, indicated by mainly fig seeds (Morrison, 1978), which prevented the possibility of species determination. In other words, it is not known which bat species were active for the majority of tents. It is quite remarkable that so little diurnal tents were found in the first place. This could be because the plots were fairly close to the transect, what could have disturbed them. According to Kunz (1982) and Chaverri & Kunz (2006), bats are sensitive to human disturbance, and this particular transect was walked at least 3 times per week. There was an instance when our main presence resulted in frightening the bats, which flew into another, unfinished tent. Other findings describe similar occurrences (Boinski & Timm, 1985; Lewis, 1995).

4.1 Quality

Bats seem to prefer tents with a high quality over tents with lower quality. Even more remarkable is that fact that bats do not seem to differentiate between the lower qualities. They do not prefer above average tents over poor quality tents for example. That means the quality for tents need to be in excellent conditions in order to be used as roosting sites. This seems legitimate, since it has been postulated by many that tent quality plays a big part in mate selection in females (Bhat & Kunz, 1995; Kunz & McCracken, 1996; Kunz, et al., 1994; Tan & Kunz, 1997). Factors associated with good quality in tents, such as big leaves and little necrosis, provide subsequently more resistance against weather conditions such as rain, which is one of the reasons tent roosts are created in the first place (Choe, 1994; Timm & Lewis, 1991). Using modified leaves that exhibit greater resistance to weather conditions, result in better mating success. As do darker roosting sites and greater sturdiness of the leaves, which are also indicators for “good quality tents” (Muñoz-Romo, Herrera, & Kunz , 2008). However, most activity was found in diurnal tents, therefore more research should be conducted to determine if bats specifically differentiate in diurnal tent quality.

4.2 Location.

Since location 2 had more bat activity than location 1, it can be suggested that bats prefer location 2 over location 1. One could argue that there was less activity in location 1 because some of its plots were close to the station, but this is not likely. The station itself does not seem to be disturbing the bats, as plenty of bats were observed roosting really close to the station outside of this research. The preference might occur because of factors like: available food in the area, the vegetation, or more specifically the density of the vegetation density, though more research is needed to confirm this. Even though these factors may play a considerable part, an interesting outlier was found in location 1. This outlier is actually a diurnal tent, as it contained 3 *Artibeus watsoni bats*. This is interesting because only a small fraction of the located tents was diurnal. The tents in location 1 seemed to be more clustered than Location 2, and there were therefore a lot of tents for the bats to choose from in the immediate near area. The way these tents were clumped is common tent-making behaviour for *A. watsoni* (Timm, 1987). Another, more likely factor could simply be that location 2 has more tents with a good quality and subsequently more bat activity.

4.3 Tent density

Overall, tent-capable leave density does not affect tent density, but when looking specifically at bifid leaves and bifid tents there does seem to be an expected correlation. The linear correlation is moderate/strong and positive. It is probable that this difference was caused by a high number of bifid tents as opposed to other tent styles, as a result of small sample areas. The fact that a strong linear correlation was found however, confirms the hypothesis that tent-capable leaves do indeed affect the tent density in a positive manner. Whereas some findings suggest otherwise (Chaverri & Kunz, 2010), Timm and Lewis (1991) agree that tent bats seem to be more abundant where there are more tent-capable plant species. For upcoming research it is advised to design bigger plots in order to get a reliable result for tent-capable leaves in general.

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Attachments

Attachment 1

Plant family preferences of *A. watsoni*, *U. bilobatum* and *E. alba* (Rodriguez-Herrera et al., 2007).

1.1 Plant preferences of *A. watsoni*

Architecture	Plant family
Umbrella	Cyclanthaceae
	Arecaceae
Boat/apical	Heliconiaceae
	Piperacea
	Rubiaceae
Apical	Araceae
	Heliconiaceae
	Marantaceae
	Melastomataceae
	Moraceae
	Urticaceae
Bifid	Arecaceae
	Cyclanthaceae
Boat	Musaceae
	Heliconiaceae

1.2 Plant preferences of *U. bilobatum*

Architecture	Plant family
Conical	Achariaceae
	Gentianiaceae
	Myrsinaceae
	Polygonaceae
Umbrella	Araceae
	Cyclanthaceae
	Arecaceae
Pinnate	Arecaceae
Apical	Strelitziaceae
Bifid	Arecaceae
Paradox	Musaceae
Boat	Heliconiaceae

