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Abundance and Species Composition of Indigenous and Exotic Fruit Trees in the Feeding sites of Fruit Bats: A Study Case of Kasanka National Park and Kafinda Game Management Area, Central Zambia

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Abstract

We conducted a basic inventory of tree species composition, density and frequency, to establish baseline data on abundance and phenology of fruiting trees in the known fruit bats' foraging areas. The study was carried out between November and December 2014 and January to February 2015, in Kasanka National Park and Kafinda Game Management Area. This area hosts one of the largest global concentrations of fruit bats estimated at ten million in one single locality every October – December/January and was therefore, found to be suitable for this study.Plot method using 20 m x 20 m square quadrats were set up inside the National Park and Kafinda Game Management Area. Each tree in the plot was identified and DBH taken at 1.3 m above ground. Tree height was determined using a tree height measuring rod and Haga Car Leiss altimeter. Identification of tree species was done by; i) direct observation, ii) use of a field guide, and iii) use of an experienced herbarium technician. Results obtained showed that there were 64 species of trees. Of these, 20 (approximately 30 %) were fruit trees, of which 16 (approximately 80 %) were available and accessible to fruit bats. *Mangifera indica* (an exotic species) and *Uapaca* spp were the most abundant fruit trees with relative abundance > 10 %. The density of the trees was high at 365/ha of which 199/ha (55 %) was covered by fruit trees. The study area had abundant flowering and fruiting trees (55% by area). Further research is required to; i) investigate other environmental factors influencing the choice of Kasanka area as a feeding and roosting site for migratory fruit bats, and ii) explore potential alternative sites for migrant fruit bats which share similar phenology and tree species composition as the Kasanka area.

Keywords: *Foraging, alternative, phenology, colony, flowering, accessible*

1. Introduction

The miombo ecoregion is located within the Zambezian Regional Centre of Endemism and covers approximately 3.6 million square kilometres spanning ten countries, Angola, Botswana, Democratic Republic of Congo, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe (WWF 2001). The ecoregion is largely Caesalpinoid woodland that is generally called broad-leaved 'dystrophic' savannah woodland (Huntley and Walker 1982). In Zambia, it is defined by the dominance or high frequency of trees belonging to the legume subfamily Caesalpinoideae and genera *Brachystegia*, *Julbernardia* and *Isoberlinia* spp. Other genera include, *Baikiaea*, *Cryptosepalum*, *Colophospermum* and *Burkea.*

The miombo is generally divided between wet and dry miombo and other vegetation communities associated with it are: mopane, itigi thicket, wetland grassland, *Acacia*/*Combretum* complexes, *Baikiaea*, *Burkea*/*Terminalia*/*Combretum* complexes, and *Cryptosepalum* which are largely non-fruit bearing. These vegetation communities usually support low densities of micro and mega chiroptera, but the Kasanka – Kafinda areas located in wet miombo of central Zambia is an exception to this rule and is the only known locality in Zambia which hosts one of the largest global concentrations of migratory fruit bats in a single locality (Ritcher, 2004), comprising eight species *viz*; Dwarf epauleted fruit bat (*Micropteropus pusillus),* Anchieta's broad-faced fruit bat (*Plerotes anchietae),* Peters's epauletted fruit bat (*Epomophorus crypturus),* Wahlberg's epauletted fruit bat (*Epomophorus wahlbergi),* Little epauletted fruit bat (*Epomophorus labiatus),* East African little epauletted fruit bat (*Epomophorus minor),* Dobson's epauletted fruit bat (*Epomops dobsonii)* and Straw-coloured fruit bat (*Eidolon helvum) (sensu* Ritcher and Cumming, 2006). Such large congregations of fruit eating bats in a single locality are only expected in tropical rain forest where fruits are more abundant (Ritcher, 2004).

It is not known at least by the current state of knowledge how forest dwelling species which mainly subsists on fruit pulp and juices, nectar, and pollen as well as chewing leaves to obtain special nutrients, which are abundant in tropical rainforests, would migrate to utilise a dystrophic miombo vegetation community which is generally poor in fruits. Other researchers, including Keely (2009), suggest that migration are probably genetically determined, instinctive and influenced also by weather conditions and the availability of food, but nothing is known of how bats recognize migration goals or how succeeding generations learn their locations. If food is one of the important factors determining their selection of sites by bats, then it becomes inevitable to investigate the abundance of fruit trees in the known feeding areas.

