HERPETOFAUNAL ABUNDANCE AND LOCAL COMMUNITY PERCEPTION OF THE SPECIES IN KAKUNGA-MUKANGU REGION OF THE KAKAMEGA FOREST NATIONAL RESERVE, KENYA

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ABSTRACT
The study was conducted to determine the distribution and abundance of reptiles and amphibians in the forest and the adjacent farmlands in Kakunga-Mukangu region of the Kakamega Forest National Reserve. It also sought to determine the perceptions of the local community towards conservation of herpetofauna in the region. The data was collected between January and April 2017 using standardized time constrained searches, drift fence and pitfall trapping methods. In addition, a questionnaire survey distributed to 60 households in the Kakunga-Mukangu region was used to determine familiarity and perceptions of the community towards reptiles and amphibians. A total of 136 individual herpes were recorded including 7 species of reptiles and 5 species of amphibians belonging to 8 genera. *Trachylepis megalura* was the most abundant species of reptiles and *Phrynobatrachus natalensis w*as the most abundant species of amphibians. Most of the species were observed in the primary forest (29.41%) whereas the least abundance of the species was observed near or within aquatic habitats (8.82%). All the respondents (100%) were aware of the presence of various kinds of reptiles and amphibians in the Kakunga-Mukangu region of the Kakamega Forest. Lizards and snakes were the commonest herpes as indicated by 48.33% and 40.00% of the respondents respectively. The study established that negative values were widespread in the community. Herptiles such as the snakes that were considered as dangerous by the majority of the communities were also least liked and enjoyed conservation support by the smallest proportion of the community members. The study established the need to enlighten the local community about the positive values of herpetofauna in the region.
Keywords: Herpetofauna, Diversity, Local community, Attitude, Perceptions, Benefits, Threats

INTRODUCTION

Biodiversity has an extreme importance in supporting life on Earth, which includes thriving human activities such as medical practices and food production (Urbina-Cardona, 2008). The substantial decline in herpetofaunal abundance and diversity is now a well-known fact among conservation biologists. The Global Amphibian Assessment and the Global Reptile Assessment have expressed serious warning in regards to recent, alarming statistics (Urbina-Cardona, 2008). Worldwide, 32.5% and 22% of amphibian and reptile species, respectively, are endangered (Canavero *et al.,* 2010), and current trends suggest even more species could become threatened in the near future. Furthermore, most forests in Africa remain unexplored for herpetofauna. Given the rampant rate of forest destruction and insecurity, there is the danger of many species of reptiles and amphibians disappearing before they are documented.

Conservationists are concerned about reptiles and amphibians because they are predators; acting as primary and secondary carnivores on insects some of which are crop pests or disease vectors (Behangana, 2004; Jena, *et al.,* 2013). The ecological effects of their decline cannot be gainsaid. Amphibians' decline leads to ecosystem level effects, including changes in the global algal community structure and primary; production, altered organic matter dynamics, changes in other consumers such as aquatic insects and riparian predators; and reduced energy transfers between streams and riparian habitats (Schneider *et al.,* 2001; McCallum, 2007).

In East Africa, most of the forests and forest fragments remain partly explored. These forests include the Eastern Arc Mountains (Howell, 1993; Kifcon, 1995;) and forests associated with the Guinea-Congolian forest such as Budongo, Bwamba, Kibale, Bwindi, Mbira and Mt. Elgon in Uganda (Vonesh, 2001) and the Kakamega Forest in western Kenya (Wagner and Böhme, (2007). Kakamega forest is the easternmost part of the Guinea-Congolian tropical rainforest system (Clausnitzer, 2005). It has a very large diversity and zoogeographical value.

