GOVERNMENT OF KARNATAKA

STATUS OF GAINT INDIAN FRUIT BAT (*Pteropus giganteus Brunnich)* IN SOUTHERN KARNATAKA

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FOREWORD

Bats are unique among mammals of their size, in their long lives, low fecundity, maternal care and slow developments. There are almost 1000 of species belonging to the order Chiroptera, Sub-order; Megachiorptera (fruit-bats) and Microchiroptera (insectivorous bats).Of these 1000 species, 25% are frugivorous and 88% exclusively tropical. The principal habitat of frugivorous bats include fruit canopy, open clearings and forest tracts. Droppings from frugivorous bats contain fruit pulp and seeds which help in seed dispersal.

Indian Bat fauna is rich and diverse and has 112 species. Due to urbanization and modern agriculture vast area of forest land is being disturbed. This in turn has an effect on the bat roosts. The major threat to bat roosts comes from the destruction of habitat and tree roosts. Due to these disturbances the huge bat roosts are being displaced and disturbed, which results in the fragmentation of the original roosts into small roosts. During this process they cause damage to the fruits and grain. This makes the farmers to develop a negative attitude about this group of animals and attempts are made to destroy the roosts which are near by the cultivated land. This is a serious problem. The bats play vital role in basic ecology of forests, seed dispersal, and regeneration of forests. In view of this there is a need for conservation of frugivorous bats.

Due to the significances of fruit bats a study was done with the objective of knowing the status & threats to fruit bats in Karnataka by the University of Agricultural Sciences, Bangalore.

It is hoped that the report will help in conservation of this important mammal in addition to other Biodiversity.

Sd/-

Additional Principal Chief Conservator of Forest and Member Secretary

2009

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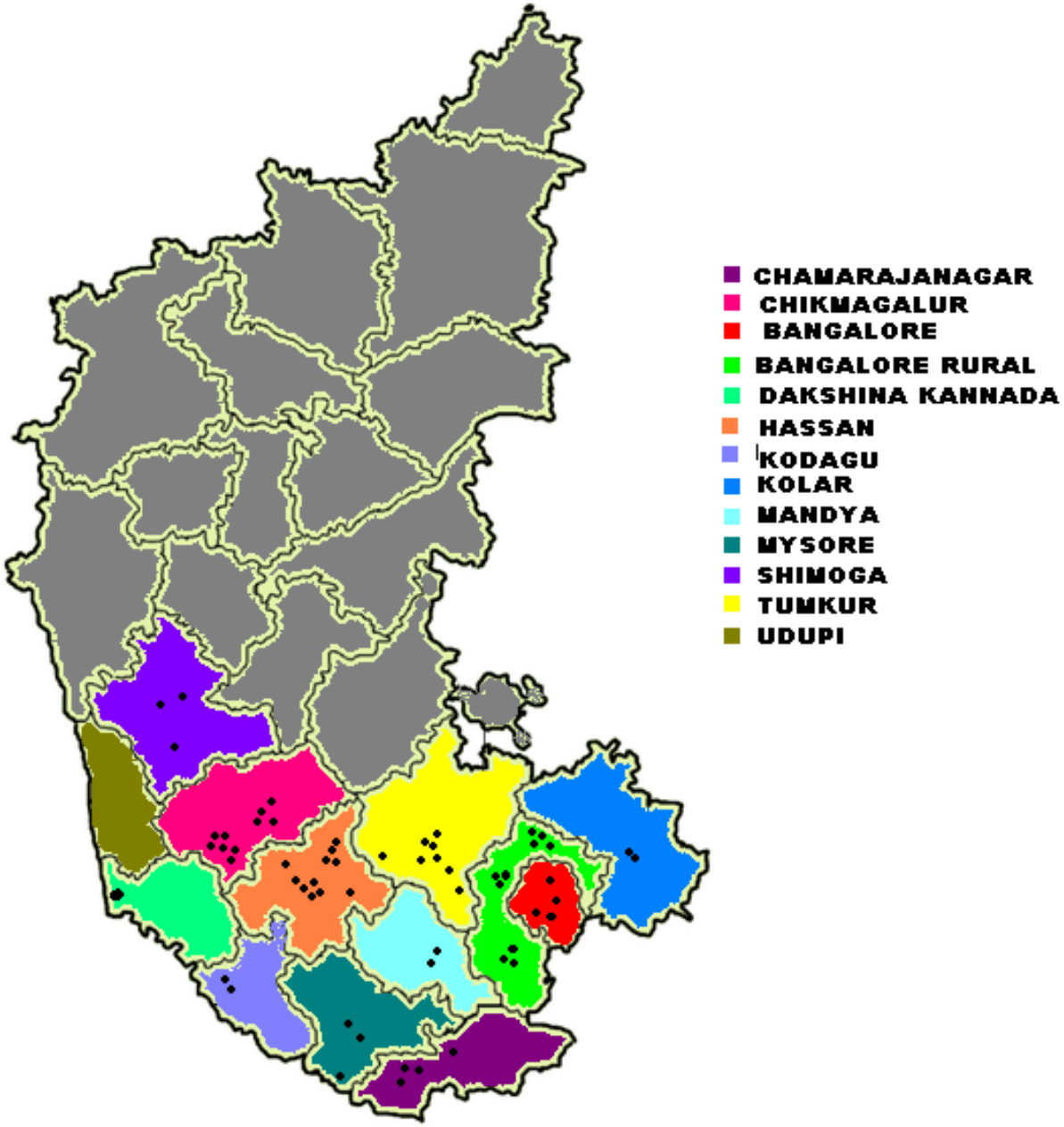

Fig.1: Map of South Karnataka with Bat roost Sites

INTRODUCTION

a. PURPOSE OF RESEARCH

Bats are unique among mammals of their size, in their long lives, low fecundity, maternal care and slow development (Findley, 1993). Bats are somewhat like birds ecologically. Bats are obviously K-strategists with relatively constant population size, greater competitive ability, iteroparity and greater energetic efficiency.

There are 4200 living species of mammals and almost 1000 of them are bats belonging to the order Chiroptera, Sub-order; Megachiroptera (fruit-bats) and Microchiroptera (insectivorous bats). Of these 1000 species, 25% are frugivorous and 88% exclusively tropical. The principal habitat of frugivorous bats include fruit canopy, open clearings and forest tracts. Droppings from frugivorous bats contain fruit pulp and seeds which help in seed dispersal.

Indian Bat fauna is rich and diverse with 112 species. India has more than 115 of the world bats including 13 megachiroptera and 99 microchireptera (Bates and Harrison, 1997). However the chiropteran diversity in the Indian Subcontinent is presently represented by 121 species belonging to 37 genera and 8 families with 112 species belonging to 33 genera and 8 families within Indian limits (Srinivasalu & Srinivasulu, 2001).

Fruit bats are physiologically and behaviorally adapted for feeding on different kinds of fruits. *Pteropus* species used flowers of 26 genera and fruits of 62. Fruits of *Ceiba* species attract 11 genera of Megachiroptera and the fruits of *Ficus* sp. at least thirteen. They also adapted to feed on guava (*Psidium guajava*), Sapota (*Achras zapota*), Banana (*Musa paradisiaca*), Litchi (*Litchi*

chinensis), Jack (*Artocarpus indica*) and mango (*Mangifera indica*) and Cashew (*Anacardium occidentale*) and Areca (*Areca catechu*) crops and in turn help in seed dispersal and pollination. The bats were observed roosting in huge colonies ranging from 500-1000 bats. Changes in the tropical ecosystems has often been limited to change in plant community, composition and structure despite the numerous contributions made by the animals. Due to urbanization and modern agriculture vast area of forest land is being disturbed by humans. This in turn had an effect on the bat roosts. The major threat to bat roosts remained to be the destruction of habitat and tree roosts. Due to these disturbances the huge bat roosts are being displaced and disturbed, which resulted in the fragmentation of the original roosts into small roosts which may be restricted to 100-500 bats. In urban areas, generally roosts trees include *Ficus species, Delonix regia,* Mango, etc. and in rural areas roosts trees include *Ficus species; Terminalia, Casuraina,* etc. very near to the cultivated lands. This situation forced the bat populations to depend on the cultivated lands and plantation crops. During this process they may cause damage to the fruits either biting off and swallowing mouthful of fruits or crush the fruit. This may cause economic loss while feeding on fruits (verghese *et al*., 1998.) This made the farmers to develop a negative impact on this group and attempts are made to destroy the roosts which are near by the cultivated land. This is a serious problem. Because bats play vital role in basic ecology of forests, seed dispersal, regeneration of forests, there is a need for conservation of frugivorous bats.

b. IMPORTANTANCE AND RELEVANCE OF RESEARCH TOPIC

Bats are very important pollinators and seed dispersers in tropical forests and have shared a long evolutionary history with angiosperms. Megachiropterans feed upon at least 145 genera of fruits in 30 families of plants (Michleburgh *et al*., 1992). The most important families are palmae (16 genera), Anacardiaceae (10 genera) and Sapotaceae (8 genera). Generally fruits are consumed when ripe, but this is not always so.