In Kasanka National Park and Kafinda Game Management Area for instance, Ritcher (2004), recorded food sources for bats which included, *Musa* spp, *Magnistipula butayei*, *Parinari curatelifolia, Syzygium* spp, *Uapaca kirkiana, Uapaca nitida*, *Uapaca benguelensis*, *Uapaca sansibarica* and others which are in fruit during the period coinciding with the arrival of migratory fruit bats. However, she did not determine the overall tree species composition, abundance and phenology of fruit trees as this may, acting together with other environmental factors, influence the number of bats that can be supported by the habitat, determine their time of arrival, length of stay and departure time.

This study was intended to provide baseline information on the ecological status of the habitat in terms of tree density and availability of fruit trees, which could be used in monitoring the habitat and in safeguarding such areas against destructive anthropogenic activities. Preventing disturbances to the habitat is important because it may lead to low reproductive success as was also recorded in birds by Robinson et al. (1995).

The role of the current impacts of climatic change scenarios combined with wild fire were also considered in this study because they can affect woody plant communities including fruit trees. Thus, understanding the abundance of fruiting trees can enable management to measure the degree of departure from baseline information and help in securing such foraging areas by managing and controlling anthropogenic activities which may fragment or destroy habitat quality and deprive bats of their food source.

This is important because worldwide, bat populations are declining at a rapid rate, due in large part to the destruction of feeding and roosting habitats and the misuse of toxic pesticides (Wilson, 2010). Human interactions with bats have also contributed to their decline. In many nations, bats are unjustifiably earmarked as nuisances or threats to public health and killed. Between 1963 and 1970, the world's largest bat colony, some 30 million Mexican free-tailed bats in Eagle Creek Cave in the Apache Sitgreaves National Forest in southeastern Arizona was reduced to 30,000 individuals, a decline of 99.9 percent. Major population losses have been recorded on all continents, and several island-dwelling Megachiroptera, such as the little Mariana fruit bat of Guam, have recently become extinct (Wilson, 2010), this is no exception to Africa and Zambia in particular where habitat transformation is a major threat to the long-term survival of bats.

Keely (2009) also showed that the decline in the populations of Old World fruit bats was attributed to excessive hunting, persecution by farmers, and deforestation. Some species have been hunted to extinction for food and medicinal potions (IUCN, 1990; Dumont 2000). Many other species are endangered or vulnerable (IUCN, 1990; Horvorka et al, 1998). Unfortunately, there is no legal protection available throughout their range in Africa. Therefore, maintenance of good quality habitat by protecting fruit trees for food and thick woodland or forests for roosting remains critical in sustaining bat populations. In Kasanka National Park, for instance, bat migration forms a basis for photographic tourism and loss of habitat quality and decline in their population size would negatively affect tourism, which is an important source of income for conservation.

In this study, we conducted a basic inventory to determine tree species composition, establish density and fruiting season, determine the abundance of fruit trees among other woody plants as an indication of food availability in areas where Ritcher (2004) conducted her studies and recorded the types of fruits eaten by bats. Information generated by this study would be utilised by the Department of National Parks and Wildlife (NPW) to maintain a minimum density of fruit trees as source of food for bats. Knowing species composition and density would also enable NPW to set lower thresholds of vegetation change below which management intervention may be required to actively manipulate the habitat and restore its physiognomic status. Understanding the nature of the habitat with respect to species composition, density and the distribution of fruit trees is critical in ensuring that the human - bat interaction of hunting and habitat clearance through logging as earlier recorded by Ritcher (2004) is monitored and negative human impacts such as *Chitemene* system of agriculture can be prevented. In emphasising the importance of determining tree density and species diversity, Keely (2009) showed that in some areas, large numbers of Old World fruit bats have been killed by farmers fearing damage to orchard crops, when in actual fact bats may only feed on crops during droughts, when native trees provide little food, otherwise most commercial fruit is harvested while it is still too green to attract Old World fruit bats.

2. Material and Methods

2.1 Location and Description of Area

2.1.1 Location

The study was carried out in Kasanka National Park and Kafinda Game Management Area. The National Park and Game Management Area are located in Serenje district of Central Province of Zambia. It is an appropriate site for studying the feeding ecology of the fruit bats, because it is the only site in Zambia where such large numbers of up to ten million gather over the period October/November – December/January every year. The National Park is located at coordinates (12º30’S 30º14’E) and altitude of 1200 m above sea level (Figure 1).

Figure 1 Location of Kasanka National Park and the adjacent Kafinda Game Management Area, Zambia. (Source: Zambia Tourist Board)

2.1.2 Climate and Vegetation

The study area is located in Agro-ecological zone III with annual rainfall ranging from 1,100 mm to 1, 700 mm (Cosson et al. 1999). The rainy season is between October/November - April. The vegetation communities are composed of mainly miombo woodlands dominated by trees of the genera *Brachystegia*, *Isoberlinia,* and *Julbernardia* spp interspersed with trees of the genera such as; *Uapaca, Protea,* and *Faurea* intermixed with wide, grassy dambos and small stands of chipya forest (Chidumayo, 1987).

