SURVEY AND CONSERVATION OF CAVE-DWELLING BATS IN COASTAL KENYA

FINAL REPORT
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ABSTRACT

Coastal Kenya has many coral caves hosting many different colonially-roosting bat species. Most of these caves are on private lands and face serious anthropogenic threats from expanding agriculture and other uses. I developed a method to count the bats inside the caves, which I then used on five occasions to obtain a starting figure for future monitoring of the bat populations. I also investigated the threats to caves and bats, including local peoples' perceptions about them. Population estimates were conducted via photography, while structured interviews and questionnaires were used to understand views of locals concerning bats and the threats they face. The caves housed 9 species of bats (1-7 per cave), one threatened (*Taphozous hildegardeae*) and one near threatened (*Hipposideros vittatus*) and housed between 100 and 73 000 individuals in each cave. The caves were most affected by agricultural activities that involved burning and cutting of vegetation near the cave entrances. Local people viewed bats negatively. They do not understand their importance in agriculture and persecute them whenever the occasion arises. Therefore, a robust public education and community outreach program is necessary to change peoples' perceptions and enhance bat conservation along the Kenyan coast.

INTRODUCTION

Coastal regions and ecosystems represent areas of global significance. They are also complex, dynamic and highly sensitive. They are economically, environmentally and culturally important. (Mclean *et al.* 2014). Bats are among the fauna that are supported by the costal ecosystems.

There is a general lack of information about the distribution, status, biology and conservation status of many species of bats particularly in the Old World tropics (Mickleburg, *et al.* 2002), as well as about their ecological roles and ecosystem services they provide. Areas with an abundance of limestone caves are always rich in bats, and the Kenyan coast is no exception. Indeed, Kenya has one of the richest bat faunas in the world with >108 species and the coastal part of the country is probably the richest in terms of biodiversity (Patterson & Webala, 2012).

There are numerous coral caves dotted along coastal Kenya, some of them with thousands of bats of several species. Most of these caves occur on private lands and in some cases with lots of human activities around. These activities may in some cases pose a threat to the bats since communities around the caves do not understand the importance of the bats and view them as a

nuisance and often times persecute them. There are no bat roost caves along the coast that are officially protected, as far as I know.

Although some of the caves along the Kenyan coast have been studied scientifically long ago, there is currently no monitoring of the bats in the caves or other conservation initiatives. Yet there is every reason to believe that the caves and the bats are under heavy pressure from rapidly increasing human population in the area. For most or all the bat species inhabiting the caves, very little or nothing is known about if and how they react to the increasing pressure on their environment. This information is, however, crucial if bats are to be conserved and managed successfully (Hutson *et al.* 2001).

The purpose of this study was to initiate a monitoring program for the bats in four nearby caves along the Kenyan coast and assess the attitude of the local people with respect to bats and bat conservation. The overall aim was hence to promote conservation of the bat caves in coastal Kenya.

Objectives

1. Map four caves that are used as a bat roosts.
2. Monitor the bat population in each cave over one year.
3. Survey the perceptions and opinions of the locals about bats.
4. Assess anthropogenic disturbances around the caves.
5. Bring together local stake holders to investigate the possibility of limited bat based eco-tourism (bat-watching from outside the caves).

MATERIALS AND METHODS

Study area

The four coral caves; Makuruhu (S03.32319, E40.04153), Kaboga (S03.33451, E40. 03076), Pangayambo (S03.32241, E40.02377) and Watamu (S03.35122, E40.01528) are located at the coast of Kenya in East Africa. The dominant climatic seasons are the southeast monsoon which occur in March–September and the northeast monsoon occurring in September-March. The annual rainfall is usually 600–1000 mm with May recording the highest monthly rainfall. Daily mean temperature ranges between 24^{o} C in July and 32^{o}C in February (Government of Kenya, 1989).

The main activities around the caves are farming and settlements. Three of the caves are surrounded by farmlands of especially subsistence crops like maize, nuts and fruit trees. Watamu cave is located in Watamu town and is surrounded by buildings.