A number of studies on reptiles and amphibians in Kakamega Forest and other parts of Kenya have been done, (Böhme *et al.,* 2005; Wagner and Schmitz, 2006; Wagner and Böhme, 2007). However, as noted by Ali *et al.,* (2018) it is difficult to assess what portion of herpetiles' populations are experiencing significant decline. That is why baseline studies are necessary to declare conservation status of these taxa in any region

that they occur. In this study, we consider the important role that local ecological knowledge (TEK) plays in biodiversity conservation. Gorenflo *et al*., (2012) argued that continued loss of biodiversity is closely linked to erosion of cultural diversity. Besides, not all animal species, whether endangered or not, would be appreciated by humans. Therefore, ethnoherpetological studies are necessary. According to Ceríaco (2012), ethnoherpetology is the study of people's relations with and knowledge about reptiles and amphibians. Such studies enable us to expand knowledge about a species' occurrence and their spatial and temporal dynamics. Importantly, the studies promote conservation of a species through social action.

The aim of this paper is to provide additional information about the abundance of reptiles and amphibians in Kakunga-Mukangu region of Kakamega Forest in Kenya. In addition, the study focused on examining the level of knowledge and attitude of the local community towards reptiles and amphibians and their conservation

METHODOLOGY

Study Area

Kakamega Forest is situated in the Kakamega County, near Kakamega Town in the formerly Western Province of Kenya. The forest extends from 0°10' and 0°21 N to 34°47' and 34°58'E, covering an area of 240 km^2, of which only 44.55 Km^2 is protected by law (Wagner & Böhme, 2007; Mitchell, 2004). It is Kenya's last remnant of Guineo-Congolian rain forest that once spanned the continent. The area receives average of 1200 mm to 1700 mm of rainfall per year. The highest amount of rainfall is experienced in April and May with a slightly drier June and a second peak roughly in August to September (short rains). January and February are the driest months. Temperature is fairly constant throughout the year, ranging between 20ºc to 30ºC.

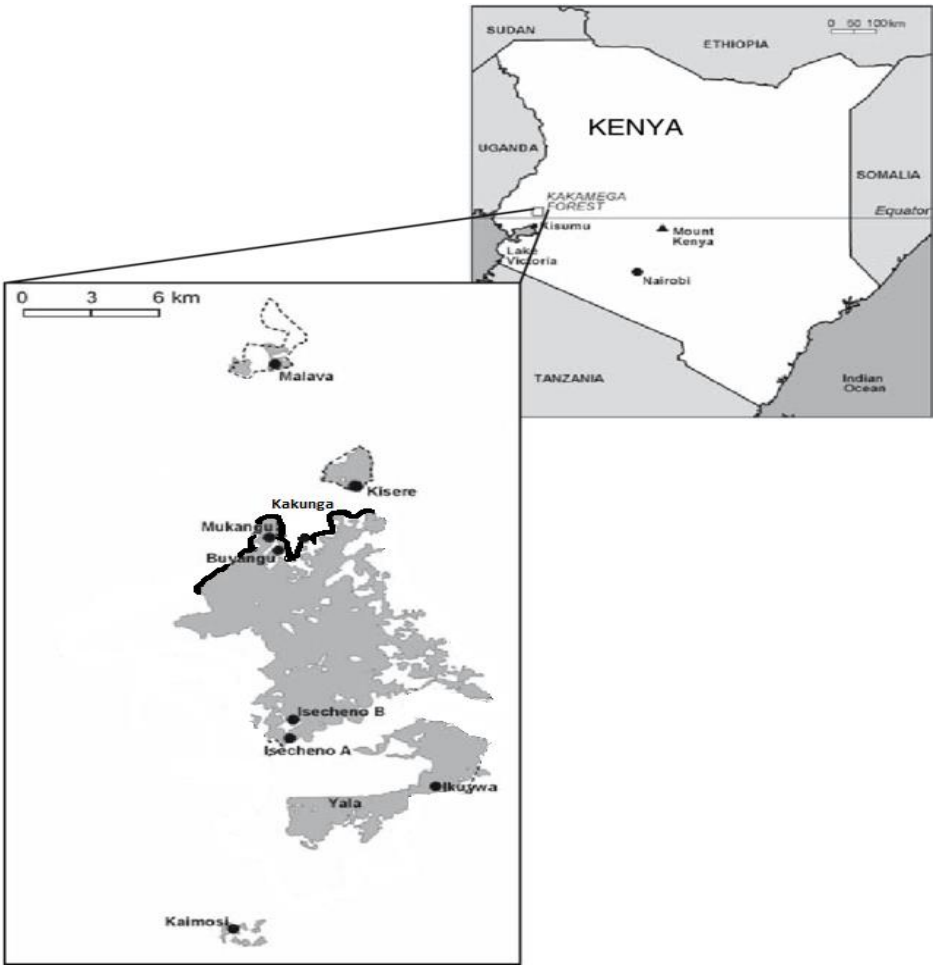

Figure. 1: Map of Kenya indicating location of Kakamega Forest.
(Source: Adopted and modified from Farwig, Braun and Böhning-Gaese, 2008).