The common vegetation communities are: *Chipya* forests comprising wooded grassland dominated by fire resistant tree species such as *Terminalia mollis, Erythrophleum africanum,* and *Combretum* spp. These forests were found in small patches in mosaic with miombo woodland throughout Kasanka. *Chipya* is notable due to absence of *Uapaca* and other common miombo fruiting species. "*Mateshi*" forest a dry evergreen forest exits in Kasanka only as small relics (Smith & Fisher, 2001).

The *Mushitu* forest located inside the National Park is important because it is the only known roost site in the Southern Africa region for a large migratory fruit bat colony (Ritcher, 2004). The "*Mushitu*" is a three-canopy closed evergreen forest of up to 27m tall and is represented by only two small patches covering an area of about 0.4 km² (Smith & Fisher, 2001). It is dominated by species such as *Khaya nyasica*, *Parkia filicoidea,* and *Diospyros mespiliformis* (Smith & Fisher, 2001). Below the upper canopy is a dense thicket of plants consisting mainly of ferns and climbers (Storrs, 1995). Waterberry *(Syzygium cordatum*) and African mahogany (*Khaya nyasica)* dominate the taller canopy layer, while Swamp fig (*Ficus trichopoda*) dominates the understory.

2.2 Field Data Collection Methods

2.2.1 Random Sampling

Quantitative data were collected by randomly selecting sampling plots in woodlands located in Kasanka National

Park and Kafinda GMA. Sample plots in Kafinda GMA, were taken starting from the Serenje/Samfya road (T2). Random numbers were generated for determining the 35 starting points of each transect from Serenje/Samfya road as baseline. The orientation of transects was 90° from T2 Road. The choice of which side of the road transects should be set was decided by tossing a coin, where the tail side corresponded to the left side of the road and head to the right side. A Total of Seventy-five (20 inside the park and 55 outside the park) sample plots measuring 20 m x 20 m were sampled. Plant species in each plot were counted, identified and measured. Sample plots inside the National Park were taken at random surrounding the roosting site within a radius of 5 km (Figure 2).

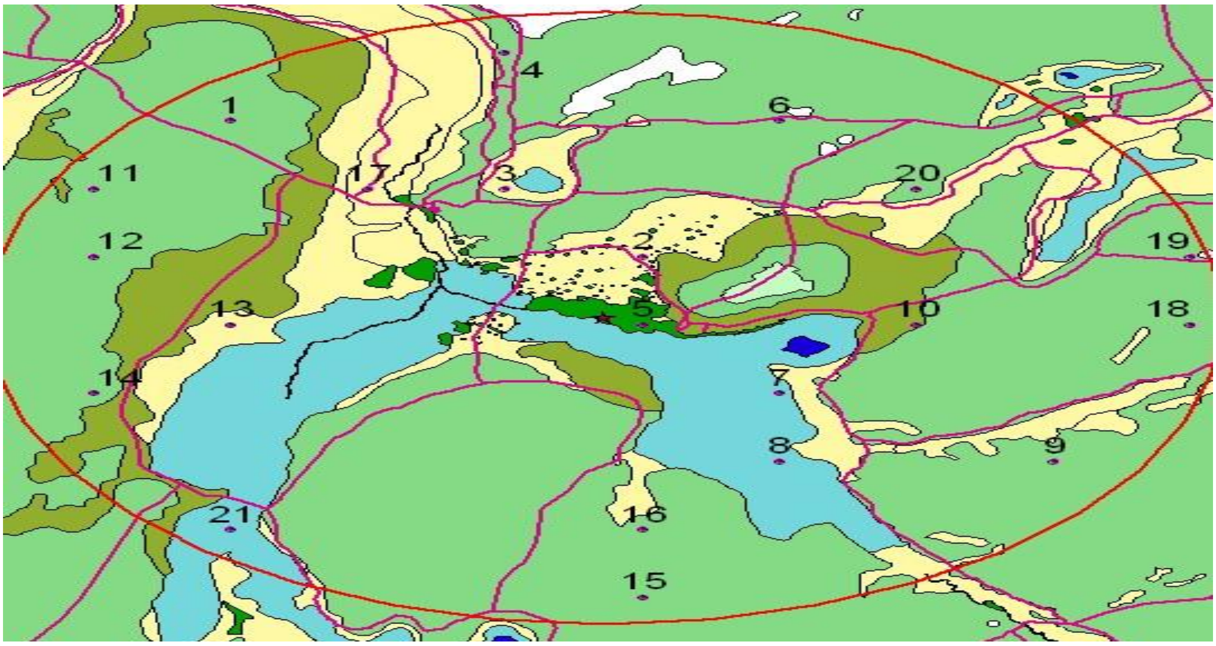


Figure 2 Location of sample plots in recorded bat feeding areas

Notes: Numbers represent sample location of plots, and blue open water, dark green riparian forest and light green open woodland and grassland respectively.