In many places fruit bats are the only animal capable of carrying large seeded fruits and can be the single, most important pollinators, seed dispersers. At least 443 plant products useful to man are derived from 163 plant species that rely to some degree on bats for pollination or seed dispersal (Fujita and Turtle, 1991). These species provide substantial ecological and economic services via pollination, seed dispersal and agricultural pest control (Mistry, 2001). For example, the common species of fruit bats (*Cynopterus sphinx, Pteropus giganteus and Rousettus leschenaultia*) visit over 114 plant species and act as an important pollen and seed vectors (Mickleburgh *et al*., 1992, Molur *et al*., 1998). In Bihar, bats are known to keep under check of destructive rodent species in cultivated crops, godowns and houses (Sinha, 2002).

Yet many bat species in India face numerous threats. There is a population decline of bats in recent years. That is for this reason, that maximum protection to fruit crops from farmers by using pesticides and habitat degradation. So an action plan for the conservation of fruit bats is of a high priority (Mickleburgh *et al*., 1992). Because many species of fruit bats are dependent on primary forests and thus threatened by the large scale destruction of forests in tropical areas. Declines in fruit eating bat populations are widespread in India due to high rate of deforestation, increased use of pesticides, habitat degradation and human consumption. So conservation of the

Indian Flying Fox (*petropus giganteus)* and identifying hotspots for bat conservation should be a priority.

c. ORIGION OF THE RESEARCH PROBLEM

Gaining knowledge of the processes on natural regeneration in disturbed habitats i.e., secondary succession and the role animals play in these processes is of considerable conservation concern today due to the vast area of disturbed land being created by human activity (Brown & Lugo, 1990; Bawa & Seidler, 1998; Holl & Kappelle, 1999; Neef, 2005). Seed dispersal is a major way that animals contribute to succession changes in tropical ecosystems. Soil seed banks are often severely depleted in disturbed areas, making deposition of seeds from undisturbed areas critical for succession to proceed (Duncan & Chapman, 1999; Rodrigues di Silva & Matos, 2006; Franklin & Rey, 2007; Simoes & Marques, 2007). The role of bats in seed dispersal and regeneration of forests is a very important function. German scientists have hit upon a novel yet cost-effective idea to revive reforestation in the tropics by using bats as seed dispersals. They have designed bat roosts-replicating large, hollow trunks-to boost seed dispersal of a range of tropical plants.

The Indian subcontinent harbors a variety of chiropterans, including frugivorus bats. However, the chiropteran diversity in the Indian subcontinent is presently represented by 121 species belonging to 37 genera and 8 families with 112 species belonging to 33 genera and 8 families within Indian limits (Srinivasalu & Srinivasulu, 2001). The Indian flying foxes are distributed throughout the tropics and being frugivorous they play a major role in pollination and seed dispersal. The numbers of the flying foxes are declining. Declines in bats populations are widespread in India due to high rate of deforestation, increased use of pesticides, degradation of habitats and human consumption.

Bats roosts on trees and huge caves in large numbers, their numbers may range from 500-1000. When these traditional roosts are disturbed the bats separate into small groups and smaller sized roosts are formed. However, the traditional roosts are more secure than the smaller sized roosts probably formed out of the main bat roosts. The smaller roosts are amenable for disturbances. These smaller roosts are more susceptible to disturbances and are being displaced, which results in the fragmentation of the original populations. The major threat to bat roosts has been the destruction of habitat and tree-roosts. It is critically important to preserve the existing bat roosts.

Since bats play important ecological and economical roles in evergreen tropical forest tracts, bats need to be conserved. The Wild Life Protection Act (1972) does not afford any level of protection to fruit bats and categorized them as vermin. Bats play a vital role in seed dispersal, regeneration of forests and many trees depend on bats for pollination and seed dispersal. Bat roosts help preserve local, indigenous biodiversity elements. For the conservation of this Indian flying fox a survey has to be made to identify the traditional bat roosts and protect them from disturbances.

d. FOCUS OF RESEARCH

The study was taken up with following objectives.

- Location of Bat roosts at different places of South Karnataka. Data of all this Bat roosts to be collected and analyzed.
- Based on the data analysis, the status of the Bat Roosts to be determined including the condition of the roost i.e., protected or not protected, disturbed or undisturbed, traditional or recent etc.

- A data base to be generated to conserve the bats and bat roosts in south Karnataka, and the importance of conservation and study its role in biodiversity.

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RESEARCH DESIGN

The research design included the following process.

1. To locate the bat roosts in different districts of South Karnataka. All the Deputy Conservator of Forests were contacted and based on their information the roosts were located. In addition, tribal people who were engaged in bat trapping and bat hunting were contacted to get the information on bat roosts. Old people in villages were contacted for more information on bats/bat roosts.

2. Information of location, roosting trees, habitat of roost trees, weather conditions, trees in blooms: fruiting, number of Bats and factors affecting the roosts were collected.

3. The roosts were frequently visited and disturbances if any were also recorded.

4. A Performa was also developed to interact with the villagers/foresters and people knowledgeable on bat roosts.

5. At selected roosts bat specimens were collected (Dead bats/Younger bats) for analysis in laboratory.

6. Area (6-8 sq.km) around the bat roosts were surveyed to record the dominant tree species on which bats were found foraging and feeding.

ORGANIZATION AND DESCRIPTION OF DATA

To locate Roosts of Giant Indian fruit bat (*Petropus giganteus)* and count the number of bats at the roosts in 10 districts of South Karnataka were selected viz. Bangalore (Urban and Rural), Hassan, Tumkur, Kolar, Chickballapura, Mandya, Mysore, Shimoga, Coorg and Mangalore. These districts were visited to locate fruit bat roost. A Proforma was developed to interact with local villagers and people knowledgeable on fruit bats. At each roost site (6-8 km) the dominant species of trees on which the bats foraged and fed, were recorded.

An effort was made to estimate the number of bats at the roost. Two observers armed with binoculars (80x30 and 70x50) counted the number of bats clinging to branches of trees by going round the roosts. *Petropus giganteus* roosts have been monitored and censuses by direct visual contacts (using a hand tally counter) at the day roosts to estimate the roost population size (Singaravelam & Marimuthu, 2003). In addition visual counts were made during the out flight of bats at early evening hours. The two observers counted the bats independently and separately, counts made independently by two observers were pooled to derive the mean size of the roost population. The numbers were averaged. At 6.20 pm few bats were observed making foraging flights. Four observers placed in four directions counted the number of bats going out of the roosting trees. The counts of each observer were added to make the size of the roost.

Roost habitat was characterized based on biotic, abiotic and human factors. Information on roosting trees were collected by interview with local people including farmers, workers and hunters regarding information about age of roosts, threats, conservation level, etc., The flowering and fruiting period of the dominant trees were found out and such trees were identified by a botanist.

A copy of proforma is enclosed. Field observation began in February 2007 and continued till October 2009.

ANALYSIS OF DATA

Interpretation and Explanation of Data

1. The data collection was made and all the collected date was tabulated and the same has been presented in this report.

2. The data sets were analyzed using statistical methods.

3. Mann;Whitney U-Test were conducted to arrive at logical conclusions from statistical tests.

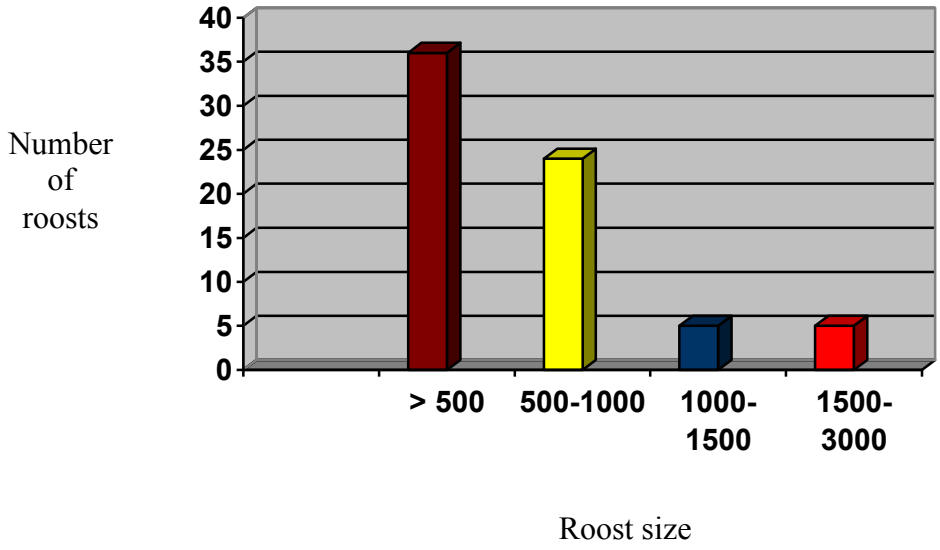
TABLES

Table 1: Distribution of bat roosts based on roost size

Sl.No	Roost Size	
	Number of Bats	Number of Roosts
1.	Less than 500	36
2.	500-1000	24
3.	1000-1500	5
4.	1500-2000	3
5.	2000-2500	1
6.	2500-3000	1

Note: Roost size is based on the number of bats present on the roosting trees. The bat counts were recorded by four observers using binoculars

Figure-1: Distribution of bat roosts based on roost size



- Statistical significant differences were found between less than 500 bat roost size and other categories by 't'-test at 5% level of significance.