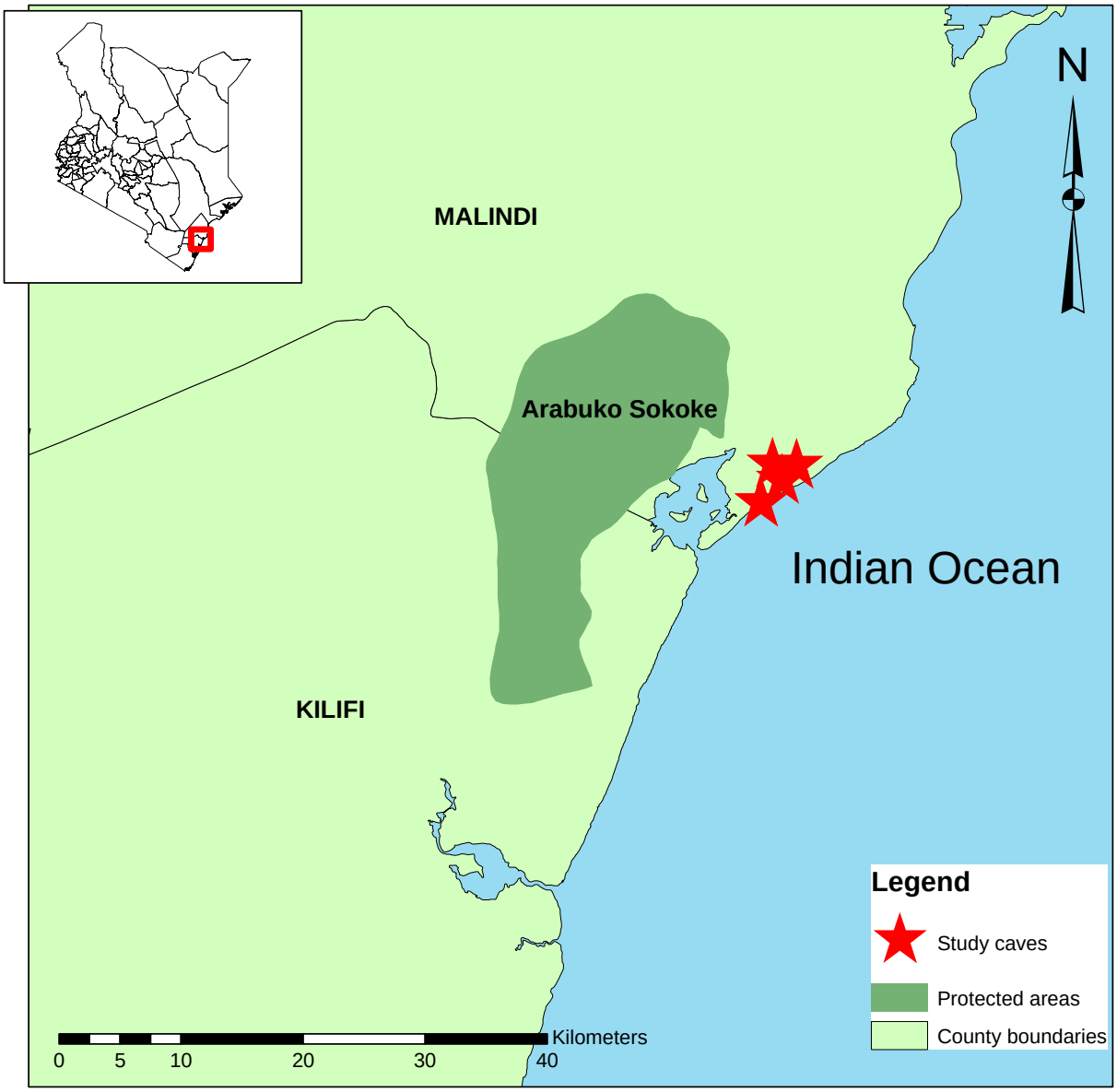

Figure 1. Map showing the location of the four study caves and the adjacent Arabuko Sokoke Forest Reserve and National Park.