2.2.2 Determining Abundance of Fruiting Trees

To determine the abundance of fruiting trees, quantitative and qualitative approaches were used to collect primary data. Qualitative information was collected through nonstructured interviews with park management staff and local community members. This provided the researchers with local knowledge on various aspects of human-bat interactions.

Quantitative data were collected by physically taking measurements in the field. Coordinates were taken for each plot using GPS. Plots were then established using a 50 meter measuring tape and setting the corners of each plot at 90^{o} using the 3, 4, 5, method. Species name and Diameter at Breast Height (DBH) were taken for all species inside the plot. Trees ≥ 10 cm DBH stem size were counted in each plot. The DBH was taken at 1.3 metres above ground by passing the tape around the tree trunk and noting readings in cm on the tape. The DBH was measured and converted using the equation $C = D\pi$. Thus $D = C/\pi$, (Chomba et al. 2013). Fruit and non-fruit trees were noted and recorded as such. The fruiting season for each fruiting tree was obtained from literature, particularly Storrs (1995) to see whether the fruiting season coincided with the arrival of fruit bats.

Where tree stems branched below 1.3 m above ground, individual stems were counted and considered as separate trees because measurements used to calculate basal area were taken at 1.3 metres above ground level (Chomba et al. 2013). The tools and materials used included; i) GPS for distances, direction and geographic locations, ii) Tape for stem diameter measurements and marking the dimensions of the plot, and iii) Forms for entering data.

3. Results and Discussion

3.1 Results

3.1.1 Tree Species Composition

The study area had 64 species of which 20 (approximately 30%) were fruit trees (Table 1 and 2).This is a high species composition which is not typical of miombo woodlands and is attributed to habitat mosaic; *Chipya* forests "*Mateshi*" forest a dry evergreen forest, and *Mushitu* forest which provided a variety of habitat conditions. The riverine vegetation for instance was dominated by mainly species of the genera *Syzygium* and *Ficus* in swampy areas which also contributed to the high diversity of species.

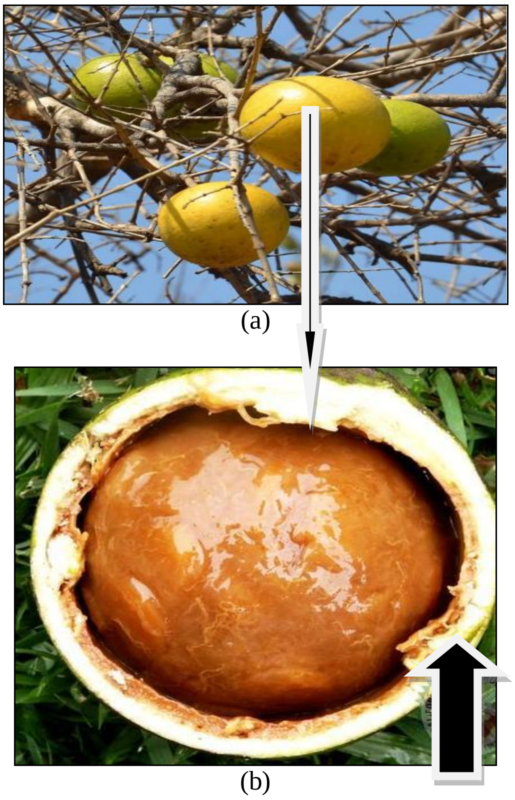
Table 1 Trees species recorded in the study area, Kasanka National Park and Kafinda Game Management Area, Zambia

No.	Scientific Name	English Name	Local Name (Bemba)	Fruit tree
1	*Acacia heteracantha*	-	Kafifi	
2	*Albizia antunesiana*	-	Musase, Mukoso	
3	*Anisophyllea boemii*	-	Mufungo	●
4	*Anona senegalensis*	-		
5	*Bobgunia madascariensis (Syn. Swartzia madagascariensis)*	-	Ndale	