METHODS

This study was conducted between January and April 2017. A combination of visual encounter surveys and drift fences with pitfall traps for sampling the herpetofauna were used. The visual encounter surveys (VES) involved timed constrained searches with two researchers walking and intensively searching within all possible herpetofaunal microhabitats such as under leaves, debris, decomposing tree stumps and logs, on tree, shrubs, bushes and wetlands for duration of 1 hour (Eekhout, 2010). In addition, linear drift fences of 5 meters long with 10 liter bucket pitfalls at both ends as described by Eekhout, (2010) were used.

The buckets were placed such that there was one bucket on either side of the fence. Only one trap station was established in each habitat type. Traps were checked daily, shortly after sunrise (between 6:00 am and 7:00 am) and late in the evening (between 6:00 pm and 7:00 pm).

For each species encountered, the scientific name, sex and life stage was recorded. The abundance of reptiles and amphibians was expressed in terms of the number of individuals observed. Additionally, the weather at the time of collection was recorded along with time, microhabitat type and behaviour of the herpetofauna.

Questionnaires with both closed-ended and open ended questions were used to determine the knowledge and views of the local community concerning reptiles and amphibians in the Kakunga-Mukangu region. The questions covered socio-demographic profile of the respondents, familiarity and importance of the amphibians and reptiles to the local residents as well as their views concerning conservation of herpetofauna. The target population comprised of about 240 households that inhabit a range of ≤1km from the forest boundary within the villages of Mukangu, Buyangu, Ivakale, Kambi and Kakunga.

Community livelihoods in this region are based on crop and livestock production with households that form villages. To ensure effective coverage of the villages, systematic random sampling technique was used whereby after obtaining informed consent from the village elders, the first household was marked and then every fourth household was included in the sample. Each household was considered a sampling unit, and each questionnaire was restricted to 1 respondent per household (preferably the oldest one). A total of 60 questionnaires were administered which made up about 25% of the target households.

Data Analysis

Data analysis was conducted using the Statistical Package for Social Sciences (SPSS) PC version 16.0 (SPSS 2007). To examine the variability in abundance between amphibians and reptiles we used independent t-test. Chi-square was used explore how knowledge and perceptions varied with each kind of herpetofauna.

RESULTS

Abundance and Distribution

By the end of the sampling period 12 species comprising 136 reptiles and amphibians were observed (Table 1). An independent-samples t-test was conducted to compare abundance of reptiles (M=15.286, SD=13.036) and amphibians (M=5.800, SD=5.357) observed. There was no significant difference in the abundance t (10) =1.516, 0.161). However in terms of absolute proportions, reptiles observed (78.68%) was significantly higher than amphibians (χ^2=33.640; df = 1; p = 0.001) whose proportion was 21.32%.

Apparently, most of the species were observed in the primary forest (29.41%) whereas the least abundance of the species was observed near or within aquatic habitats (8.82%). The results indicate significant variation in abundance of the herptofauna across the five habitat types that were considered in this study (χ^2 = 11.253; df= 4; p= 0.24). Information on Table 2, shows that the most dominant species in the primary forest was the *Trachylepis varia* (Variable skink). Within the secondary forest, the most dominant species was the stripped skink (*Trachylepis megalura*) which was also the most dominant species within the forest glades and forest edges. Toads were the most dominant herpetofauna in the aquatic habitats.