Methodology

Cave mapping

Using an eTrex20 GPS the area around each cave was mapped and a point at each entrance was taken. This was done in September 2014. The perimeter of the floor and the height of the caves were measured using tape. The maps of the caves were developed in arcMap v10.2.1.

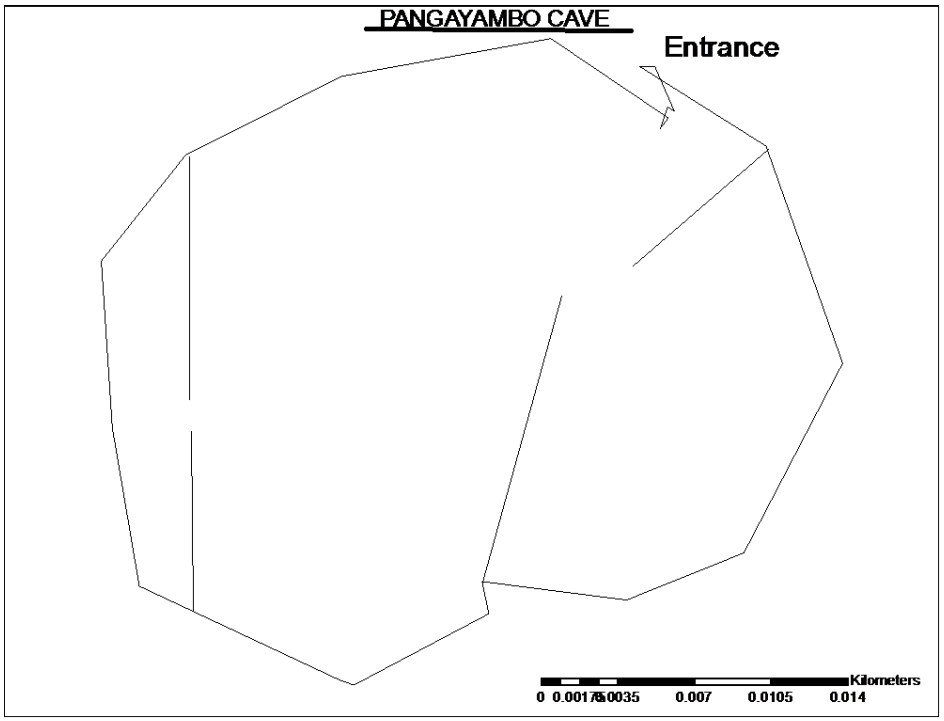

Figure 2. A map of Pangayambo cave showing the outline of the interior of the cave as an example.

Bat monitoring

Population estimates of bats inside the caves were done using digital photography. Using red light so as not to disturbed the bats more than necessary, moving slowly and staying away from the bats as far as possible, I took photos of the bats roosting on the walls of all sections of each cave. I used a D3200 Nikon camera with an 18-55mm lens and a SB700 flash. The photos were taken from the left side of the cave from the entrance moving round to the right, thus covering the entire walls and roofs occupied by bats. The roof of the cave was divided into two parts, using a tape measure so as to have part of it in the left and another in the right side. This was done five times from October 2014 to February 2015, in all of the caves in the same manner.

On entering the caves the bats were given time to calm down after the disturbance caused by our entering the caves before starting the photography. Two independent observers (I and Michael Bartonjo, my field assistant) estimated the number of bats in each cave each month from the photos and the average from the two observers was used. The counts from the two observers differed by averagely three bats per photograph.

Young individuals were counted as independent bats. Since the estimates were based on photographic images it was not possible to age the bats. The month that young were first seen was considered the month they were born.