6	*Brachystegia boehmii*	-	Ngasa, Musamba, Muombo	
7	*Brachystegia spiciformis*	-	Muputu	
8	*Burkea africana*	-	Kapanga, Mukoso	
9	*Cassia abbreviata*	Long pod cassia	Munsokansoka, Musambamfwa	
10	*Capassa violecea (Lonchocarpus capassa)*	Lilac tree	Chiya	
11	*Combretum molle*	Bush willow	Montamfumu, Mulama, Kaunda	
12	*Citrus sinensis*	-		●
13	*Dalbergia nitidula*	-	Kalongwe	
14	*Diospyros mespiliformis*	African ebony	Muchenja	●
15	*Diospyros batocana*	-	Muntafita	
16	*Diplorynchus condylocarpon*	-	Mwenge	
17	*Erythrina abyssinica*	Lucky bean	Mulunguti	
18	*Erythrophleum africanum*	-	Kayimbi, Mukoso	
19	*Faurea intermedia*	African beech	Saninga	
20	*Ficus spp*	-		●
21	*Hymenocardia acida*	-	Akapempe	
22	*Isoberlinia angolensis*	-	Umutobo	
24	*Julbernardia paniculata*	-	Umutondo	
25	*Lannea spp.*	-	Kaumbu, Kabumbu	
26	*Lantana camara*	-		
27	*Magnistipula butayei*	-	Mubwilili, Mukwebula	●
28	*Mangifera indica*	Mango	Mango, Umwembe	●●
29	*Maprounea africana*	-	Kafulamume	
30	*Maquesia macroura*	-	Museshi	
31	*Montes africanus*	-	Chimpampa	
32	*Morus nigra*	-		
33	*Musa spp*	-	Inkonde	●●
34	*Ochna schweinfurthiana*	-	Kabanga	
35	*Oldifieldia dactylophylla*	-	Kampangwila, Lunda, Muonga	
36	*Ozoroa reticulata*	-	Kulukumo	
37	*Parinari curatellifolia*	-	Umupundu	●
38	*Peltophorum africanum*	-	Mwikalankanga	
39	*Pericopsis angolensis*	-	Mubanga	
40	*Persia americana*	-	Kotapela	●●
41	*Phyllocosmus lemaireanus*	-	Mwembembe, Musengameno, Kampombwe	
42	*Piliostigma thonningii*	-	Mufumbe, Nachimfumbe	
43	*Pinus kesiya*	-		
44	*Pericopsis angolensis*	-	Mubanga	
45	*Phyllocosmos lemaireanus*	-	Mwembembe, Musengameno	
46	*Protea spp*	-	Musoso	
47	*Pseudolachnostylis maprouneifolia*	-	Musangati	
48	*Psidium guajava*	-	Mupela	●●
49	*Pterocarpus angolensis*	-	Mulombwa	
50	*Rothmania englerana*	-	Mupulupumpi, Mwinebala	
51	*Schrebera trichoclada*	-	Kapande	
52	*Strychnos cocculoides*	Bush orange	Kasongole	●
53	*Strychnos spinosa*	Elephant orange, Monkey ball	Sansa	●
54	*Syzygium guineense guineense*	-	Musafwa	●
55	*Syzygium cordatum*	Water berry, Water tree	Mufinsa	●
56	*Syzygium g. huillense*	-	Mufinsa	●
57	*Terminalia mollis*	-	Mubobo, Chimpakwa Namwinshi	
58	*Uapaca nitida*	-	Musokolobe	●
59	*Uapaca sansibarica*	-	Musokolobe	●
60	*Uapaca banguelensis*	-	Makonko	●
61	*Uapaca kirkiana*	Wild loquat	Musuku	●
62	*Vitex doniana*	-	Mufutu	●
63	*Zahna africana*	-	Chibangalume	
64	*Ziziphus abyssinica*	-	Kangwa, Kalanangwa	

Notes: Exotic fruit trees were only found in the Game Management Area and not inside the National Park. Single dot (●) denotes indigenous fruit tree and double dots (●●) represents exotic fruit trees.

We identified 16 (80%) of the fruit trees as being available and accessible when bats arrived. Four (4) of the 20 were either out of season or had hard shells (e.g. *Strychnos* spp.) that bats were unable to break open and access its juicy parts (Figure 3 a & b; Table 2).



(a)

(b)

Figure 3 *Strychnos* spp, a) fruits on a tree, and b) hard shell of *Strychnos* fruit containing juicy parts, but too hard to be broken by bats. (Source: http:www.crfg.org).