1.3 Plant preference by *E. alba*

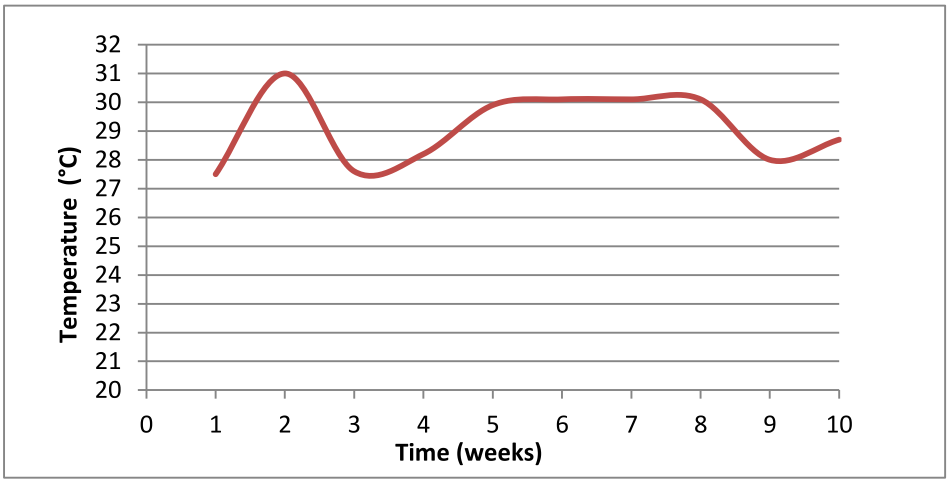
Architecture	Plant family
Boat	Heliconiaceae
	Marantaceae

Attachment 2

Climate data measured at the field station. Temperature and humidity are only measured for ten week.

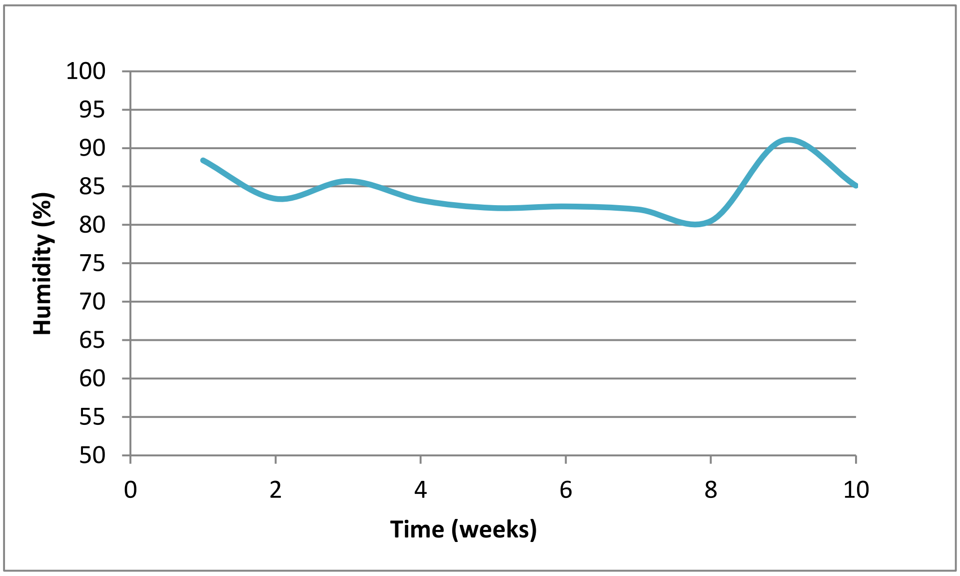
2.1 Temperature

Fluctuation of the temperature (°C) measured over ten weeks.