Knowledge and Attitudes the Local Community about Herpetofauna in Kakamega Forest

All the respondents were aware of the presence of reptiles and amphibians in the Kakunga-Mukangu region of the Kakamega Forest. Results showed that most of the respondents were knowledgeable about snakes, lizards and frogs found in Kakamega Forest.

The differences between respondents who were knowledgeable and those were not was statistically significant for snake (χ^2 = 50.581; df =1; p = 0.000, and frogs (χ^2= 58.065; df=1; p = 0.000) whereas 100% of the respondents said that they knew lizards. Although not statistically significant (χ^2=5.226; df =1; p=0.611), majority of the respondents claimed that they were not aware of the presence of tortoises in the area.

Table 1: Abundance and distribution of reptiles and amphibians in major habitats types in Kakamega Forest

Common name	Scientific name	Count	%
Reptiles			
Forest cobra	*Naja melanoleuca*	1	0.74
Stripped skink	*Trachylepis megalura*	35	25.74
Variable skink	*Trachylepis varia*	32	23.53
Tropical house gecko	*Hemidactylus mabouia*	8	5.88
Brook's gecko	*Hemidactylus brooki*	12	8.82
Jackson's forest lizard	*Adolfus jacksoni*	13	9.56
Peter's writhing skink	*Lygosoma afrum*	6	4.41
Sub-total		**107**	**78.68**
Amphibians			0.00
Natal puddle frog	*Phrynobatrachus natalensis*	*3*	2.21
Mascarene rocket frog	*Ptychadena mascareniensis*	2	1.47
Dwarf puddle frog	*Phrynobatrachus mababiensis*	*3*	2.21
Angolan river frog	*Rana angolensis*	6	4.41
Kisolo toad	*Bufo kisoloensis*	15	11.03
Sub-total		**29**	**21.32**
Total		**136**	100.00

Table 2: Abundance and distribution patterns of herpetofauna in five habitat types in Kakunga-Mukangu region of the Kakamega Forest

Animal species	Primary forest	Secondary forest	Forest edges	Glades	Near water /wetland	Total
Reptiles						
Striped skinks	5	9	9	12	0	35
Jackson's forest lizards	3	1	8	0	1	13
Tropical house geckos	5	2	1	0	0	8
Brook's geckos	7	3	2	0	0	12
Variable skinks	9	4	3	15	1	32
Peter's writhing skink	3	1	2	1	0	6
Forest cobra	0	0	0	0	0	1
Amphibians						
Toads	3	1	0	2	9	15
Frogs	5	3	1	2	1	14
	8	4	1	4	10	29
Total	**40**	**24**	**26**	**32**	**12**	**136**
Percentage	**29.41**	**17.65**	**19.12**	**23.53**	**8.82**	**100**

The respondents varied significantly ($P<0.05$) on their views about the sites where they normally see the various kinds of herpetofauna. In most of the cases, the informants gave multiple responses about the habitats. However, it can be inferred from information on Table 3 that most of the species are seen within the forest as compared to other habitat types. According to the respondents, lizards and snakes were the commonest herpes in the forest with 48.33% and 40.00% respectively. However, it was evident that these species were also quite common on farms. Most of the sightings of tortoises were also within the forested area as indicated by 23.33% of the respondents. In the case of frogs and toads, it was clear that most of these herpes were encountered within the farms 56.67% and the forest 36.67%.