Table 2 Indigenous and exotic fruit trees in Kasanka and Kafinda Game Management Area, as food supporting millions of bats during the period November - January/February, Zambia

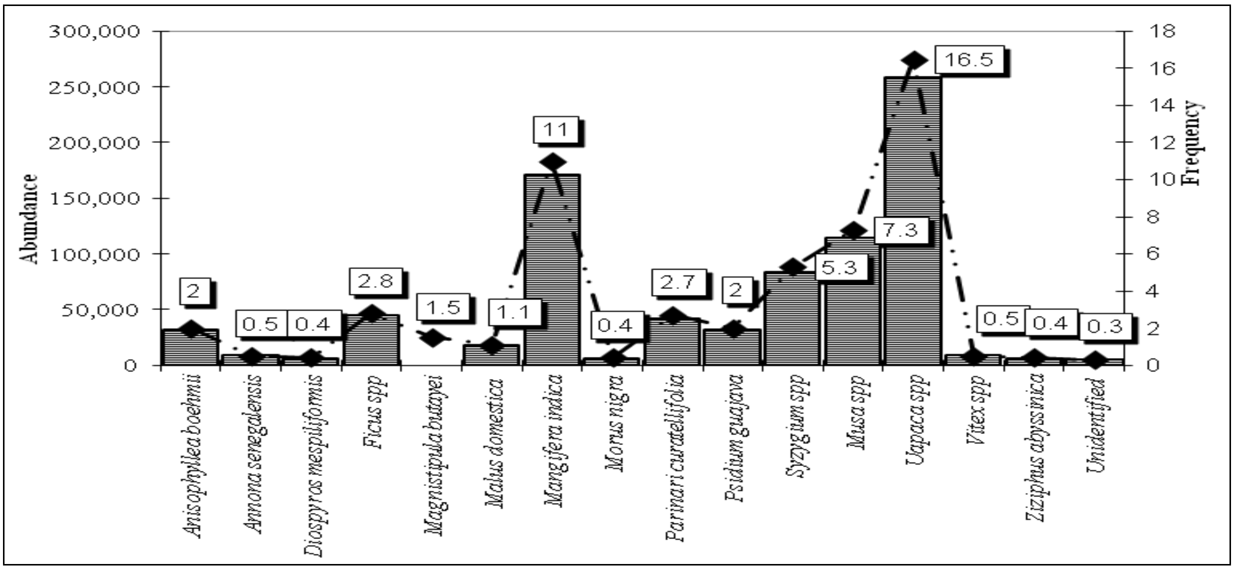
No.	Species	Season of fruiting	Remarks
1	*Anisophyllea boemii*	September- November/December	☑
2	*Citrus sinensis*	Any time of year	☑
3	*Diospyros mesipilliformis*	April - September	◙
4	*Ficus spp*	Any time of year	☑
5	*Magnistipula butayei*	October - January	☑
6	*Mangifera indica*	Rainy season	☑
7	*Musa spp*	Any time of year	☑
8	*Parinari curatellifolia*	September- November/December	☑
9	*Persia americana*	Any time of year	☑
10	*Psidium guajava*	Any time of year	☑
11	*Strychnos cocculoides*	September- November/December	☑ ♦♦
12	*Strychnos spinosa*	September- November/December	☑ ♦♦
13	*Syzygium cordatum*	November - March	☑
14	*Syzygium guineense guineense*	October - January	☑
15	*Syzygium g. hullense*	December/January-March	☑
16	*Uapaca nitida*	September – November/December	☑
17	*Uapaca sansibarica*	September – December	☑
18	*Uapaca kirkiana*	August-November/December	☑
19	*Uapaca benguelensis*	August-November/December	☑
20	*Vitex doniana*	April - August	◙

Notes:

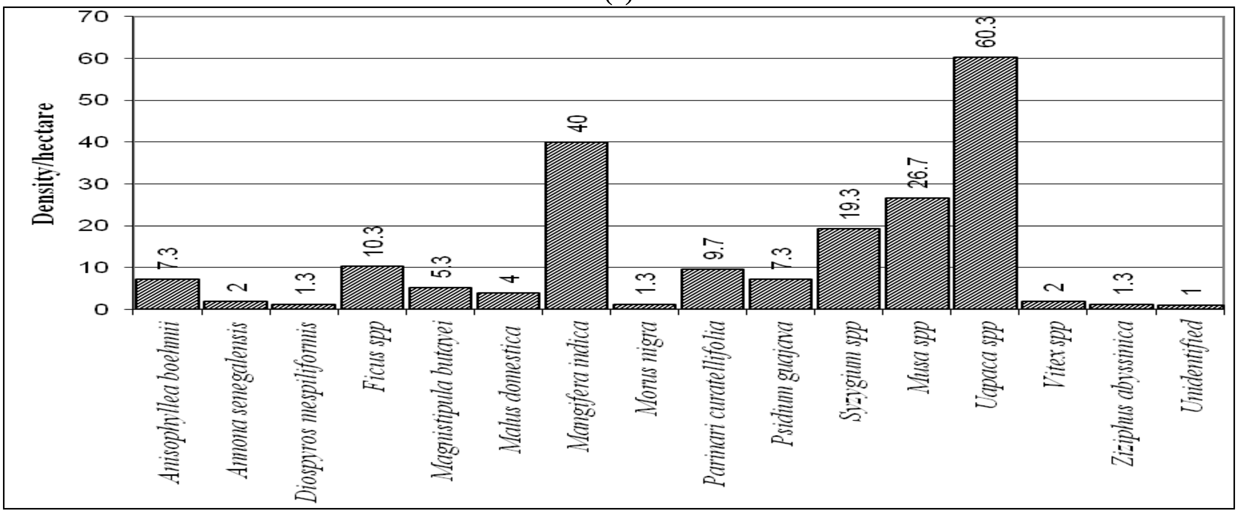
♦♦ Fruit is hard and bats cannot break to access its juicy parts; ☑ within bat season; and ◙ out of bat season.