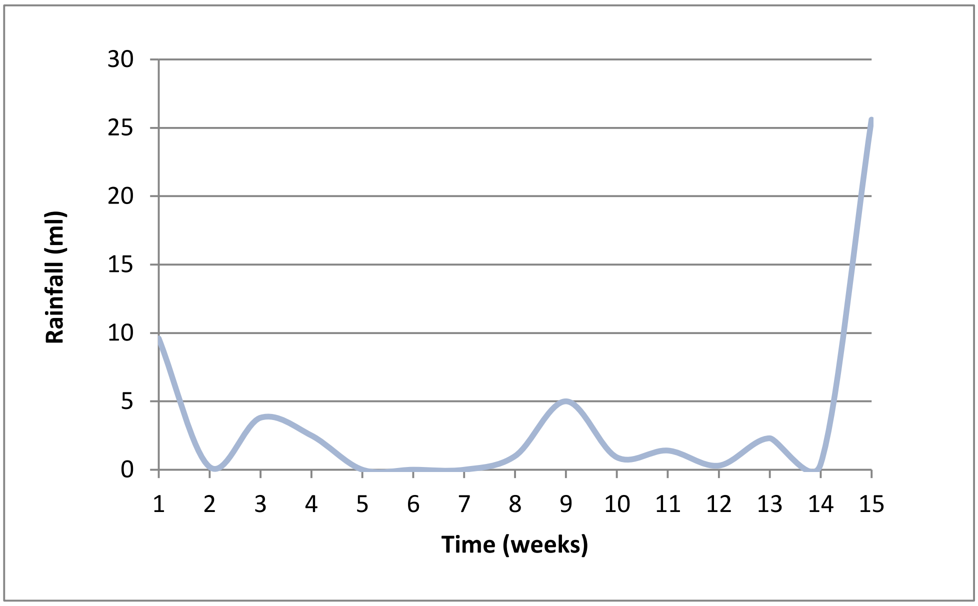


2.2 Humidity

Fluctuation of the humidity (%) measured over ten weeks.



Fluctuation of rainfall (ml) measured over fifteen weeks.



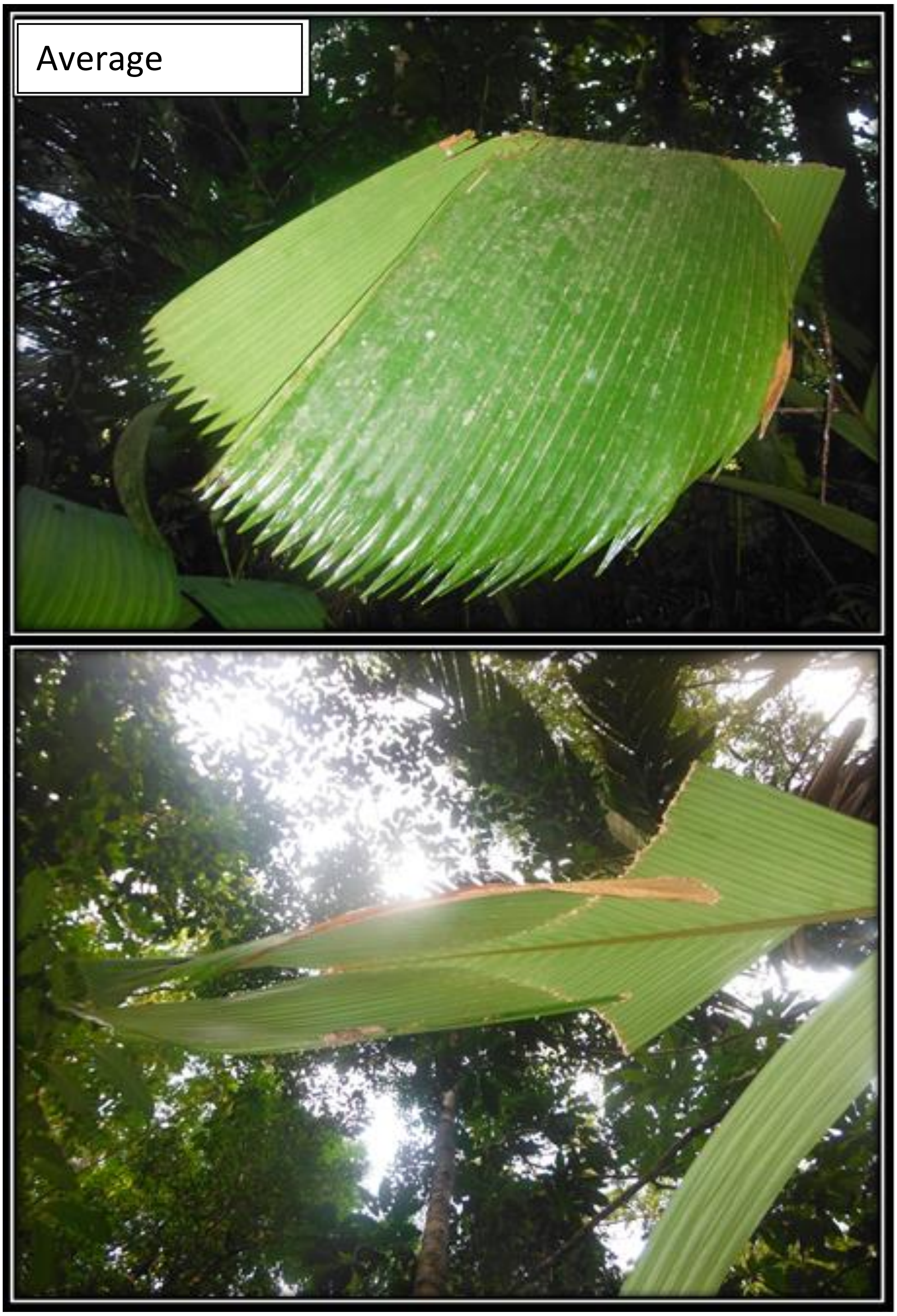
Attachment 3

Qualities of the tents with pictures

3.1 Poor quality= 1

3.2 Below average quality= 2

3.3 Average quality= 3



3.4 Above average= 4

3.5 Good quality= 5

Attachment 4

A guideline to help interpreting the Pearson correlation values.