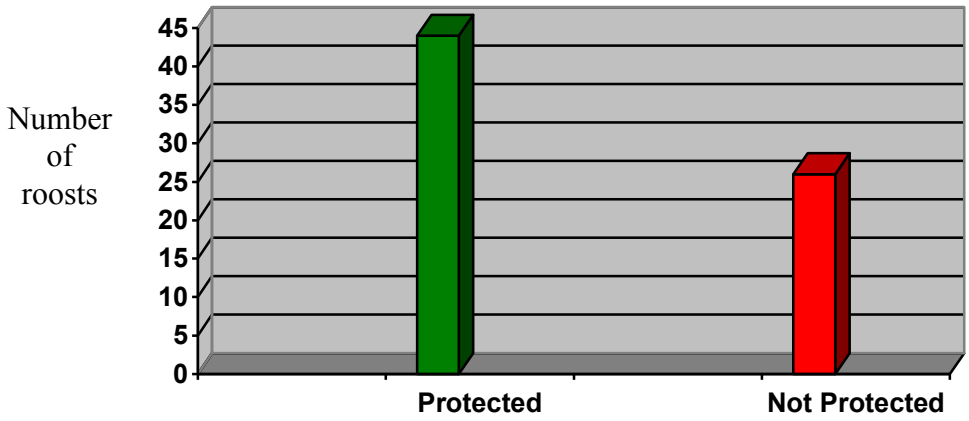
Table 2: Classification of bat roosts based on the protection

Roost Type	Number of Roosts
Protected Roosts	44
Not Protected Roosts	26

- Protected Roost: The Roost which are located in the safe place such as, temple, mosques, church, villages, etc. are well protected by the people because of religious beliefs. Roosts that are located in the compound wall of any government, private offices and even schools and hospitals are also well protected.

- Not Protected Roosts: The Roost which are located in the places such as; developing area, away from the town, near to National Highway, any private land constantly undergo pruning. So such roosts are not protected.

Figure-2: Classification of bat roosts based on the Protection



- Statistically significant differences were found between the categories indicating that in southern districts of Karnataka, bat roosts are well protected (t-test at 5% level of significance) and local people are affording protection by sentiments and religious beliefs.

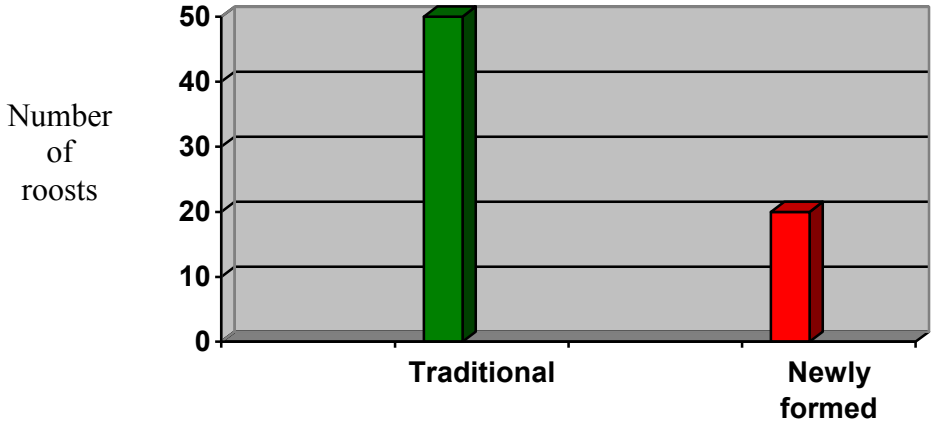
Table 3: Classification of bat roosts as traditional roosts and newly formed roosts

Roost Type	Number of Roosts
Traditional Roosts	50
Newly formed Roost	20

Note:

- Traditional Roost: The Roosts which are present from over 50 years and the bat population should be stable.
- Newly formed Roosts: The Traditional roosts which are disturbed due to tree pruning and may be due to lot of human disturbances will separate into smaller groups and may shift to near by trees for roosting. Such roosts are called as newly formed roosts.

Figur-3: Classification of bat roosts as traditional and newly formed roosts



- There were statistical significant differences between the traditional and newly formed roosts based on the number of years the roost has remained intact.

Table 4: Classification of bat roosts as disturbed and undisturbed

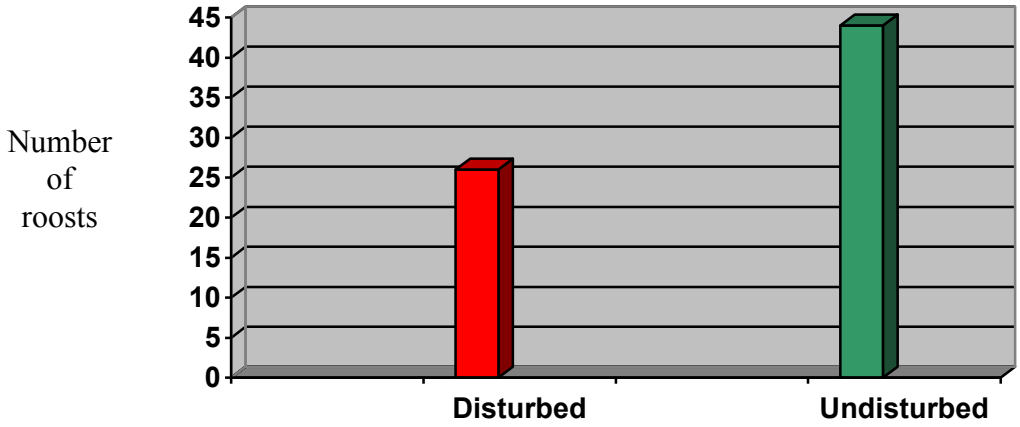
Roost Type	Number of Roosts
Disturbed Roosts	26
Undisturbed Roost	44

Note:

- Disturbed Roost: The roosts which are frequently disturbed by humans activities such as tree pruning, sound (noise) and light disturbances caused by traffic, hunting for food and medicinal use, climatic disturbances i.e. high wind velocity, high intensity light, heavy rainfall etc. such roosts are considered as disturbed roosts.

- Undisturbed Roosts: The roosts which are not disturbed by any one of the above reasons such as human disturbances and climatic disturbances are considered as undisturbed roosts. The protected roosts are generally undisturbed.

Figure-4: Classification of bat roosts as disturbed and undisturbed



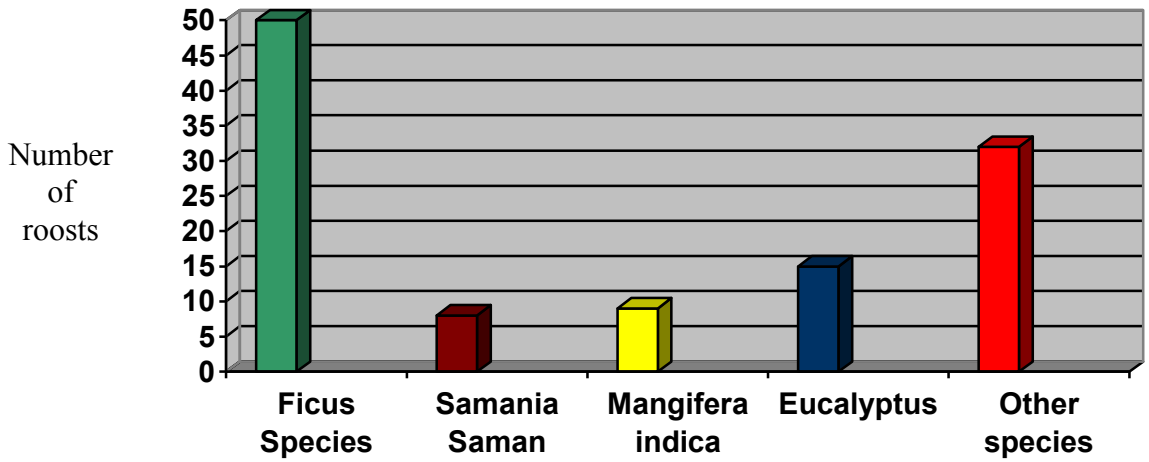
- There were statistical significant differences between disturbed and undisturbed bat roosts based on small 't' test at 5% level of significance.