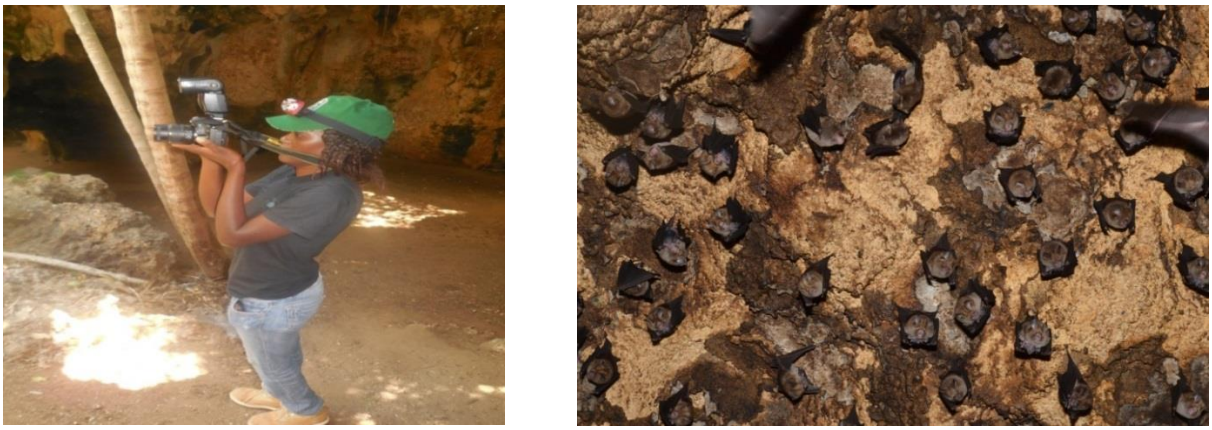

Figure 3. Taking photographs of bats inside Pangayambo cave (left) and sample of photos taken in Makuruhu cave showing *Hipposideros caffer* (right).

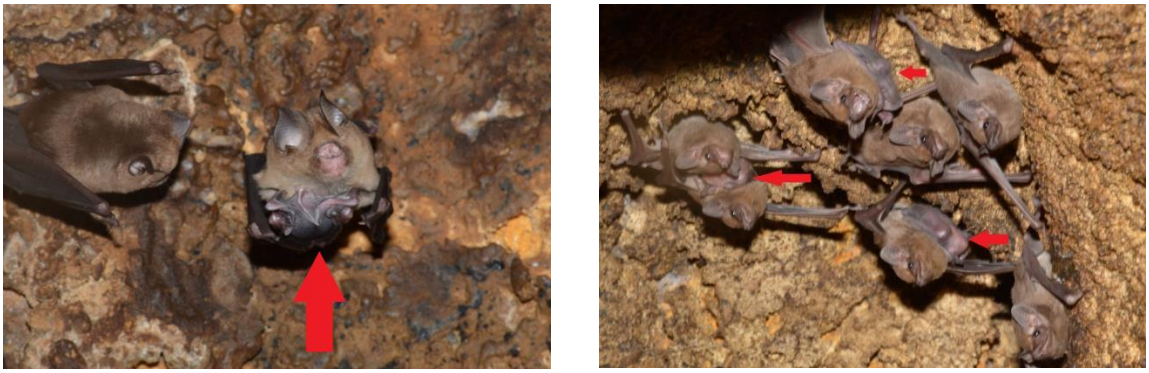

Figure 4. *Hipposideros caffer* from Kaboga cave (left) and *Coleura afra* in Makuruhu cave holding young (red arrows).

Interviewing

Eighty interviews were conducted through questionnaires. Twenty questionnaires were administered around each cave. Only one person per household was interviewed to avoid repetition from members of the same household, who could, however, interfere with the interview. The questionnaires were in English and Swahili and they were interpreted in Giriama in cases where the respondents were not conversant with either of the above two languages. Where some of the respondents were not able or willing to write, the investigators filled in their responses in the questionnaire. The interviews were done from March to May 2015.


Figure 5. A respondent filling in the questionnaire (left) and Michael Bartonjo, my field assistant, helping an illiterate respondent to fill in the questionnaire (right).

Participants for two trainings/workshops were drawn from the questionnaire respondents and others who were willing and this was done in the month of June and July 2015. The issues of bat conservation, their benefits and how to mitigate conflicts that arise were discussed and the participants got to ask more question about bats. Wildlife clubs were initiated in Jimba secondary and Jimba primary schools as they were the closest to the study sites.