Pearson correlation values	**Interpretation**
Exactly –1	A perfect downhill (negative) linear relationship
–0.70.	A strong downhill (negative) linear relationship
–0.50.	A moderate downhill (negative) relationship
–0.30.	A weak downhill (negative) linear relationship
0.	No linear relationship
+0.30.	A weak uphill (positive) linear relationship
+0.50.	A moderate uphill (positive) relationship
+0.70.	A strong uphill (positive) linear relationship
Exactly +1.	A perfect uphill (positive) linear relationship

Attachment 5

In the following attachment you can find the Spss outputs of all tests performed in this research.

5.1 One way anova output

Here you can find the output of the one way anova test conducted In order to test if bats differentiate between different tent qualities.

Descriptives

Bat_activity

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
poor	74	.08	.275	.032	.02	.14	0	1
below average	75	.09	.293	.034	.03	.16	0	1
average	66	.08	.267	.033	.01	.14	0	1
above average	22	.00	.000	.000	.00	.00	0	0
good	50	.46	.503	.071	.32	.60	0	1
Total	287	.14	.351	.021	.10	.18	0	1

Test of Homogeneity of Variances

Bat_activity

Levene Statistic	df1	df2	Sig.
35.539	4	282	.000

ANOVA

Bat_activity

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.241	4	1.560	15.225	.000
Within Groups	28.901	282	.102		
Total	35.143	286			

Multiple Comparisons

Dependent Variable: Bat_activity

LSD

(I) Tent_quality	(J) Tent_quality	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
poor	below average	-.012	.052	.815	-.12	.09
	average	.005	.054	.922	-.10	.11
	above average	.081	.078	.298	-.07	.23
	good	-.379*	.059	.000	-.49	-.26
below average	poor	.012	.052	.815	-.09	.12
	average	.018	.054	.745	-.09	.12
	above average	.093	.078	.230	-.06	.25
	good	-.367*	.058	.000	-.48	-.25
average	poor	-.005	.054	.922	-.11	.10
	below average	-.018	.054	.745	-.12	.09
	above average	.076	.079	.337	-.08	.23
	good	-.384*	.060	.000	-.50	-.27
above average	poor	-.081	.078	.298	-.23	.07
	below average	-.093	.078	.230	-.25	.06
	average	-.076	.079	.337	-.23	.08
	good	-.460*	.082	.000	-.62	-.30
good	poor	.379*	.059	.000	.26	.49
	below average	.367*	.058	.000	.25	.48
	average	.384*	.060	.000	.27	.50
	above average	.460*	.082	.000	.30	.62

*. The mean difference is significant at the 0.05 level.

5.2 Independent t-test

Here you can find the output of the independent measure tests conducted to determine differences in tent-capable leaves and bat activity for location 1 and 2.

Group Statistics

	Location	N	Mean	Std. Deviation	Std. Error Mean
Total_activity	Dry location	60	.08	.279	.036
	Flooded location	90	.41	.517	.054

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Total_activity	Equal variances assumed	121.934	.000	-4.492	148	.000	-.328	.073	-.472	-.184
	Equal variances not assumed			-5.019	142.625	.000	-.328	.065	-.457	-.199

Group Statistics

	Location	N	Mean	Std. Deviation	Std. Error Mean
Total_leaves	Dry location	60	47.95	17.675	2.282
	Flooded location	90	23.38	24.437	2.576

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Total_leaves	Equal variances assumed	1.479	.226	6.704	148	.000	24.572	3.665	17.329	31.815
	Equal variances not assumed			7.140	146.967	.000	24.572	3.441	17.771	31.373

5.3 Pearson output

Here you can find the output of the Pearson test. a Pearson correlation coefficient was calculated to test the correlation between tent-capable leaves and tent density.

Correlations

		Total_leaves	Total_tents
Total_leaves	Pearson Correlation	1	.036
	Sig. (2-tailed)		.660
	N	164	150
Total_tents	Pearson Correlation	.036	1
	Sig. (2-tailed)	.660	
	N	150	150

Correlations

		Total_bifid_leaves	Total_bifid_tents
Total_bifid_leaves	Pearson Correlation	1	.646**
	Sig. (2-tailed)		.000
	N	149	149
Total_bifid_tents	Pearson Correlation	.646**	1
	Sig. (2-tailed)	.000	
	N	149	150

**. Correlation is significant at the 0.01 level (2-tailed).