Table 5: Classification of bat roosts based on the roosting tree

Sl.No	Tree	Number of Roosts
1.	*Ficus* species	50
2.	*Samania saman*	15
3.	*Mangifera indica*	9
4.	*Eucalyptus*	8
5	Other Tree Species (Silver oak, Tamarind, Casuarina, etc.)	32

Note: Area (6-8 sq.km) around the bat roosts were surveyed to record the dominant tree species on which bats were found foraging and feeding.

Figure-5: Classification of bat roosts based on the roosting tree



- *Ficus* sp. constituted the dominant species on which the bats roosted. There were statistical significant differences between the number of bat roosts on *Ficus* sp. and other tree species in southern Karnataka.

Fruit Bat on the roosting tree

Fruit Bat on Bamboo Tree

Roosting Tree

Indian Flying Fox, *petropus giganteus*

Samania saman
(Rain Tree)

Mangifera indica
(Mango Tree with Blossom)

Eucalyptus globulus

P.gigantus feeding on fruits of *Ceiba pentandra*

Ficus benghalensis

Albizzia lebbeek

Artocarpus hirsutus

Appendix 1: Observations on bat roosts *of Petropus giganteus* in Southern Karnataka, 2007-09

Sl.No	Location	Bat Roost/tree	Habitat of Roost	Weather Conditions	Fruiting period, (months)	Noisy period	Roost size	Status
1.	Gowdaregere, Channarayapatna, Hassan 12^0 53' 51.90'' N, 76 ^{0} 22' 44.34''E.	2 *Mangifera indica* trees	Road side trees. Left side of B'lore-Hassan road	Dry period all most round the year	Mar -May	Apr-May	50-70	Temporary roosts, bats are frequently disturbed by traffic/people & light.
2.	Chikmagalur Town, DC's office + police station. 13^0 18' 44.35'' N, 75^0 46' 15.20''E.	Casurina equisetitolia, Eucalyptus globulus, *Mangifera indica*, *Ficus* benglalensis, *Samania saman*	In town, Urban built up area. heavily used road & residential area	June to Sept	Feb-Mar	Mar-Apr	1500-1800	Highly disturbed roost, jungle crows nuisance. Ground littered with fecal pellets , noisy even during day
3.	Bommenahalli, Kunigal, Tumkur. 13 ^{0} 01' 12.94''N, 77^0 01' 16.85''E.	*Ficus* benghalensis	Road side tree.	Low Rainfall area	Sep-Oct	Oct-Nov	70-80	Road side, Highly disturbed, fragmented population. Frequently disturbed by traffic/lights.
4.	Anchipura, 4km away from Nelamangala cross 13^0 05' 56.51''N, 77^0 23'13.12''E.	*Ficus* mysorensis	Road side tree	-do-	-do-	-do-	50-70	Road side Highly disturbed by moving traffic.
5.	Mandya Railway station 12^0 31'21.94''N,	*Samania saman*,	>50 years old tree Garden	Hot, humid,	Feb-Mar-April	Mar-Apr	150-180	Temple, religious site, safe well protected

	76^0 53’ 49.68’’E.	Eucalyptus comondulensis	tree groups near a temple.	warm				and undisturbed area.
6.	Bangalore, Bugle Rock park, Basavanagudi. $12^0$56’33.16’’N, $77^0$34’ 24.03’’E.	*Ficus benghalensis, Mangifera indica, Samania saman*, Eucalyptus comondulensis	Garden , tree groups, protected area	Salubrious, pleasant, humid/wet	-do-	Mar-Apr	650-710	Main drained by BDA. Farm land before roost is undisturbed & ancient one.
7.	Padubdri, ,NH47, Mangalore 12^0 52’ 09.70’’N, 74^0 50’33.22’’E.	*Ficus benghalensis, Samania saman,*	5 years old tree, road side tree	Warm, humid, sultry	Feb-Mar-April	Mar-Apr	50-60	Fragmented population highly disturbed.
8.	Mangalore town, Hampanaghatta, Mangalore. 12^0 52’ 09.70’’N, 74^0 50’33.22’’E.	*Ficus benghalensis, Samania saman*	>50 years old tree. Tree groves amidst urban set –up.	Warm, humid, sultry	Mar-May	Mar-Apr	50-75	Noisy, disturbed by people and traffic
9.	Tiptur town, Tumkur 13^0 15’ 12.53’’N, 76 ^{0}28’41.48’’E.	*Ficus benghalensis, Samania saman*	<5 years old tree Outskirts of town,	Dry, Warm, deciduous	Mar-May	Apr-May	50-60	Fragmented roost, noisy, relatively undisturbed.
10.	Malleshwaram Railway station, Bangalore. 13^o.00’39.10’’N $77^0$33’42.30’’E.	*Ficus benghalensis, Samania saman Albizzia*	>50 years old tree Temple area, near to road.	Salebreous , cool, pleasant	Dec-Mar-April	Mar-Apr	100-150	Temple, religious site , big roost with birds like Mynahs. Safe & secure roost, undisturbed.

		lebbeek Cassia fistula						
11.	Purashanahalli / Belavangala/Doddaballapur. 13º07'32.46''N, 77º36'15.60'' E.	*Ficus benghalensis,*	>5 yrs. old tree A village area	Dry, warm, weather	Feb-April-May	Apr-May	800- 900	Relatively undisturbed, but threats of hunting in the nights, protected by the village people.
12.	Bethinagerae /Nelamangala 13^0 05' 56.51''N, 77^0 23'13.12''E.	*Ficus benghalensis,*	>5 years old tree A village social forestry area	Cool, pleasant	-do-	Mar-Apr	600-650	Undisturbed area , but highly threatened by hunting.
13.	Madhipura/Nelamangala Bangalore rural 13^0 05' 56.51''N, 77^0 23'13.12''E.	*Ficus benghalensis,*	>10 years old tree, Village area	-do-	-do-	-do-	500-600	Relatively undisturbed, protected by the local people
14.	Byatha /Doddaballapur 13º07'32.46''N, 77º36'15.60''E	*Ficus benghalensis,*	>50 years old Center of village near a temple	-do-	-do-	-do-	700 -800	Religious place, highly protected by the village people.
15.	Ardeshahalli/Doddaballapur. 13º07'32.46''N, 77º36'15.60''E	*Ficus benghalensis,*	>50 years old tree. Outside the village	-do-	-do-	-do-	1100-1200	Undisturbed, relatively safe.
16.	Banavadi / Soluoor 13° 6' 8 0.00''N, 77° 23' 24E	*Ficus benghalensis,* , 3 trees	>10 years old tree Village area	-do-	-do-	-do-	1500-1600	Undisturbed area, relatively safe.
17.	Bettahalli/Yelahanka 13° 06' 27.00N,	*Ficus benghalensis,*	>10 years old Semi urban	-do-	-do-	-do-	500-600	Disturbed area, with some hunting

	77° 36' 13.12''E		area					
18.	Gidaddapalya /Kunigal 13 ^{0} 01' 12.94''N, 77^{0} 01' 16.85''E	*Ficus benghalensis,* 30 trees	>50 years old tree Village area	-do-	-do-	-do-	2600-2800	Undisturbed , safer
19.	Sopanahalli / Gubbi 13° 18' 39.28''N, 76°65'32.04'' E	*Ficus benghalensis,*	NH 208 , next to the road, >2 years old tree	Warm, dry, but pleasant	-do-	Mar-Apr	200	Highly disturbed by moving vehicles.
20.	Betthadahelli/ Tqerikerae Shimoga. 13.9° 55' 20.10''N 75.6°34'13.35'' E	*Ficus benghalensis,*	NH 208 >3 years old tree	-do-	-do-	Mar-Apr	200	Highly disturbed, fragmented populations
21.	Manasagangotri, Mysore university. 12°18'11.88'' N 76°38'45.12'' E	Several species of trees	Inside the Mysore university campus	Shaded, cool, wet	Sep-Oct Nov-Dec	Oct-Nov	>1000	Traditional roosts,; undistributed, meets all requirements for bat roosts
22.	Aranya bhavan, Institute of Wood Sciences and Research Malleshwarm, Bangalore 13^{o}.00'39.10''N 77^{0}33'42.30''E	Several species of trees	>50 years old tree Well protected, breeding occurs	Cool, wet, pleaseant	Feb- April- May	Mar-Apr	>600<700	Traditional roosts, undistributed bats forage long distances for food.
23.	Nagadevaru temple, Birur- Lingadhahalli Road, Birur 13^{0} 35' 51, 47'' N, 75^{0} 58' 00, 31'' E	*Ficus benghalensis,*	35 M tall with well spread canopy inside the temple, more than 60 years	Hot/warm, dry, months	March- may-June	Mar-Apr	250-300	Traditional roost, undisturbed, Well protected. The bats forage in the surroundings cultivated and hilly