Figure 6. Training of students from Jimba secondary school (left) and wildlife club members from Jimba primary school after training.

RESULTS

Caves

The four caves varied considerably in size, from 385 to 21 000 m^2 (table 1). All caves except the smallest one (Watamu) had multiple entrances and considerable variation in light and humidity inside, caused by variation in air flow.

Table 1. Sizes of the monitored caves.

Cave	**Area m^2**	**No. of entrances**	**Comments**
Makuruhu	21 000	4	Four high chambers and numerous small inaccessible chambers.
Kaboga	1 275	3	One high chamber and two smaller (but accessible) ones
Pangayambo	725	3	Three small accessible chambers
Watamu	385	1	One chamber with a large opening

Bats

At least nine bat species occurred in the four caves (Table 2). Identification of the species were done during preliminary surveys of the caves, that involved hand net captures and close up photography in 2014. Identification was based on Patterson and Webala (2012). Makuruhu and Kaboga caves housed six and seven species respectively, while Pangayambo and Watamu caves had one species each.

Table 2. Mean counts of bat species in each of the caves across all the months.

Family	**Bat Species**	**STUDY CAVES**			
		Makuruhu	**Kaboga**	**Pangayambo**	**Watamu**
Emballonuridae	*Coleura afra*	29681	4958		
	Taphozous hildegardeae	21240	3884		
Hipposideridae	*Hipposideros caffer*	11753	530		
	Hipposideros vittatus		2547		
	Triaenops afer	9649	238		
Megadermatidae	*Cardioderma cor*			107	
Miniopteridae	*Miniopterus africanus*	271	678		
	Miniopterus minor	404	313		
Pteropodidae	*Rousettus aegyptiacus*				8932
	TOTALS	**72998**	**13148**	**107**	**8932**

(a) (b) (c)

Figure 7. Some of the bats from the four caves: *Hipposideros vittatus* from Kaboga cave *(a), Miniopterus minor* in Makuruhu cave *(b)* and *Cardioderma cor* from Pangayambo cave *(c).*

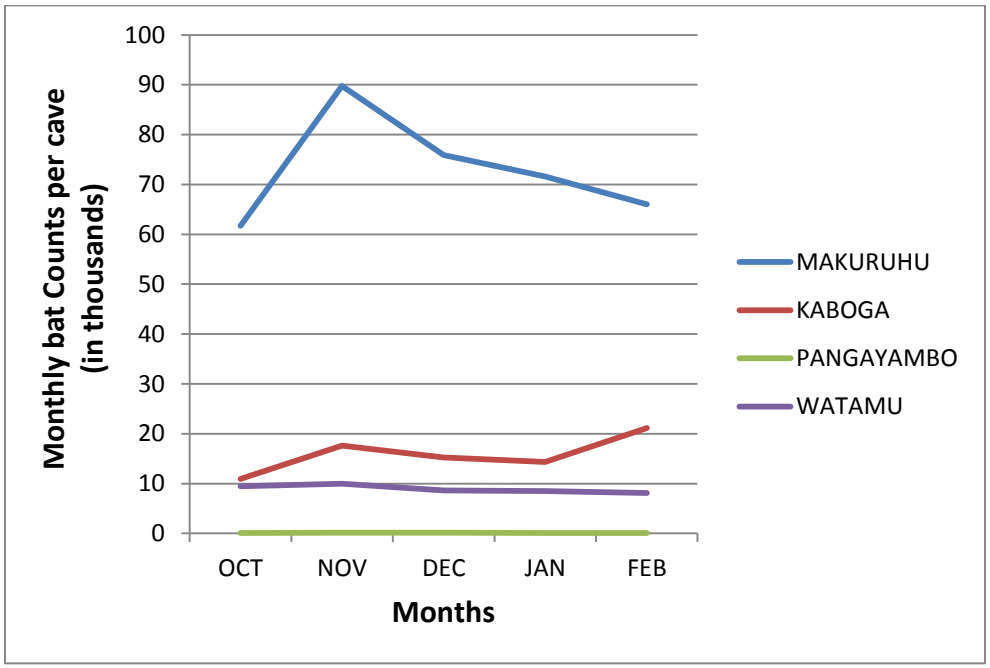

Figure 8. Monthly variations in the number of bats in each cave in 2014-15.