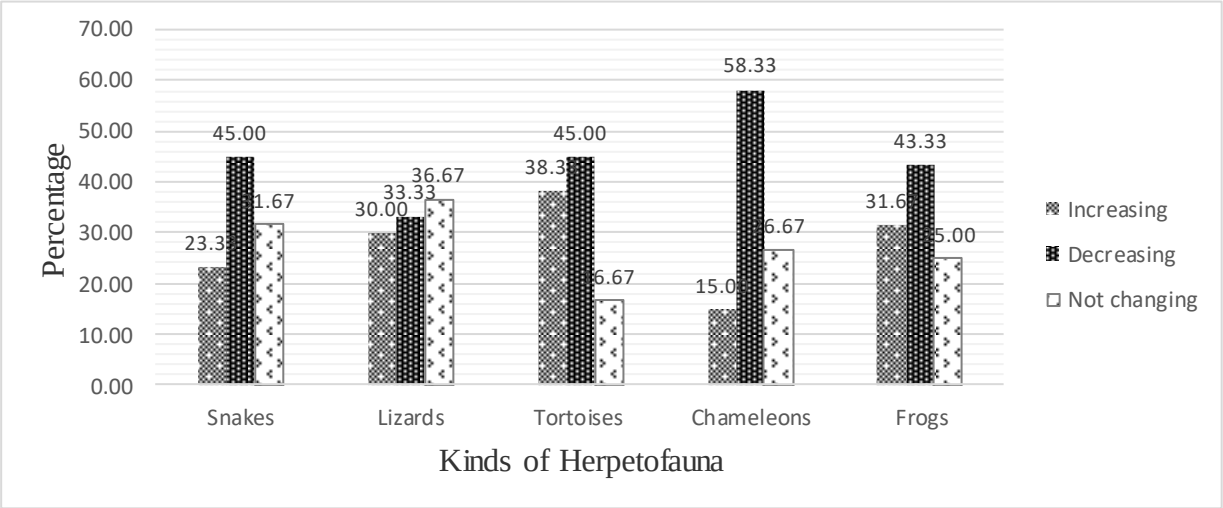

Figure 2: Local community knowledge about kinds of herpetofauna found with the Kakunga-Mukangu region of the Kakamega Forest

Table 3: Local community knowledge about presence of herpetofauna in different habitat types

Kind of hepetofauna	Forest	%	Farm	%	House	%	Water	%	Differences acrosshabitats
Snakes	24	40.00	12	20.00	3	5.00	2	3.33	χ^2 =30.512; df=3; p=0.001
Lizards	29	48.33	22	36.67	17	28.33	9	15.00	χ2 =11.052; df=3; p=0.011
Tortoises	14	23.33	11	18.33	1	1.67	4	6.67	χ2 =14.533; df=3; p= 0.002
Chameleons	12	20.00	17	28.33	1	1.67	3	5.00	χ2 =20.697; df=3; p=0.001
Frogs	22	36.67	34	56.67	12	20.00	19	31.67	χ2 =11.621; df =3; p=0.009

The respondents varied significantly on their perception about the trend in the abundance of snakes in the study area (χ^2 = 7.340; df=2; p = 0.025). According to the majority of the respondents (45.00%), the abundance of snakes in the area has been decreasing. In the case of lizards, the informants did not vary significantly about the trend in the abundance of the species (χ^2 = 0.740; df=2; p = 0.691) but a majority of the respondents felt that the abundance was not changing. Most of the respondents also felt that the number of tortoises, chameleons and frogs and toads were deceasing in the area. The differences in the perceptions were statistically significant for chameleons (χ^2 = 29.540; df=2; 0.000) and frogs (χ^2 = 12.740; df=2; p=0.002) but not for the tortoises (χ^2 = 4.940; df=2; p=0.085).