			old					tracts.
24.	Salapura, Banavara –Arasikere Road 13^0 18’ 32.10’’ N, 76^0 14’ 51.89 ‘’ E	*Ficus benghalensis,*	30M tall, Road side tree. Being an avenue tree, it appears a temporary roost	Warm, dry weather	-do-	Mar-Apr	100-150	Small roost, numbers although few, highly variable, surrounding vegetation not very supportive.
25.	Arasikere town , 13^0 18’ 32.10’’ N, 76^0 14’ 51.89 ‘’E	*Eucalyptus,neem, Melia sp. Ficus religiosa* trees,	Road side trees in the town, compound wall broken, cluster of trees disturbed.	Dry period throughout the year except June - July	April , May, June	Apr-May	250-275	Traditional roost in the area under disturbance So bats roosted on near by trees. Need immediate protection.
26.	Bellur cross- Hirisave, Road- Kadabhally 12^0 59’ 00.00’’ N, 76^0 43’ 00.00’’ E	Ficus *benghalensis,*	9 km before Hirisave on Bangalore-Hassan	Warm, dry, deciduous	-do-	Apr-May	14-20	Highly Temporary, Appears to be a off shoot from a main traditional roosts.
27.	Bundinutta, Bhadra river stream in Ballehonnur town 13^0 14’’ 33.43’’ N 75^0 39’ 14.56’’ E	Bamboos, Canes, silk cotton trees	0.5 km before Balehonnur town At the edge of the river stream, over hanging at 20m above water	Humid, warm	Oct-Jan-Feb	Jan-Feb	> 1000	A traditional roosts, not well protected although inaccessible, breeding observed, important in Malnad
28.	Kote Anjaneya Temple, Shimoga 13^o 55’ 20.10’’ N, 75^0 34’ 13.35’’ E	*Ficus benghalensis,* and other species of *Ficus*	At the outskirts of the Shimoga town	Dry, warm, sultry	Feb-April-May	Apr-May	About 1000	A traditional roost not well protected, near Bhadra river stream, near a temple so Well guarded

29.	Ginkerehalli, Arasikere, Hassan., 13^0 18' 32.10'' N; 76^0 14' 51.89 '' E	Ficus *benghalensis,*	In the village, a 150 yrs old tree well spread canopy,	Dry period throughout the year except	Jun - Jul	Aug-Sep	100-150	Traditional of 12 years old, well protected roost. Breeding prevalent.
30.	Ramjihally Koppalu, Gandsi, Arasikere, Hassan, 13^0 18' 32° 10'' N, 76^0 14' 51.89 '' E	*Ficus religiosa* tree	A 250 year old tree near a temple, breeding takes place	Dry period round the year except Jun-Jul	Feb-Apr-May	Mar-Apr	150	The tree also parasitized by a Neem and other plant parasites. Tree is in a temple area so no shooting is done, villagers are protecting.
31	ZARS, Mudigere 13° 7' 60N 75° 37' 60E	*Ficus benghalensis,. Cidar sp. Mangifera indica Artocarpus hirsutus*	Behind laboratory building Typical cardamom ecosystem,	All the four seasons like spring winter Monsoon Summer	Feb to Apr	Aug - Oct	1000-1200	Less disturbed, not followed the shade regulation practices, but hunting is seen during night and heavy pruning of trees.
32	Sharadamba estates, hale kote, Mudigere. 13° 7' 60N 75° 37' 60E	*Mangifera indica, Artocarpus hirsutus Ficus sp. (Basari Goni,Halasu*)	Cardamom coffee ecosystem just 2-3 km away from ZARS.	All the four seasons like spring winter Monsoon Summer	Feb-Apr	Aug - Dec	700-800	Cardamom ecosystem supports roost, but severe shade regulation affects the bat roost because of
33	Halose estate, Mudigere 13° 7' 60N 75° 37' 60E	*Silver oak, Ficus sp. (Basari Goni,etc)*	Robusta coffee ecosystem	Pleasant, heavy rains, humid	-do-	Sep-Oct	600-700	Original bat roost has been distributed by severe tree pruning.
34	Hassan town, DC's	*Eucalyptus sp.*	In town, urban	Hot, warm	Jan - Mar	Aug -	2000-	Undisturbed, Noisy

	residence and hotel Ashoka 13^0 18' 32.10'' N, 76^0 14' 51.89 '' E		built up area heavily used road school area.			Dec	2500	even during day time particularly during mating season.(sep-oct)
35	Kesavalalu estate Daradahalli, Mudigere. 13° 7' 60N 75° 37' 60E	*Ficus sp(Basari), Artocarpus sp. (Halasu)*	25km away from Mudigere town.	Cool, humid, rainy	Mar - May	Aug - Dec	300-400	Planters hunt for the meet. Changed cropping situation, severe shade pruning.
36	Bygoore estate, Chikmagalur 13^0 18' 44.35'' N, 75^0 46' 15.20''E.	*Ficus sp. (Basari, Goni,etc)*	30km away from Chikmagalur town	-do-	Mar - May	Aug - Dec	1000-1100	Habitat not been disturbed very ideal roost site good foraging observed.
37	Giri estate, Chikmagalur 13^0 18' 44.25'' N, 75^0 46' 15.05''E.	*Ficus sp.*(basari) Terminalia sp.	30 km away from Chikmagalur, coffee ecosystem	-do-	Mar - May	Aug - Dec	300-400	High elevation, not much disturbed, long range foraging was seen.
38	Byduvalli estate, Mudigere 13° 7' 60N 75° 37' 60E	*Ficus sp.*(basari) Terminalia sp	15 km away from mudigere, Robusta coffee +cardamom ecosystem	-do-	Mar - May	Aug - Dec	150-200	Robusta ecosystem is holding less roost size due to Severe tree pruning.
39	Chipregathi estate, Mudigere 13° 7' 60N 75° 37' 60E	*Ficus sp.*(basari) Terminalia sp	15 km away from mudigere Robusta coffee+ cardamom ecosystem	-do-	Mar - May	Aug - Dec	300-350	Robusta ecosystem is slightly disturbed, people hunting for meat
40	Mallandoor estate, Chikmagalur.	*Ficus benghalensis,*	25km away from	-do-	Mar - May	Aug - Dec	700-800	Typical bat roost. No disturbance,

	13^0 18’ 44.25’’ N, 75^0 46’ 15.05’’E.	*Casia sp. Mangifera indica*	Chikmagalur					No predator etc.
41.	Sannaghattahalli, Thubkere, Dodballapura Bangalore rural 13^0 14’ 56.65’’N, 77^0 23’23.15’’E.	*Ficus religiosa –*	100 years old tree, *single tree with 0.5 sq.km canopy cover.*	Dry, warm	Feb-May	Mar-Apr	800-1000	Tree with a small temple at base, public property, roost well protected.
42.	Vishwa composit P.U. college, Kempegowda road, Belur, Hassan 13^0 18’ 32.10’’ N, 76^0 14’ 51.89 ‘’ E	*Eucalyptus sp., Tamarindus indicus, Silver oak*	In the town near college	Dry period through out the year	Feb-May	Mar-Apr	300-400	Disturbed roosts the bats were a nuisance to public so tree is cut and the bats roosting in neighboring trees.
43	Thungariver bridge, Tirthahalli 13^0 41’ 32.10’’ N, 75^0 71’ 51.89 ‘’ E	*Bamboo*	Bridge built in 1931 at the edge of a river, over hanging over 8m above.	Heavy rains, humid, cool, evergreen trees	Oct-Jan-Feb	Feb-Mar	800-900	40-50 years old , roosts appear to be safe, no disturbance. During day time noisy.
44	Kushal Sawmill, Devanur road, near town, Banavara, Hassan 13^0 18’ 30.10’’ N, 76^0 14’ 49.89 ‘’ E	*Ficus religiosa*	25 years old tree 1 km away from town.	Dry period, warm, through out the year	Mar-May	Mar-Apr	400-500	Roosts appear to be same well protected by sawmill owner.
45	Arakalgudu, Hassan, Bus stand. 13^0 18’ 32.10’’ N, 76^0 14’ 51.89 ‘’ E	*Rain trees- 2*	Bus stand Arakalagudu.	-do-	Feb-May	Mar-Apr	550+	25 years old tree, Traditional roost, No disturbance, Protected by public.
46	Srinivaspura, Kolar Near Police station	*Eucalyptus tree-8*	Near Police station	Hot, dry, warm	Oct-Jan	Jan-Feb	350-400	No disturbance, new and small roost.