3.1.2 Abundance and Density of Fruit Trees

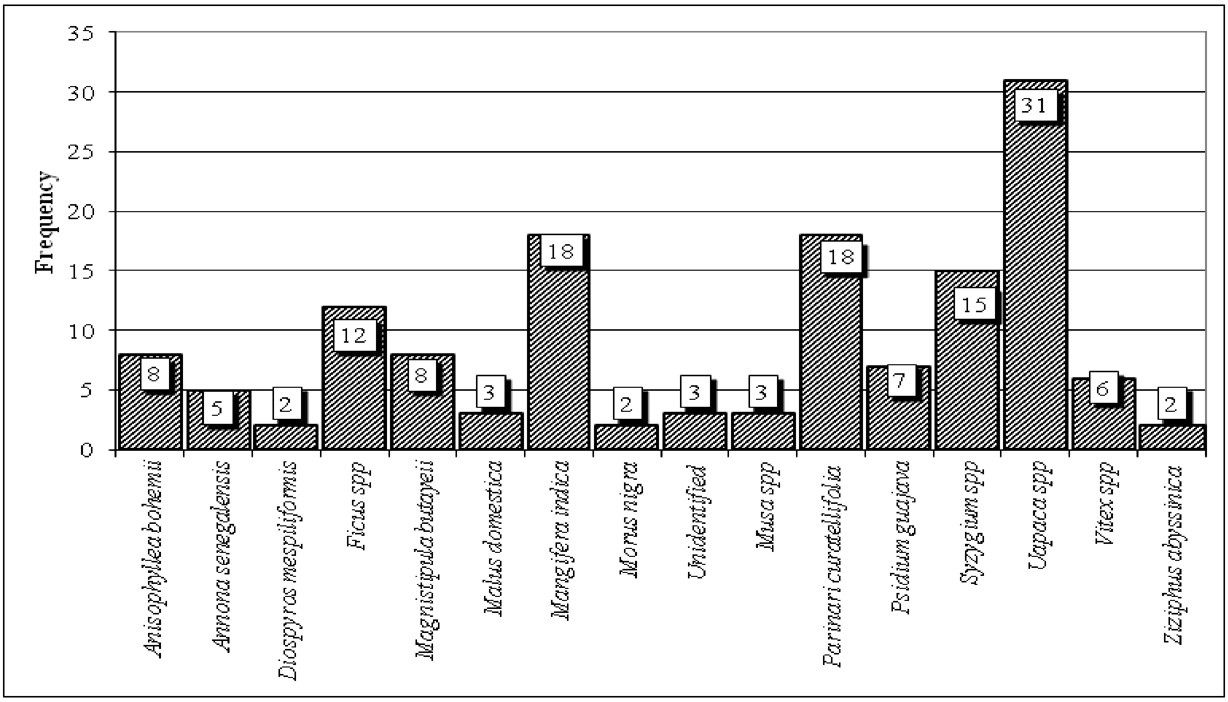
Of the 16 fruiting trees available to bats, *Uapaca* spp, *Mangifera indica*, were the most abundant with relative abundance being > 10% (Figure 4 a, b & c).Total tree density was high at 365/ha of which more than half 199 (approximately 55 %) /ha were fruit trees.



(a)



(b)



(c)

Figure 4 a) Relative abundance of fruit trees, b) density of fruiting trees, c) frequency, Kasanka National Park and Kafinda Game Management Area, Zambia. (Notes: *Musa* spp, *Psidium guajava* and *Mangifera indica* are exotic plants planted by people living in GMA for food)

3.2 Discussion

Our findings show that the current state of fruit tree density in the bats foraging area was high. This is probably because the two areas are protected as National Park (IUCN Category II) and Game Management Area (IUCN Categeory VI). In National Parks, human settlements are not allowed save for isolated illegal activities and wild fire. In the Game

Management Area, human settlements and activities are strictly regulated in compliance with a subsisting General Management Plan. Such efforts may have contributed to the high abundance of fruit trees recorded in this study.