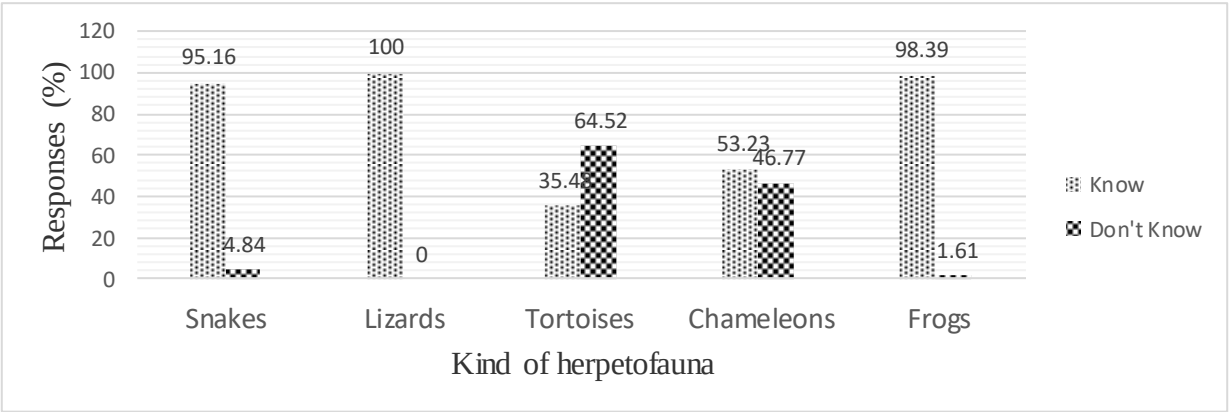

Figure 3: Local community perception about the trend in the abundance of reptiles and amphibians in the Kakunga-Mukangu region of the Kakamega Forest

Attitudes towards conservation

Apparently, with 53.33% chameleons and tortoises (45%) were the most likeable kinds of herpetofauna known by the local community in the study area whereas snakes were the least likeable herpetofauna species (35%). As shown by information in Table 4, most of the respondents (65%; n=39) revealed that they would like chameleons to be conserved whereas only 42% would like snakes to be protected and conserved. It was clear that tortoises and frogs were considered harmless by majority of the respondents.

Table 4: A summary of the perception of the local community about conservation of herpetofauna in Kakunga-Mukangu region of the Kakamega Forest

Kind of herpetofauna	1. Do you like the animal?				2. Do you like the animal to be protected/ conserved?				3. Is the animal dangerous?			
	Yes		No		Yes		No		Yes		No	
	n	%	n	%	n	%	n	%	n	%	n	%
Snakes	21	35.00	39	65.00	25	41.67	35	58.33	42	70.00	18	30.00
Lizards	26	43.33	34	56.67	32	53.33	28	46.67	29	48.33	31	51.67
Tortoises	27	45.00	33	55.00	33	55.00	27	45.00	10	16.67	50	83.33
Chameleons	32	53.33	28	46.67	39	65.00	21	45.00	12	20.00	48	60.00
Frogs	13	21.67	47	78.33	26	43.33	34	56.67	12	20.00	48	80.00

Threats facing reptiles and amphibians

The results on threats causing decline in reptiles and amphibians showed that most of the respondents felt that killing and harassment by the community members was the major threat at 83% (Table 5). A substantial proportion of the respondents also felt that deforestation and recurrent droughts contributed to the decline of the species.

Conservation measures towards protecting reptiles and amphibians

The 55% felt that there was need to establish more areas where these species could be protected (Table 6). Relatively significant number of the respondents also suggested the need for conservation awareness (32), active protection of key habitats such as wetlands (25%) and rehabilitation (reforestation) of the degraded forest areas (18%).

Table 5: showing the results of the respondents on the threats key facing reptiles and amphibians

Type of threat	Number of respondents	Percentage
Hunting/killing/harassment	50	83.33
Habitat deteriorations/deforestation	17	28.33
Drought/climate change	18	30.00
Forest fires	3	5.00
Environmental and habitat pollution	2	3.33
Over exploitation	1	1.67

Table 6: showing conservation measures towards protecting herpetofauna

Conservation strategy	Respondents	Percentage
Awareness creation	19	31.67
Enforcement of laws and policies	3	5.00
Reforestation	11	18.33
Protection of wetlands and other habitats	15	25.00
Mitigating pollution	3	5.00
Establishment of more conservation areas	33	55.00
Local people to participate in their conservation	3	5.00

DISCUSSION

Abundance and distribution

The study was able to document seven species of reptiles and five species of amphibians. These numbers of species were much fewer than those recorded by Wagner and Böhme (2007) who recorded 25 amphibians, one turtle, 22 lizards and 36 snake species from within the forest and its immediate environment. This could be contributed to the differences in the sampling effort and the geographical scope of the study. *Trachylepis megalura* was recorded as the most abundant species of the reptiles while *Phrynobatrachus natalensis* as the most abundant species of the amphibians. *Naja melanoleuca* (Forest cobra) was recorded once. The occurrence of a number of herpetofauna has been related to the presence or absence of specific habitats for vital activities such as nesting, hibernation, estivation, foraging, adult residency, and terrestrial dispersal (Ali *et al*., 2018; Boace *et al*., 2010; Whitfield, 2003). Besides, the data supports the fact that heterogeneous habitats have better potential to support numerous reptile species (Tsetan & Ramanibai, 2011). Though it was expected that most of the species recorded would be from within the forest edges, we established that most of the herpetofauna were found within the primary forest itself. This underscores the significance of the protecting the integrity of the natural forest. *Trachylepis megalura* and *Adolfus jacksoni* were the most dominant species within the forest edge which indicates that the forest edge matrix is an ideal habitat for these species.