	13^0 09’ N, 78^0 11’ E							
47	Kolar Town 13^0 09’ 32.10’’ N, 78^0 11’ 50.89 ‘’ E	*Eucalyptus tree*	Near KSRTC office	-do-	Jan-Feb	-do-	250-300	Recent roost , small one, no disturbance.
48	Holenarasipura ,Hassan 13^0 18’ 32.10’’ N; 76^0 14’ 51.89 ‘’ E	*Ficus benghalensis, rain tree*	Govt. hospital	Dry period through out the year	Feb-May	Mar-Apr	450-500	Traditional roost, no disturbance
49	Mann’s Compound , Madikeri, Behind J C Colllege 12°30'N, 75°45'E	*Casuarina, Eukalyptus , Mango , Jamun, Dhoopada Mara Basseralia serrata, Gauva, Spathodea companulatum,*	Very old trees planted in open area,	Humid, wet, heavy rains	Jan-Apr	Mar-Apr	250-300	Well protected, 50 years old, bats numbers are increasing- Numbers fluctuate- less in rainy period -more in post monsoon.
50.	Kodigarahalli cross, Shuntikoppa, Madikeri 12°30'N, 75°45'E	*Ficus benghalensis,*	Located in the town, near *RFO, Changappa*	Evergreen trees, humid, wet, heavy rains	Sept-Dec	Oct-Nov	600-700	No disturbance, traditional roost, Two bats found dead across electric wires
51	Near Hunsur Bus stand-Mangalore- Bangalore Road. 12° 18' N, 76° 19' E.	*Avenue tress, Eucalyptus*	Safe, very high, *road side Hunsur main road*	-do-	Oct-Dec	-do-	300+	Comparatively safe, slightly disturbed my traffic/people.

52	Induwal, Mandya 30 Km from Mysore 12°30'N, 77°0'E	*Eucalyptus other trees*	*On Mysore – Bangalore road, 105 kms away from Bangalore.*	-do-	Sep-Nov	-do-	250+	Not protected, Disturbed by traffic and light.
53	Temple of lord kengal, Kengal, Channapatana 12° 58' N, 77° 32' E	*Eucalyptus Ficus trees*	Temple place near kengal	-do-	Sep-Jan	-do-	800	Religious place.Protected, No disturbances,
54.	Hanumanahalli, (Tovikere)Madhugiri, Tumkur Tq. 13° 39' 38" N, 77° 12' 33" E.	*Ficus benghalensis, Hippe, Basari, Goni,*	30 Km away from Tumkur. interference-10trees/village	Warm, dry, deciduous	Feb-May	Mar-Apr	>1000	Well protected by the local people
55.	Soppinahally, Gubbi, Nittur hobli, Tumkur 13° 20' N, 77° 08' E.	*Ficus benghalensis, Goni*		-do-	Feb-April-May	-do-	1000-1500	Un disturbed, well protected by the local people
56.	Maisandra police station, Maisandra, Chunchungiri hobli, Turuvekere Tq. 13° 16’ 72. 87’’ N 76° 66’ 37. 51’’ E	*Ficus sp., Goni, Basari*	Roost tree is present near a police station	-do-	-do-	-do-	600	Well protected, not disturbed
57.	KG temple, middle point between CS pura and Gubbi Tq. Tumkur 13° 18' 38 N 76° 56' 40 E	*Hippemara*	Adjacent to high school	-do-	Jan-May	-do-	500	Protected, slightly disturbed by people.
58.	Ganganahalli gate, Turuvekere, Tumkur	*Hippemara*	½ Km inside right side	-do-	-do-	-do-	350	Road side tree, not well protected

	13° 15’ 32. 64’’ N 76° 60’ 35. 58’’ E							
59	Somalapura-Idukkinahally, cholur road, Gubbi, Tumkur 13° 18' 38 N 76° 56' 40 E	*Nerale, hippemara*	10-15years old tree,	-do-	-do-	-do-	550	Not well protected. Hunting, netting were common.
60	MN kote, Tyagatur, Nittur Hobli-Gubbi tq.tumkur 13° 18' 38 N 76° 56' 40 E	*Nerale, hippemara*		-do-	-do-	-do-	600	
61.	Ujre,-Belthanagadi road, Mangalore 13° 05' N 75 ° 23' E	*Ficus sp* 2 -3 trees	15-20 years old tree. Left side of the main road on the out skirts of Town.	Hot humid, coastal tract with good precipitation	Feb-May	-do-	200 nos.	Small roost, not well protected on left side from ujjre town
62.	Belthangadi town, Mangalore 13° 05' N 75° 23'. E	*3-4 trees of palms and Ficus sp*	15-20 years. *0.3-0.5 Km on left side from ujjre*	do	do	do	300nos. *bats*	The roost trees amidst dense vegetation, well protected by the owner
63	B..C. Cross junction – near A.k.Residencey on NH -47 Mangalore 14° 08' N 75° 55' E	on 4-5 trees Ficus sp palms a coconut garden	5-6 Km from B.C Cross junction on left side	do	do	Feb-March nuts in Nov-Dec)	400-600 bats	Its well protected , well clustered, small roosts , 25 years old,
64	Farangipet, on NH 47,	*Rain Tree*	30-35 years	-do-	-do-	-do-	600-800	Well protected, old

	mangalore 12° 84’ 38’’ N 75° 24’ 79’’ E	*Other trees*	0.5 Km inside, in a close vegetation patch				bats	traditional roosts
65	Kaggalipura, Bangalore-Kanakapura Road, Kanakapura 12° 16' 29" N 76° 53' 40" E	*Ficus religiousa*	25-35 years old tree, On left side of the road from Kanakapura	Warm, dry, weather	Dec-Jan	Jan-Feb	200-250 bats	Not well protected, needs protection, near to town
66	Siddaiahyanapur, Harohalli, Kanakapura 12° 33' 00" N 77° 25' 00" E	*4 Ficus religiousa tree* *1 Albizzzia lebbeek* *1 neem tree*	50 years old tree, in a village	-do-	-do-	-do-	>2000 bats	Well protected by the villagers, highly noisy, bats recorded feeding on Basre, grapes, Guave.
67	Rahugodlu gate/Somanahalli gate, 2-3 Km before Kaggalipura 15° 13' 18.04"N 75° 30' 56.08"E	*Silver oak tree*	25 years old tree	-do-	-do-	-do-	450-500	Undisturbed, well protected by the villagers.
68	Kenchanaguppe Gate, Near Bidadi town 12° 12' N 77° 33' E	*Eucalyptus comandulensis*	15-20 years old tree on the road side of Bidadi main road	-do-	-do-	-do-	500 bats	Well protected and undisturbed
69	Uppinangady, Saihtra Siddelingeswaraswamy Temple, Netravati river steam 12.8438 N 75.2479 W	*Mangifera indica-1,* *Enterolobium saman-2* *Couroupita guianensis*-1 *Tamorindus*	>50 years old, near Sangam, where kumaradhara, a tributory of Tungabadra (from east)	Humid, wet, sultry	Mar-May	Apr-May	750-900	Well protected roosts . The bats population is increasing ,very noisy.

		indica -1 Ficus sp. 1 jack,teak,cocnut,	joins netravathi , atributory of Kauvery					
70	Uppinangadi, NH-48, Hassan –Mangalore road, Padubidri 13 08 N, 74 46 E	*Mangifera indica-1, Enterolobium saman*	20-25 years	do	do	Dec-May	350-500	Well protected.

CASE STUDY - 1

GIANT INDIAN FRUIT BAT (*Pteropus giganteus* Brunnich) ROOST IN KARNATAKA, SOUTH INDIA: A CASE FOR PRESERVATION AS A HERITAGE SITE

Introduction

Many of the lesser-known taxa such as bats have received little protection and face considerable threats and higher rates of endangerment. India's bat fauna is rich and diverse. India has more than 11% of the world's bats including 13 megachiroptera and 99 microchiroptera (Bates and Harrison, 1997). However, the Chiropteran diversity in the Indian subcontinent is presently represented by 121 species belonging to 37 genera and 8 families, with 112 species belonging to 33 genera and 8 families within Indian limits (Srinivasalu and Srinivasalu, 2001). These species provide substantial ecological and economic services via pollination, seed dispersal and agricultural pest control (Mistry 2001).For example, the common species of fruit bats (*Cynopterous sphinx* Vahl. *Pteropus giganteus* and *Rousettus leschenaultia* Desmarest) visit over 114 plant species and act as an important pollen and seed vectors (Micheleburgh *et al*., 1992, Molur *et al*., 1998).Yet many bat species in India face numerous threats. They may cause economic loss while feeding on fruits (Varghese, 1998; Srinivasalu and Srinivasalu, 2001a). But this is neglible compared to their beneficial roles. In India meat and other parts of body of fruit bats are used to cure respiratory disorders, menstrual problems and as food. Fruit bats are often referred as messengers of god, Lord Shiva. Bats conserve rain forests too. For instance, *Latidens salimali* Thonglongya is the prime seed disperser in the rain forest, which help us a lot in the restoration of tall fruiting trees of Agasthiyarmalai range of southern Western Ghats(Vanitharani, 2005).In Bihar, bats viz., *Megaderma lyra* are known to keep

under check destructive rodent species in cultivated crops , godowns and houses(Sinha, 2002).