Studies carried out in Zimbabwe by Fenton et al. (1998) stressed the importance of knowing species composition and density in bats' habitat because the degradation of habitats for bats is a pervasive problem in conservation. Fenton et al. (1998) however noted that the same picture did not apply to birds, that not all organisms are equally affected by reduction in density, species composition and tree canopy in woodlands. Species of micro-chiroptera which are largely insect eating bats persisted even in sites devoid of fruit trees and where tree canopy has been virtually eliminated (Brosset et al., 1996).

In our study which focused on fruit bats, we emphasize that it is eminent that the conservation one species, would be affected by other species. Increase in elephant populations for instance, which are prime destructive force of woodlands (Racey & Entwistle, 2000), may reduce tree density which raises the question of whether Kasanka National Park management team should focus on species management or the habitat.

3.2.1 Abundance of Fruiting Trees and Fruiting Season

The abundance of fruiting trees would be attributed to the ecological location of the area in Ecological Zone III of the country which receives the highest amount of rainfall of between 1,200 - 1,700 mm /y^{-1}. Such high rainfall characterises the abundance of wet dambos and perennial rivers and streams which are suitable habitats for fruit bearing trees of the genera *Syzygium* (Figure 5 a & b) which provide juicy fruits as acknowledged by Cumming & Bernard (1997). Such habitat mosaic contributes to the high diversity and abundance of fruit trees a factor not earlier investigated by Ritcher (2004).

(a)

(b)

Figure 5 a) Riverine vegetation and b dambos which are characteristic of wet habitats suitable for *Syzygium* spp a genus of fruit trees utilized by bats. Kasanka National Park, Zambia.

Regarding the fruiting season, Ritcher (2004) showed that arrival time of migrant fruit bats was October/November and departure was around December/January. This period coincides with the rainy season and fruiting season (Storrs, 1995) during which time 18 (approximately 80%) of the recorded 20 fruit trees eaten by bats as recorded by Ritcher (2004) were fruiting.

Arriving during the fruiting season (October – January) which coincided with the rainy season ecologically reduced search time for food. Trees ripening in the rainy season had adequate moisture and their fruits were juicier which may as noted by Ritcher (2004) eliminated the need for bats to search for water to drink which ultimately conserved energy that bats needed to fly in search of water.

4. Conclusion and Recommendations

4.1 Conclusion

In this study it has been shown that the current density of trees in areas used by bats is 365/ha and the density of fruit trees is 199/ha. It would appear from the current status that these are baseline densities needed to maintain feeding areas in a condition that would support current numbers of migrant fruit bats.

In the mean time, efforts should be made to ensure that such tree densities (365/ha for all tree species combined and 199/ha for fruit trees) are not reduced because that would have a negative impact on food availability when the physiognomy of the habitat has been transformed as earlier shown by Robinson et al. (1995). Intuitively, these results only provided baseline information on habitat quality and do not in any way suggest reasons why bats migrate to Kasanka area. They also do not suggest that this locality has the highest concentration of fruit trees among all the wet miombo vegetation communities in Zambia, but rather convenient to state that an abundance of fruit trees is inevitable in fruit bat feeding areas. Further research is required to examine other environmental factors that may influence the choice of Kasanka National Park and Kafinda GMA as destination area for migrant fruit bats.

4.2 Recommendations

In Kafinda GMA like other similar areas in Zambia, human habitation and other anthropogenic activities related to primary extraction of resources are practiced. In Central Zambia where the study area is located soils are dystrophic, acidic, highly leached and poor in macro and micro nutrients. Compounded by high poverty levels, perennial food shortages, exacerbated by low levels of education, communities are left with no option but to depend on the extraction of forest based resources for their survival. To cope with poor soils in the absence of artificial fertilizers which is beyond their reach, communities practice a traditional form of shifting cultivation called the *chitemene* system. In this practice, trees are chopped down, lopped or pollarded in the field and the cut branches and stems are collected and piled together at a central location then burned between September – early November when the moisture content is low and temperatures are high as to support combustion. The ashes lower the acidity and introduce phosphorous, which increases soil fertility.

Trees are unselectively cut down for fuel wood for cooking, and some of it is taken for sale at Tuta Bridge for drying fish. Trees are also cut down during the harvesting of caterpillars contributing further to decrease in tree density and the number of fruiting trees.

In view of the current increase in human population, it is likely that the demand for wood fuel would increase. Based on this baseline study the Department of National Parks and Wildlife, should consider formulating and implementing comprehensive General Management Plans for the National Park and GMA in order to safeguard the foraging areas against destructive human activities.

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