The month of November had the highest number of bats and this was also when the young of *Coleura afra* and *Taphozous hildegardeae* were first observed. *Hipposideros caffer* had young from the month of December. Makuruhu cave had the highest number of bats in general (table 2) and also had the highest numbers in each of the sampling months (Figure 8)

Questionnaire

A higher number of respondents (58%) perceived bats as a sign of witchcraft or bad omen, 37% of them saw them as just any other animal or birds and only 5% saw them as a sign of blessing (figure 9).

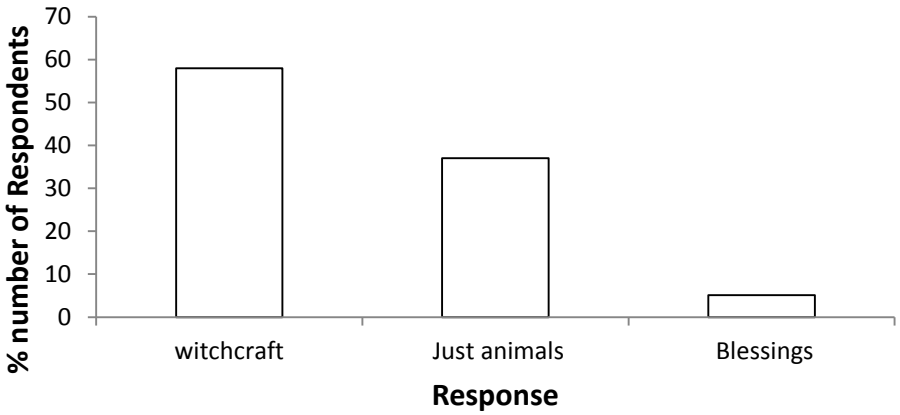

Figure 9. Perception of the community around roost caves on bats

Of the people interviewed, 68% (N = 80) thought that bats are not beneficial in any way to them or the environment and only 32% thought they are beneficial. Only 43% of the respondents believed they can do anything to promote bat conservation (figure 10).

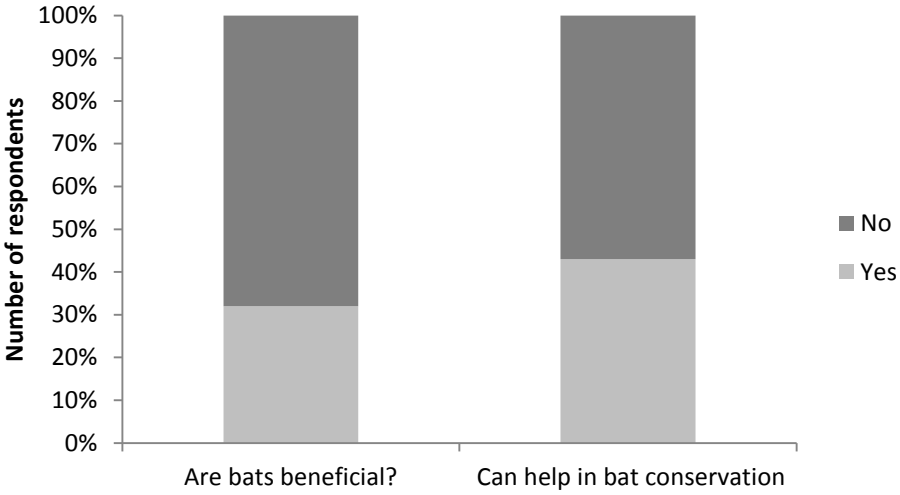

Figure 10. Response to benefits and conservation of bats in the area.