Materials and Methods

Roosting site

The roosting site is located in a village called Gidadapalya located 15 km north of Kunigal town(map) Tumkooru (Lat/Lon: 13.3° N 77.1° E) is a village with about 50% under vegetation cover. The village has 150 houses and farmers cultivate diversified crops like tomato , ragi arecanut , coconut , sapota and other vegetables . The village is surrounded by forest plantations of *Casurina, Acacia* and indigenous tree species like *Ficus, Bahunia*, *Samanea saman, Tamarindus indica* and other species. The roosting site extends to about one acre (10,000 sq mtrs) and is covered with indegenous species of trees as mentioned above. The canopy cover is almost 100%. The ground cover is diverse and surrounded by thick *Lantana* bushes.

● Bat roost at Kunigal (Tumkooru)

History

It is believed that the bats *Pteropus giganteus* have been residing in this village from the past 75 years. The present roosting site is the third place that the bats have changed since at the first place the trees were cut as it was a private property .The bats shifted to the second place. Even at this place the trees were cut. Later the bats shifted to the present place where there are 30 *Ficus bengalensis* (banyan) trees and bamboo clumps. The land and property of roost site belongs to Mr.Gangadhar where bats are roosting from the past 18-20 years. Mr. Gangadhar and villagers are very keen to see that the roost site be declared a heritage site.

It is believed that a rishi had advised Mr.Gangandhar's father to protect these bats. So this place is conserved / protected by villagers. The villagers are nature loving is evidenced by the maintenance of good vegetation cover (75%) in the village.

A small temple is at the center of roost site. Lantana plants were manually planted to protect intervention of cattle and people inside the roost site. So bats are left undisturbed. Lantana bushes act as buffer. There is a huge collection of leaf litter from banyan trees and bat guano (fecal droppings) at the site. . It is collected in April – May after the rains and around 10 tractor loads (each load costs Rs. 1000/-) are collected per year and villagers use this manure for cultivating ragi, areca, coconut and other crops. .

Bat counts

An effort was made to estimate the number of bats at the roost. Two observers armed with binoculars (80x30 and 70x50) counted the number of bats clinging to branches of trees by going round the roosts, prior to evening flight .The two observers counted the bats independently and separately, The numbers were averaged. At 6.20 pm few bats were observed making foraging flights. Four observers placed in four directions counted the number of bats issuing out of the roosting trees. The counts of each observer were added to make the size of the roost.

Observations

Feeding and foraging behavior of bats was recorded on four dates during December 2007 to January 2008 using four wheeler drive vehicle, binoculars 80 x 30 and telescopes, when bat feeding on fruits, twigs and flowers in and around the roost (5 km^2) were recorded. Opportunistic observations were also recorded on numbers, reproductive status and threats to the roost.

Results and Discussion

The breeding commenced in December in these bats. The young ones are born during February to April. The adult bats weighed up to 1 kg(n=6).Bats foraged on trees like niligiriflowers (*Eucalyptus*), 3 to 4 species of *Ficus*, banyan tree, hippie (*Madhuka*), sapota (*Achras zapota*) and they feed on the young shoots and buds of these trees and

fruits of *Ficus*. In general, the bats were observed leaving the roost for foraging by 6.pm in the evening. The bats were observed making recognizant flights around the trees and then dispersing in all directions for foraging. The young ones were left at roost and the mother bats foraged to nearer places in order to return to the roost early. The bats were observed drinking the water in near by ponds by surface diving. Thus the area around the roost provided shelter, food and breeding requirements for the fruit eating bats. Surveys for the roosts of *P.giganteus* during the last four years indicated a sharp decline in Bangalore Urban and Rural districts, Tumkooru, Chickmagalur, Shimoga and Hassan in southern Karnataka. In this context, roost size of 2,600 individuals and their breeding assumes significance.

Threats

Hunting of bats has been one of the great threats here, as elsewhere (Mickleburgh et al. 1992 and 2001). People come from far off places for hunting *viz*., Shimoga and Tumkur. The prospective hunters, who hail from out side the village observe the flight paths, time, height and direction of fly ways. They erect large poles to hang the mist nets.

The trapped bats are picked and sold at Rs.200/bat. However, if the hunters are noticed by the villagers, they are chased away and punished. The hunters also use guns for killing. Apart from serving as food the bats are used for medicinal purposes. Interaction with villagers revealed that on an average about 10% bats are killed at this roost. Observations at other roosts revealed that about 30 % bats are eliminated by hunting alone in different parts of Karnataka.

Economic importance

Bats play a crucial role in the ecosystem. A very simplistic example being fruit bats task as flower pollinators and in seed dispersal and that of insectivorous bats in controlling much of the insect pest's population. Although fruit bats damage a small percentage of agricultural crops, their role in forest regeneration more than compensates

this loss in the long term from the perspective of the greater good. However, in the area bats were not observed implicating in any economic damage to any cultivated crops.

Folivorus bats consume flowers and fruits effecting seed dispersal and pollination. Some of the adaptations of bat pollinated syndrome include nocturnal anthesis, color emission and presentation of rewards to the pollinators. We studied the bat pollinated plants such as *Parkia bidandulas*, *Bassia latifolia*, *Ciba pentendra* and *Kigelia pinnata*. Bats helped in cross pollination. (Nathan *et al*., 1991).

Public awareness on the importance of flying foxes in pollination, seed dispersal and the benefits of their excrement (as natural organic manures) may create better understanding to preserve their roosting habitats.

Table1. Nutrients and microbial composition of guano and bolus of flying fox, *Pteropus giganteus* (range in parentheses)

Parameter	Guano	Bolus
Total nitrogen (%)	2.6 ± 0.5 (2–3.3)	3.3± 0.82 (2–4)
Total phosphorus (%)	4.2 ± 0.8 (3.1–5.2)	4. 3 ± 0.6 (3.5–5)
Potassium (%)	0.6 ± 0.04 (0.6–0.7)	0.7 ± 0.04 (0.6–0.7)
PH	7.3 ± 0.1 (7.1–7.4)	7.1 ± 0.3 (6.7–7.4)
Bacteria (cfu/g dry wt)	29 $x10^4$ ± 50 (25–32 x 10^4)	48 $x10^4$ ± 28 (46–50 x 10^4)
Actinomycetes (cfu/g dry wt)	5.55 x 10^4 ± 7.8 (5–6 x 10^4)	4.1 x 10^4 ± 7.8 (3.5–4.6 x 10^4)
Fungi (cfu/g dry wt)	2.9 x 10^4 ± 3.5 (3.1–4.3 x 10^4)	4.6 x 10^4 ± 3.5 (4.3–4.8 x 10^4)

Source: Santhosh *et al.* 2006

Over 200 species of flying foxes are distributed throughout the tropics and being frugivorous they play a major role in pollination and seed dispersal (Sharoukh Mistry, 2000). The Indian flying fox, *P. giganteus* commonly roosts on large trees (e.g. *Ficus*). They earned the name 'flying fox', as the head and fur resemble a fox. Their roosting results in the accumulation of substantial amount of guano on the floor. They swallow soft fruits or extract juice and spit out the remains known as bolus, containing the residual fruit pulp of fibrous fruits and seeds. Besides fruits, they are also known to feed on juice and pollen of various tree flowers. Although flying foxes are widespread species, they are facing threats mainly due to loss of roost trees, hunting and pesticide use.

The Indian Flying Fox is the largest bat occurring in the region and is known to live in close proximity to humans. Anecdotal accounts of *P. giganteus* suggest that some roosts have increasing populations whereas others are decreasing. Isolated studies have provided some insights into possible disturbances and their impacts. However, as a species very little is known about *P. giganteus* population trends in the wild.

Some development work around human habitations and expanding roads have in the recent past affected roosts by the roadside; increasing interest in bat meat and hunting for medicine have resulted in depletion in numbers in some roosts; disturbance to traditional roosts has resulted in bats finding alternate roosts nearby or farther away (Molur and Walker, 1998). Bats have been known to shift roosts from old native trees such as the fig trees to introduced non-native trees such as Eucalyptus and Casuarina; some roosts are reported to have disappeared (Chakravarthy, 2007).

The property belongs to Mr. Gangadhar who is very much interested and he is ready to donate this site which is about 1 acre with 30 trees of *Ficus* to government agencies if it can be declared as a heritage site and protection is provided to these roosting bats.

There is a small Muneshwara temple in the place where people worship the god and by belief the whole area is protected and conserved. Observations have revealed that the bats are not of any nuisance value to the villagers as they do not damage the crops of the farmers and they feed on the sprigs of foliage of *Ficus*, *Madhuka latifolia*, *Eucalyptus* and many other tree species and people have a very good thought for these bats. Interactions with villages using the performa revealed that all supported the idea of declaring the roost as heritage site. The villagers had many reasons for declaring the site as a protected area.

The reasons are as follows

- Village with less population – around 150 families having conservation attitude and is well vegetated and villagers want to conserve the bats and trees.

- Bats roosts especially of *P. gigantus* are dwindling rapidly due to cutting of trees and increasing human populations in Karnataka, traditional roosts have been drastically reduced.

- The village (Gidadapalya) has a good vegetation all round and forest lands too, far and near.

- Lantana bushes act as Buffer zone- prevents the interventions by cattle and humans to the roosting site.