As documented by Wagner and Böhme (2007), most of the amphibians such as *Phrynobatrachus mababiensis, Rana angolensis* and *Bufo kisoloensis* were observed within wetlands. Amphibians need both terrestrial and aquatic ecosystems to survive and this makes them very vulnerable to habitat changes (Becker *et al.*, 2009; Hussain & Pandit, 2012). Since, habitat loss, degradation and fragmentation, are the biggest threats to amphibians, affecting nearly 4,000 species worldwide (Stuart et al., 2004, 2008), there is urgent need to continuously monitor the diversity of these highly sensitive species in Kakunga-Makangu region of the Kakamega Forest.

Local community awareness and perceptions

The local community could identify the various species of amphibians found within the Kakunga-Mukangu region of the Kakamega Forest. Notably, majority of the inhabitants were familiar with snakes, tortoises and chameleons which were not documented during our field studies. As noted by Pooley (2000), analyzing the differences between local ecological knowledge and scientific knowledge represents an important opportunity for conservation research.

The study established that the local community was aware of the different habitats where the herpetofauna are found. For instance most of the lizards, snakes and snakes were encountered in the forest. Although, it was evident that these species were also quite common in the farms, the findings suggest that the community was aware of the significance of the forest in sustaining the occurrence and survival of these species. The information given by the community availed critical information on the current geographic distribution of herpes in the study area.

Attitudes and perceptions towards herpes

The respondents' reports showed that snakes, frogs, tortoises and chameleons were considered as dangerous. Previous studies have shown that people are averse to animals that they consider as dangerous (Davey *et al*., 2003; Shepard, 1997). The study showed that tortoises and chameleons were the most 'loveable' herptiles in the region. Little is known about people's attitude towards amphibians but according to Shepard, (1997) affection or dislike towards organisms may depend on their symbolic image which, is influenced by culture and tradition. Several studies have also shown existence of a strong bias towards relatively large, charismatic animal species which are most often mammals and birds (Bonnet *et al.*, 2002; Clucas *et al.*, 2008; Seddon *et al.*, 2005; Trimble &Van Aarde, 2010; Nemésio et al., 2013). In addition, age, gender, education level and distance from the conservation area influences attitudes and perceptions towards wild animals (Shibia, 2010). In this study, these factors were not examined but the negative value- 'dangerous' and how this value related to the perceptions that the animal is 'likeable' and 'should be conserved' was considered. In this case we found that herptiles such as the snakes that were considered as dangerous were also least liked. They also enjoyed conservation support by the smallest proportion of the respondents. This observation is consistent with the observations by Pooley (2000) who found that what people feel and believe about the environment determines their attitudes towards it. In this case, the negativistic attitude towards snakes is of great concern given that only a single individual of the reptile was documented in the field.

Threats and conservation measures

According to the respondents, killings, habitat deterioration and climate change were found to be the leading causes of herpetofaunal population decline in region. However, majority of the respondents suggested that environmental education and

protection of their habitats would help in conserving these species.

CONCLUSION

The study was carried out with the objective of contributing to the knowledge on the diversity and abundance of herpetofauna in Kakamega Forest and more importantly provide a baseline data on the level of awareness of the local community about herpetofaunal species in the area. Based on both the ecological surveys and the questionnaire surveys, the primary forest harbours the highest abundance of herpetofauna in the study area. This underscores the significance of the protecting the integrity of the natural forest. The study establishes the need to enlighten the local community about the positive values of herpetofauna in the region. It would be really encouraging if future studies will show a positive attitude towards conservation herpetofauna by the indigenous people.

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