DISCUSSION

Pangayambo cave is used for small scale and local tourism by the owner and its floor is swept often. There is also a wooden staircase down to the cave which is continuously repaired and replaced. This might be causing disturbance to the bats and so it is not a preferred roost. Apart from tourism, all the area around the cave is used for farming and the owner continuously burn maize stalks and weed, this might perhaps affect the bats.

Apart from being in the middle a town centre, **Watamu cave** is located in a garden and is completely fenced off with a brick wall and a gate. There is little human activity in the cave. This could be supporting and protecting the bats. However, this cave have a very small area compared to the other three caves in this survey, but had the third highest mean number of bats. The concern is that the owner has plans to sell off the land with the cave, which will then be filled up for construction of a hotel. This will almost certainly be detrimental to the bats roosting in this cave.

Figure 11. *Rousettus aegyptiacus* in Watamu cave (left) and the cave with a brick fence around it (right).

Makuruhu and **Kaboga caves** are both surrounded by farmlands. Due to the seasonality of rains in coastal Kenya the people grow crops once a year in this area. No tourism or other activities occur in these caves and very few people even know that the caves exist or that there are thousands of bats. Makuruhu cave is on the land of an old lady. She perceives bats negatively and does not allow people to enter the cave with the view that it could bring bad omen to her home unless they give her ‘a good a reason’ to go in the cave. The main problems are the human activities around the caves and the people not being aware that there are bats in the caves. Those that are aware don’t see the need of protecting the bats since they do not know why they should.

Makuruhu and Kaboga caves harbour large populations of an endemic and threatened species (*Taphozous hildegardeae*) and in addition thousands of other bats that most likely are important but yet largely unstudied components of the local ecological communities. The value of their ecosystem services in insect control is totally unknown.

Figure 12. Assessing the effect of a recent burning activity outside the entrance of Makuruhu cave with one of the local guides.

The workshop and trainings were a good platform since it brought together school children, parents, teachers, land owners where the caves are and other stake holders. The attendees were trained on the benefits of bats and emphasis was on the ones that they can easily relate to like pollinating their crops, dispersing seeds, pest and insect control and help in forest regeneration especially the mangrove forests which protect them from floods. They also got to ask questions and get scientific clarification.

The wildlife clubs initiated in Jimba secondary and Jimba primary schools were taught more on bats. They were taught on how they can do bat watching especially in the evenings and not interfere with their school programs nor disturb the bats. Most showed great interest and they

spread the information to their parents back home how bats were important who came to us asking more questions about bats. This only shows that more needs to be done in this region and to involve the community more in conservation of bats and their roosts. These caves with others in the areas must be considered very important for the conservation of bats in Kenya and Africa and should be given high conservation priority as they hold a rich bat fauna.

ACKNOWLEDGMENTS

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APPENDICES

Appendix 1: Questionnaire for the interview

Survey Methods and Conservation of Bats in Caves in Coastal Kenya

This questionnaire is meant to collect information about bats from the community around cave roosts and will only be used for scientific research.

Date: _____ Nearest Bat Cave :_____NearestTown/Village:_____

Respondent Name: _____ Age:_____
Phone:_____

KNOWLEDGE AND BELIEFS ABOUT BATS

1. Have you ever seen a bat……..
   If yes
   a. Where …….....
      …….....
      …….....
   b. How many. 1-5……5-10……..10-50……more than 50…….

2. How many types of bats do you know. List them.
   ……..
   ……
   ……

3. What do bats feed on on……
   ……
   ……

4. What comes into your mind when you see/hear bats
   ……
   ……
   ……
   ……

5. What are the traditional beliefs in your community about bats
   ……...
   ……..
   ……..
   ……..

BENEFITS AND CONFLICTS FROM BATS

6. Are bats beneficial to you/your community in any way……
   If yes, How…….
   …….
   …….

7. Do you know any negative effects of bats…….
   If yes, which ones……...
   ……...
   ……...

8. What do you think can be done to mitigate conflicts between bats and people in your community…….....
   ……...
   ……

BAT CONSERVATION

9. Do you think bats should be conserved ……
   ……

10. Can you join/help in conserving bats around your community…….
    If the answer is yes, what would you do
    ……
    ……
    ……

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