- Many Villagers are organic farmers- it will encourage farmers to go for organic farming and realize or derive multiple benefits.

- Other animals and birds inhabiting the roost site – Mongoose *(Herpestes auropunctatus)*, wild boars (*Sus scrofa*), snakes, birds such as peacocks, woodpeckers, chloropsis, pied cuckoo, owls, etc, hares, rodents and foxes are found here. This indigenous biodiversity elements are crucially important for the productivity of the village. The area has 30 *Ficus* trees-so in addition to bats other biodiversity components too are protected.

- The roost site will be conserved in the long run because the whole community is involved and participatory approach is sustained. As for instance the conservation of spotted pelicans and painted storks in Maddur, Mandya district Karnataka, South India.

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CASE STUDY – 2

GIANT INDIAN FRUIT BAT (*Pteropus giganteus* Brunnich) ROOST, IDENTIFYING HOT-SPOTS FOR CONSERVATION IN SOUTH KARNATAKA, SOUTH INDIA: A CASE FOR PRESERVATION AS A HERITAGE SITE

Introduction

The identification of hotspots for conservation priorities has often been based on the species richness and endemism of plants and vertebrates, primarily because of extensive data available on these taxa (Dinnerstein and Wikramanayake, 1993; Meyers *et al*., 2000). India has 11.6% of the global bat species (13 mega chiroptera and 99 microchiroptera, Bates and Harrison, 1997), which is on par with birds and substantially higher than plants. Bats are very important pollinators and seed dispersers in tropical forests and have shared a long evolutionary history with angiosperms. Megachiropterans feed upon at least 145 genera of fruits in 30 families of plants (Michleburgh *et al*., 1992).

In many places fruit bats are the only animal capable of carrying large seeded fruits and can be the single, most important pollinators and seed dispersers. At least 443 plant products useful to man are derived from 163 plant species that rely to some degree on bats for pollination or seed dispersal (Fujita and Turtle, 1991). These species provide substantial ecological and economic services *via* pollination, seed dispersal and agricultural pest control (Mistry, 2001). For example, the common species of fruit bats (*Cynopterus sphinx, Pteropus giganteus and Rousettus leschenaultia*) visit over 114 plant species and act as important pollen and seed vectors (Mickleburgh *et al*., 1992, Molur *et al*., 1998).

Yet many bat species in India face numerous threats. In terms of endemic species, India has a higher proportion of endemic bat species than either plants or birds. There is a population decline of bats in recent years. So an action plan for the conservation of fruit bats is of a high priority (Mickleburgh *et al*., 1992). Because many species of fruit bats are dependent on primary forests and thus threatened by the large scale destruction of forests in tropical areas. Declines in fruit eating bat populations are widespread in India due to high rate of deforestation, increased use of pesticides, habitat degradation and human consumption. So conservation of the Indian Flying Fox (*Petropus giganteus)* and identifying hotspots for bat conservation should be a priority.

Materials and Methods

Roosting site

The roosting site is in a village called Sidaiahyanapura located 2 km north of Harohalli in Kanakapura taluk, Bangalore Rural, South Karnataka (12° 58' 00'' N, 77° 28' 00'' E 980 AMS). Sidaiahyanapura is covered by 55% vegetation. The village has approximately 200 houses with a population of >500, most of them being farmers. Ragi is the main crop. They also cultivate coconut, sapota, guava and other vegetables. The village is surrounded by indigenous trees, *Ficus religiousa, Albizzia, Bahunia*, *Samanea saman, Tamarindus indica* and other species. The roosting site extends to about ½ acre which is a private land belonging to one Mr. Ramanna and three brothers. The bats roosts are found on four *Ficus,* one *Albizzia* and one neem tree.

History

The bats are resident to this place from the past 50 years. Initially the bats were roosting on four *Ficus sp.* trees. Due to some disease the trees died and the bats shifted to the nearby trees i.e. the present roost. Earlier, the bats were extensively

hunted for meat and medicinal purposes. Of late local villagers are vehemently protecting the bats and they are not allowing hunting. The villagers have sentiments regarding the bats and are collectively guarding it. Together with bats, the villagers are protecting other biological entities like birds, reptiles, amphibians and small vertebrate animals. Indigenous trees and other flora are also being protected.

Bat counts

The bats at the roosting site were monitored by 4 observers armed with binoculars (80x30 and 70x50). The bats were counted by direct visual counts (using a hand tally counter). Counts made independently by the four observers were pooled to derive the mean size of the roost population. At the early evening hours bats were observed making foraging flights. Four observers placed in four directions counted the number of bats issuing out of the roosting trees. The counts of each observer were added to make the size of the roost.

Observations

The bats and bat roosts were observed for four continuous days during 2007-2009 and their feeding and foraging behavior were recorded. The observations were made by four observers using binoculars (80x30 and 70x50) and telescopes. The observations were made in and around the roost site over 4-5 km^2 using a four wheeler driven vehicle. Data was collected on the feeding and foraging behavior, their foraging time and feeding time, reproductive status and threats to the roosts and their present status etc. A proforma was developed in local language (kannada), for interaction with villagers on the importance of the bats and the bat roosts.

Results and Discussion

The breeding commences in December in these bats. The young ones are born during February to April. Bats foraged on trees like *Eucalyptus*, *Ficus*, *Madhuka latifolia, Bahuinia* and they feed on the young shoots and buds of these trees. A survey of 5 km^2 area around the roost revealed that bats foraged principally on *Ficus* springs and fruits. The bats were observed making recognizant flights around the trees and then dispersing in all directions for foraging. The young ones were left at roost and the mother bats foraged to nearer places in order to return to the roost early. The bats were observed drinking water in near by ponds by surface diving. Thus the area around the roost provided shelter, food and breeding requirements for the fruit eating bats. Surveys for the roosts of *P.giganteus* in the vicinity of kanakapura town and surrounding areas indicating that indigenous fruits bearing species like *Ficus,* Tamarind, *Albizzia,* teak, *Bahunia* and others which are key to the sustenance of bats in the district.

Threats

Hunting of bats has been one of the great threats here, as elsewhere (Mickleburgh et al. 1992 and 2001). *Tigalru* are seduled tribe people who mainly depend on hunting i.e. fish hunting and animal hunting and also bats. They also harvest lotus flowers, neem foliage etc. They are also involved in trading wild plants and animals in cities. These hunters, who hail from out side the village observe the flight paths, time, height and direction of fly ways. They erect large poles to hang the nylon nets. The trapped bats are picked and sold at Rs.200/bat. However, if the hunters are noticed by the villagers, they are chased away and punished. The hunters also use guns for killing. Apart from serving as food the bats are used for medicinal purposes. Observations at other roosts revealed that about 30 % bats are eliminated by hunting alone in different parts of Karnataka.

Economic importance

Bats play a crucial role in the ecosystem. A very simplistic example being fruit bats task as flower pollinators and in seed dispersal and that of insectivorous bats in controlling much of the insect pest's population. Although fruit bats damage a small percentage of agricultural crops, their role in forest regeneration more than compensates this loss in the long term from the perspective of the greater good. However, in the area bats were not observed implicating in any economic damage to any cultivated crops.

Folivorus bats consume flowers and fruits effecting seed dispersal and pollination. Some of the adaptations of bat pollinated syndrome include nocturnal anthesis, color emission and presentation of rewards to the pollinators. We studied the bat pollinated plants such as *Ficus balerica, Ficus religiosa, Tectona grandis, Ciba pentendra* and *Kigelia pinnata*. Bats helped in cross pollination. (Nathan *et al*., 1991).

Public awareness on the importance of flying foxes in pollination, seed dispersal and the benefits of their excrement (as natural organic manures) may create better understanding to preserve their roosting habitats.

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native trees such as the fig trees to introduced non-native trees such as Eucalyptus and Casuarina; some roosts are reported to have disappeared (Chakravarthy, 2007).

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Observations have revealed that the bats are not of any nuisance value to the villagers as they do not damage the crops of the farmers and they feed on the sprigs of foliage of *Ficus*, *Madhuka latifolia*, *Eucalyptus* and many other tree species and people have a very good thought for these bats and they are protecting this area due to some religious belief and sentiments. Interactions with villages using the performa revealed that all supported the idea of declaring the roost as heritage site. The villagers had many reasons for declaring the site as a protected area.
The reasons are as follows

- Village with less population – around 120 families having conservation attitude and is well vegetated and villagers want to conserve the bats and trees.
- Bats roosts especially of *P. gigantus* are dwindling rapidly due to cutting of trees and increasing human populations in Karnataka, traditional roosts have been drastically reduced.
- The village (sidaiahyanapura) has a good vegetation all round.
- Many Villagers are organic farmers- it will encourage farmers to go for organic farming and realize or derive multiple benefits.
- Other biological entities like birds, reptiles, amphibians and small vertebrate animals.
- The roost site will be conserved in the long run because the whole community is involved and participatory approach is sustained.

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